water resources FOR THE DELAWARE RIVER BASIN PLAN

a common vision for a common resource a common vision for a common resource

SEPTEMBER 2004

The Delaware River Basin Commission

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Organizations

- Aqua America
- Association of New Jersey Environmental Commissions
- Aventis Pasteur
- Bayshore Discovery Project
- Chester County Water Resources Authority
- City of Philadelphia Water Department
- Delaware Department of Natural Resources and Environmental Control
- Delaware Estuary Program
- Delaware Farm Bureau
- Delaware Nature Society
- Delaware River Foundation
- Delaware River Port Authority
- Delaware Riverkeeper Network
- Delaware Valley Regional Planning Commission
- DuPont Company
- Exelon Generation, LLC
- Federal and State Emergency Management Agencies
- Kittatinny Canoes
- Lejeune Properties
- Merck and Company
- Merrill Creek Reservoir Owner's Group
- Monroe County PA Conservation District
- Montgomery County Planning Commission, PA
- National Park Service
- National Resources Conservation Service
- National Weather Service
- New Jersey Department of Environmental Protection
- New Jersey Future
- New York City Department of Environmental Protection
- New York State Department of Environmental Conservation
- Partnership for the Delaware Estuary
- Pennsylvania Department of Environmental Protection
- Pike County PA Soil Conservation District
- Pocono Mountain Vacation Bureau
- PSEG Services Corporation
- Rohm & Haas
- Stroud Water Research Center
- The Nature Conservancy
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- U.S. Geological Survey
- Upper Delaware Council
- Upper Pittsgrove Township NJ
- Warwick Township, Water and Sewer Authority PA
- Wildlands Conservancy

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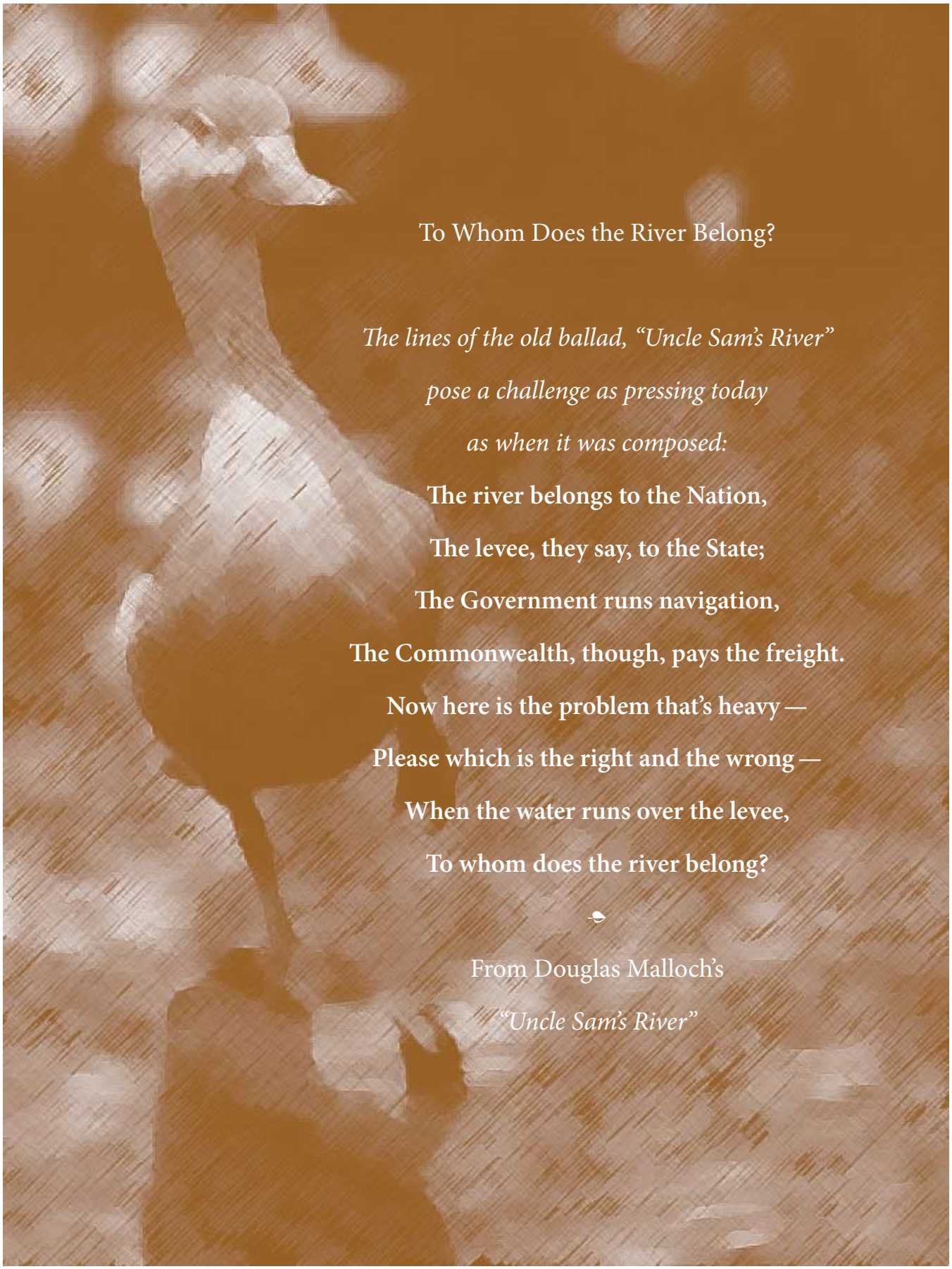
It is the intent of this Water Resources Plan for the Delaware River Basin (Basin Plan) to engage all entities with responsibility or interest in water resources, as well as all whose actions affect our water resources, in partnerships for the protection, enhancement and efficient use of water.

The Basin Plan serves as a non-binding guide to the signatory parties and the Basin community. This Plan does not create any legal rights, nor is it intended to benefit any person or class of persons. The provisions of the Basin Plan are not enforceable against any of the signatory parties, their agencies, political subdivisions, officers, or employees or any other person. This Plan is not an Executive Order or regulation, does not have the force of law, and does not alter any existing legal requirement.



To Whom Does the River Belong?

The lines of the old ballad, "Uncle Sam's River"
pose a challenge as pressing today
as when it was composed:

The river belongs to the Nation,
The levee, they say, to the State;
The Government runs navigation,
The Commonwealth, though, pays the freight.
Now here is the problem that's heavy —
Please which is the right and the wrong —
When the water runs over the levee,
To whom does the river belong?

From Douglas Malloch's
"Uncle Sam's River"

INTRODUCTION

A Challenge and a Vision

Water flows through every aspect of our lives. We depend on it for transportation, for power, for commerce, for inspiration—indeed, for life itself. Too often this precious resource is taken for granted, or guarded so jealously that its fluid nature is forgotten. Can we meet the challenge of safeguarding our water resources now and for generations to come? This Plan is an attempt to meet that challenge, to take into account the many aspects of our water resource and the many needs it must meet, and to weave them into a unifying vision for the Delaware River Basin.

In 1769, a visiting Englishman commented on the "mess" in the Delaware River off Philadelphia — a mess that by World War II had become a stew of toxins that tarnished ships' metalwork and sickened sailors. The water lacked enough oxygen to support fish and other aquatic life. However, the words of an old ballad posed a vexing challenge: "To whom does the river belong?" Management efforts were piecemeal, driven by conflicting interests over water diversions, dam construction, and fishing rights. It would take half a century, two Supreme Court decrees, two record droughts and one record flood to bring about a sense of shared ownership of the vital resource that is the Delaware River and its tributaries.

In September 1961, President Kennedy and the four Basin state governors signed the Delaware River Basin Compact, creating the Delaware River Basin Commission (DRBC), marking the first time in U.S. history that the federal government and a group of states joined together as equal operating partners in a river basin planning, development, and regulatory agency. Through coordinated resource management efforts, substantial improvements have been made in the quality of our shared waters. By 1981, for example, the DRBC's pollution abatement efforts resulted in a 76% reduction in the amount of oxygen-demanding wastes being discharged into the Delaware River estuary, the tidal stretch of the river between Trenton and the Delaware Bay.

Today, the Delaware River supports year-round fish populations, offering excellent small mouth bass, striped bass, shad, and trout fisheries, once again sustained by the water's oxygen. Marinas are being built on the river banks, along with bike trails and parks. The upper reaches of the river have received national recognition for their scenic and recreational value, including excellent water quality. Because conditions and needs are constantly changing, we must continue to identify new problems and work to maintain and improve conditions through planning and cooperative management. Meeting multiple needs will remain a challenge. But we have come a long way towards recognizing common concerns for our common resource. This Plan is intended to guide our efforts.

Introduction

We let a river shower its banks with a spirit that invades the people living there, and we protect that river, knowing that without its blessings the people have no source of soul.

Thomas Moore
The Re-Enchantment of Everyday Life

The Challenge

On September 29, 1999, the Governors of the four Delaware River Basin states (Delaware, New Jersey, New York and Pennsylvania) signed a resolution challenging the Basin community to develop a unifying vision: a comprehensive Water Resources Plan for the Delaware River Basin.

Water resources planning and management cut across traditional political and programmatic boundaries. Characteristics of the Delaware River Basin that present challenges to the development and implementation of a unified water resource plan are as follows:

Physical Attributes: The river and its tributaries drain 13,539 square miles of varied landscape with distinct topography, soils, hydrology, natural habitat, development patterns, and economic interests.

- **This challenges the development of a Plan to address a variety of water resource issues through scale-appropriate resolution and implementation actions. Solutions need to be appropriate for local conditions as well as regional needs.**

Political Fragmentation: The Delaware River is the political divide between New York, Pennsylvania, New Jersey and Delaware. The land within these four states is further subdivided into 42 counties, and 838 cities, towns, boroughs and townships. The multiplicity of governmental units is further compounded by a division of

REASONS FOR DEVELOPING A BASIN PLAN

- To establish a unifying vision for water resources management in the Basin
- To identify a set of objectives and strategies for achieving goals and desired results
- To better coordinate ongoing efforts to preserve, protect, and enhance the water resources of the Basin and the ecological, social and economic benefits they provide
- To identify additional needs for more effective water resources management
- To articulate roles and responsibilities
- To recognize and account for all water resource uses in decision-making
- To identify and consider the relationship between land use and water resources in decision-making
- To invite all levels of stakeholders into the process of water resources management
- To continue the successes and progress of the last 40 years through the next 30 years

responsibility for water resource-related programs at the federal and state levels and a wide array of private organizations and individuals involved in water resource use, distribution, treatment and protection.

- **Institutionalizing coordination and cooperation among these numerous entities may be the greatest challenge.**

Multiple Pressures on the Resource: In all, nearly 15 million people, or roughly 5% of the U.S. population, rely on the ground and surface water resources of the Basin. New York City relies on the Delaware system for roughly half of its water supply and a lesser amount is exported for use in areas of New Jersey outside the Basin. That water supply source is a basin that covers only four tenths of a percent of the continental U.S. and includes some of the nation's most quickly developing counties. Three quarters of the non-tidal river — about 150 miles — is included in the National Wild and Scenic River System.

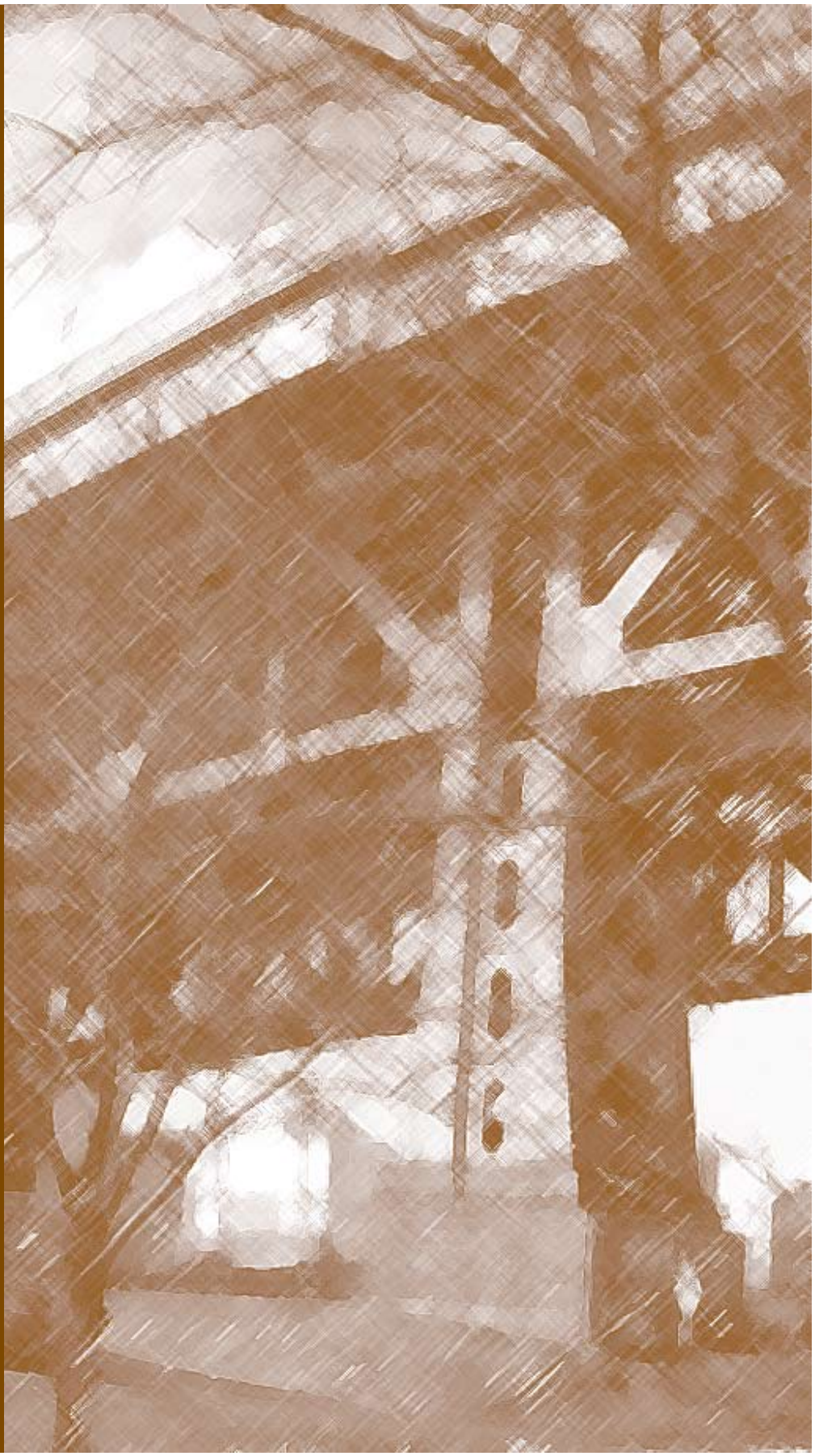
- **Sustaining current uses, planning for future populations and economies, and protecting the landscapes critical for water resources depends on knowledge and the ability to educate current and succeeding generations to be resource stewards.**

The Unifying Vision: In response to the Governors' challenge, the DRBC convened the Watershed Advisory Council. Composed of people representing a wide range of stakeholders, this group has forged a unifying vision for the Basin, a goal-based plan to guide policy and action to achieve the following results:

- *Supply* — Managing both the quantity and quality of the Basin's waters for sustainable use
- *Waterways* — Managing the system of waterway corridors to reduce flood losses, improve recreational experiences, and to protect, conserve and restore riparian and aquatic ecosystems
- *Land Management* — Integrating water resource management considerations into land use planning and growth management while recognizing the social and economic needs of communities
- *Cooperation* — Strengthening partnerships for the management of water resources among all levels of government, the private sector, and individuals sharing an interest in sustainable water resources management
- *Stewardship* — Providing opportunities to enhance appreciation and commitment to the protection, improvement and restoration of the Basin's water resources

"In the end,
our society will be
defined not only
by what we create
but by what we
refuse to destroy."

John Sawhill



THE BASIN PLAN

Purpose, Structure and Use

The purpose of the Basin Plan is to provide a unified framework for addressing and redressing new and historic water resource issues and problems in the Delaware River Basin. The Plan emphasizes an integrated approach, recognizing for example, that water supply and water quality cannot be managed separately; that ground water and surface water are two aspects of the same resource, separated in time and space, but fundamentally interrelated. Integrated management means considering all aspects of the water resource in decision-making. Conversely, it means recognizing that a wide range of decisions — not just those traditionally associated with water management — can affect our water resources. This Plan is based on the premise that the river that divides us also brings us together.

Organization and Use of the Plan: The Plan sets a direction for policy and management decisions over the next 30 years and should be used as a guide for policy setting, decision-making and prioritizing actions originating from governmental units, private entities, organizations, and individuals. It forms a framework within which existing and new programs can be incorporated and coordinated for effective results. It also may to lead to new areas of research and study to support the achievement of the Desired Results.

To a large extent this Plan builds on the successes of a variety of existing and ongoing efforts, including the Comprehensive Conservation and Management Plan (CCMP) for the Delaware Estuary, and the management plans for the 152 miles of the Delaware River that are included in the National Wild and Scenic Rivers System.

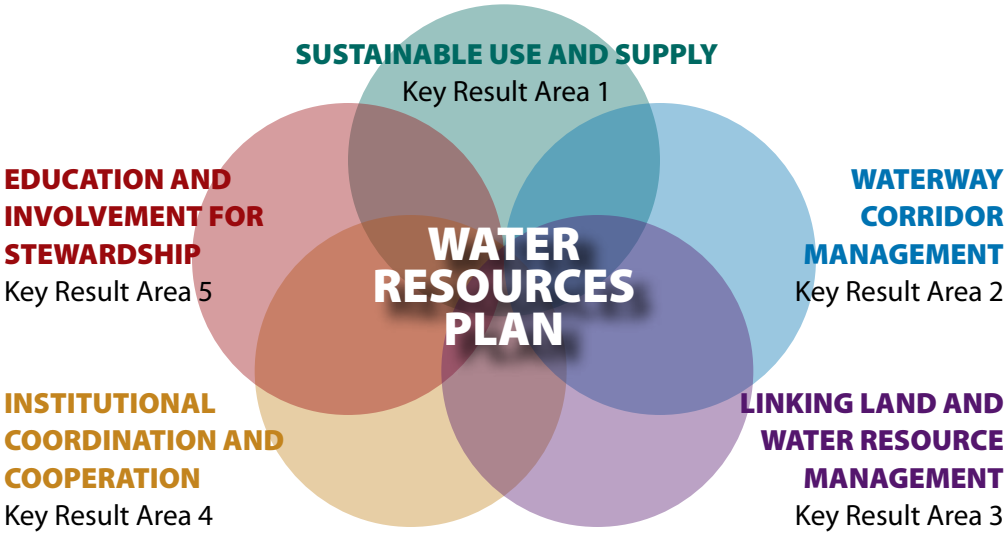
The Plan is prefaced by a set of Guiding Principles that form the foundation for water resource management. Policy changes and actions to implement the Goals and Objectives of this Plan should be judged against the Guiding Principles.

The main body of this Plan is divided into five interrelated Key Result Areas. As Figure 1 illustrates, although unique in some aspects these areas are interrelated and attention to each of the five areas of concern is essential for the improvement of water resources management. An outcome statement — the Desired Result — is articulated for each Key Result Area, with a set of Goals and Objectives essential to achieving the Desired Results for the Basin's water resources. The structure is illustrated in Figure 2.

The narrative for each Key Result Area identifies the water resource issues related to the Desired Result and how the concept of integrated management should be applied. The text accompanying each Goal explains the major tasks and challenges for achieving the Goal, and provides background for a set of Objectives. Objectives, those actions necessary for achieving the Goals, are listed in the "Matrix of Goals and Objectives" (Matrix).

Each Goal and Objective has an identification number to relate it to a principal Key Result Area. The number is strictly for convenience and reference and does not imply any priority within this Plan. The Matrix also includes proposed milestones, dates and outcomes for each Objective and suggested time frames for interim and long-term results. The final column cross-references other Goals with which a

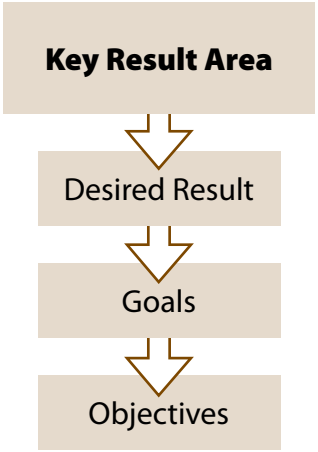
Figure 1: The Five Key Result Areas



given Objective is associated, because Objectives can relate to more than one Goal. The interrelationships noted in the Matrix highlight the application of integrated management, the theme of this Plan.

The Importance of Integrated Management: The concept of integrated management is used throughout the Plan. Integrated management means acknowledging links among topics or concerns and combining or incorporating this consideration when assessing options, and developing policy and management plans. Like water itself, managing our water resources must infiltrate everything we do because the results of our actions are interconnected. Integrated management motivates the development of a greater range of alternatives and can be more cost effective than a traditional single-issue approach to resource management. An explanation of integrated management in the context of each Key Result Area is found in the narrative for each section. In the Matrix, Objectives are listed under the Goals with which they are most directly associated. The actions required to achieve the Goals are numerous, varied and may seem disconnected from one another. But we know that the results of our actions are not isolated. In the Matrix, the column entitled "Supports Goal" lists other Goal(s) associated with each Objective, underscoring the interrelated nature of water resources management. This Plan provides a framework for understanding the many connections — particularly those linking water and land — and for integrating our actions to achieve a shared vision for the Delaware River Basin.

Figure 2: Water Resources Plan Organization



The Basin Plan Map: The "Watershed Regions of the Delaware River Basin" map, which accompanies this Plan, illustrates the river's unifying nature by assembling the Basin's many watersheds — areas drained by a single waterway or watercourse — into groups, or sub-basins, and by gathering sub-basins into regions. The watershed groupings are based on considerations of hydrologic boundaries, physiographic provinces, development patterns and current cataloguing of water quality data.

The map is useful for characterizing and assessing baseline conditions, for prioritizing issues, for developing regionally and locally specific strategies, and for forming partnerships for implementation. Like this Plan, the map is designed to help us think outside traditional political and programmatic boxes. The map encourages us to think in terms of our watershed address — of our relationship to the river, its tributaries and watersheds, and how our plans and actions depend on and affect these resources.

Moving from Plan to Action: The final section of the Basin Plan document discusses the actions necessary to improve water resources management, and to make the Desired Results of this Plan a reality. Roles and responsibilities will be described more clearly when specific implementation strategies are developed, but the actions that each governmental level, private sector entity and individual should explore are noted in the final section of this Plan.

The Resolution of 1999 that directed the development of the "Water Resources Plan for the Delaware River Basin" also directed calls for the development of a periodic report on progress. In order to account for progress, relevant indicators must be chosen, monitored and reported. Indicators help to assess how well the management strategies are working, and where additional efforts might be needed.

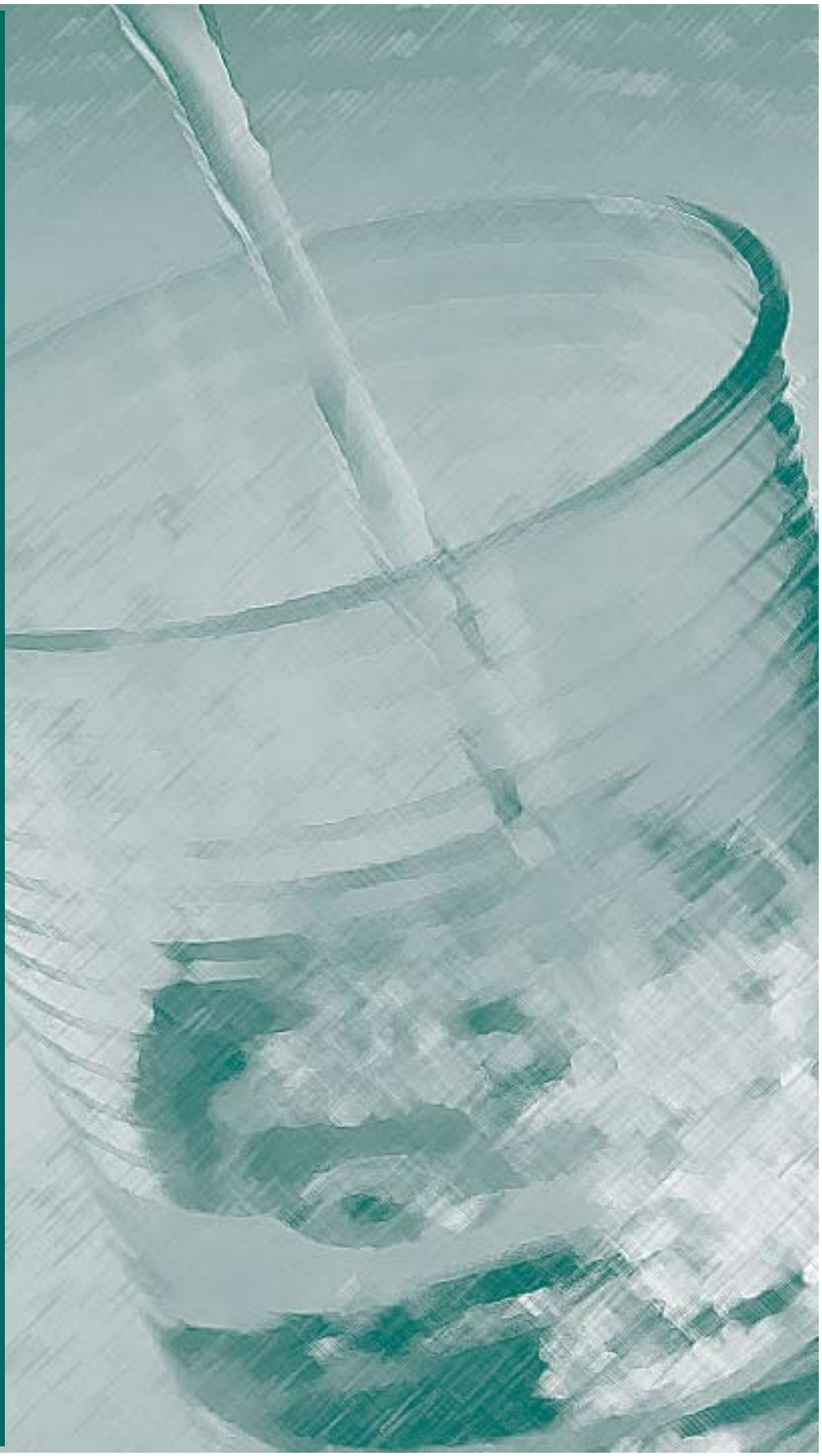
Guiding Principles

Actions to be taken to implement the Goals and Objectives of this Plan should be judged against these Guiding Principles.

1. Water is a precious and finite natural resource, it is essential to all life and vital to ecological, economic and social well-being.
2. The disparate distribution of water resources among watersheds poses a challenge to equitable allocation and use.
3. Prudent water management requires a commitment to ecological integrity and biologic diversity to ensure a healthy environment; to a dynamic economy; and to social equity for present and future generations.
4. The most effective way to eliminate pollution is to prevent it's occurrence.
5. Integrated management is crucial for sound results. When making water resource management decisions:
   - Link water quality and water quantity with the management of other resources
   - Recognize hydrological, ecological, social and institutional systems
   - Recognize the importance of watershed and aquifer boundaries
   - Avoid shifts in pollution from one medium to another and avoid creating a problem in a different location or environmental medium
   - Push the boundaries of technologic possibility while balancing economic constraints
6. Improved land management is essential for improving the condition of water resources.
   - Decision-making should be based on sound scientific principles and an understanding of the relationship between land and water resources
   - Effective integrated management requires coordinated planning and action by all levels of government including federal, regional, state, and local levels
   - Existing planning efforts can provide the foundation for improving land and water resources management
7. Individually and collectively, we are responsible for the stewardship of our water resources through their judicious use and management.
   - An informed public is vital to an improved environmental future
   - Public–private partnerships and enhanced cooperation are necessary for improved results
   - Successful decision frameworks are those flexible enough to encourage and adapt to innovations and new knowledge
8. Existing legal structures and laws provide the framework in which management decisions are made.
9. Decision-making should give due consideration to the policies and requirements in existing laws and the legal rights of persons and entities potentially affected by water management decisions.
10. Authority to make integrated management decisions shall be derived from existing law as applicable, and may entail modifying or enacting new laws.
11. Legal structures should be utilized that facilitate managing water resources within entire basins, watersheds, and aquifers, rather than on the basis of political jurisdictional boundaries, while continuing to respect the sovereignty of states and their political subdivisions.
12. In water resources management, preferable actions are those that are structured to accommodate and be consistent with:
    - Preservation and enhancement of ecological integrity
    - Sustainability
    - Feasibility
    - Resilience to natural variability

"Water runs like a river through our lives, touching everything from our health and the health of ecosystems around us to farmers' fields and the production of the goods we consume."

Peter Gleick
The World's Water



KEY RESULT AREA 1

Sustainable Use and Supply

Desired Result: *An adequate and reliable supply of suitable quality water to sustain human and ecological needs for the next 30 years.*

What does sustainable use and supply mean? An integrated approach to managing our water resources is necessary to meet current and future human and ecological needs. Competition for water to meet the needs of homes, cities, farms and industries is increasing. At the same time, the importance of water in the streams and rivers for environmental and recreational uses is also growing. It is necessary to ensure, for now and the future, that the demands we put on our water resources do not exceed what they can sustain.

Why is integrated management important? The Basin Plan advocates the integrated management of water resources. This means considering the many fundamentally interrelated aspects of the water resource in decision-making, including:

- Water quality and quantity
- Surface and ground water
- Demand and supply management
- Environmental, social, and economic dimensions
- Legal dimensions

Water quality and water quantity are interrelated characteristics. Traditionally, policy makers have addressed water supply and water quality as separate issues, even though they are fundamentally interrelated characteristics of the water resource. Poor water quality affects water supply by increasing the costs of treatment and, in some cases, rendering the water resource unsuitable for potable use. Reduced flows in streams may decrease both the capacity of streams to assimilate point and nonpoint source pollutants, and impair the suitability of water for downstream users and aquatic life. Persistent low flow conditions can lead to warmer water temperature, increased nuisance plant growth and algal blooms, and lower dissolved oxygen levels, causing stress and damage to native aquatic communities. During wet weather, stormwater runoff can increase the loadings of bacteria, sediment, salts, pesticides, nutrients, and hydrocarbons from the land. High flow conditions can also scour stream channels and damage the filtration ability of flood plains.

Surface and ground water are inextricably linked. Another tradition that has confounded wise management has been the artificial separation of ground water and surface water issues. In fact, this separation is a matter of time and location, not of an inherent difference in the resource. Water is a limited resource cyclically exchanged between the earth and atmosphere. Precipitation that infiltrates the soil re-emerges as flow to streams and lakes or recharges ground water. Maintenance of ground water levels, through the natural process of infiltration and recharge, supports stream base flows, surface water quality and healthy aquatic ecosystems. Additionally, the geology of ground water systems can influence the character and quality of surface water systems. One example of this can be seen in the impact of

"We forget that the water cycle and the life cycle are one."

Jacques Cousteau

acidic mine drainage waters, where runoff from exposed bedrock materials can lead to pollution of waterways if not properly treated.

Demand and supply must be in balance. Demand can be reduced by using water more efficiently. This includes decreasing losses through distribution systems, employing conservation habits and incentives, encouraging technological innovation for increased efficiency, and re-using or recycling water. Options to enhance supply include surface storage, Aquifer Storage and Recovery (ASR), conjunctive use, and stormwater management. Soil conservation and wetland protection also contribute to storage potential by maintaining the natural storage capacity of soils and wetlands.

Environmental and social consequences must be reconciled with economic costs and benefits. Water is transient, limited in quantity, and subject to profound changes in quality from human use and landscape alterations. Thus, water has social and economic as well as environmental dimensions. Cleaner water in source water streams, rivers and reservoirs requires less treatment, enabling the supply of safe drinking water at a lower cost to residents and other users. Cleaner water means healthier fish, shellfish and waterfowl, lower risk to public health, and healthier economies. Healthy river corridors and waterscapes are aesthetically pleasing. They form a foundation for economically significant recreational activities and enhance the quality of life in our communities.

Diverse legal and regulatory regimes and principles must be coordinated. Historically, common law has dealt separately with ground and surface water withdrawals. Sound management requires a regulatory framework that establishes uniform principles for ground water and surface water and considers the interrelationships between them.

Laws addressing water quality are distinct from equitable principles governing interstate flow and from state laws governing intrastate water rights. Integrated management involves coordinating these legal regimes. Stormwater management laws and ordinances generally focus on controlling peak flows during and following development, yet the volume of runoff and infiltration amounts can also affect stream flows, water quality and ecosystems, and should be part of this focus.

Goals for Sustainable Use and Supply

1.1 Equitably balance the multiple demands on the limited water resources of the Basin, while preserving and enhancing conditions in watersheds to maintain or achieve ecological integrity.
1.2 Ensure an adequate supply of suitable quality water to restore, protect and enhance aquatic ecosystems and wildlife resources.
1.3 Ensure an adequate and reliable supply of suitable quality water to satisfy public water supply and self-supplied domestic, commercial, industrial, agricultural, and power generation water needs.
1.4 Ensure adequate and suitable quality stream flows for flow-dependent recreational activities.

Goal 1.1: Equitably balance the multiple demands on the limited water resources of the Basin, while preserving and enhancing conditions in watersheds to maintain or

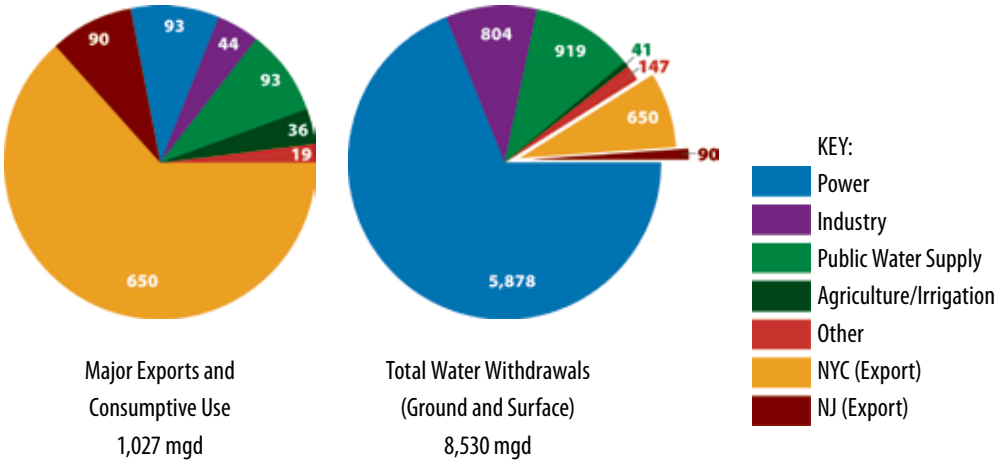
achieve ecological integrity. To equitably balance multiple demands, it is essential to understand the types of human and ecological demands being made on the hydrological system. To set realistic targets for preserving and enhancing conditions in watersheds to maintain or achieve ecological integrity, requires a clear understanding of existing conditions, and of the needs of aquatic and riparian populations. Those watersheds that currently approximate natural conditions should be protected to preserve their ecological and hydrological functions and those that have been degraded should be considered for restoration or enhancement.

Assessing current water use. Improving our understanding of water use will help us to manage resources more effectively and focus our efforts to promote efficient water use. The generation of reliable data requires accurate and up-to-date records on all ground water and surface water withdrawal allocations, wastewater discharge permits, and connectivity among withdrawal, use, and discharge points. Data management problems currently hamper the development of a precise water use and discharge data set for all watersheds in the Basin. However, existing information for individual watersheds can be used to estimate water use in other watersheds with similar conditions.

A summary of water withdrawals, exports and consumptive use in the Delaware River Basin based on data from 1996 is shown in Figure 3. There are two major exportations of water from the Basin. The largest (approximately 650 mgd) is to New York City, which obtains around half of its water supply from a system of upper Basin reservoirs that provide the water and make releases to the river designed to ensure a minimum rate of flow. The other major export (approximately 90 mgd) from the Basin is via the Delaware and Raritan Canal, which carries water to northeastern New Jersey. Limitations on these exports, of 800 mgd and 100 mgd respectively, were established by the Supreme Court Decree in 1954. The New York City aqueduct system and the Delaware and Raritan Canal are illustrated in Figure 4.

The largest water using sectors in the Basin are those of power generation, industrial use and public water supply. In recent years, at the Basin-wide scale, industrial water use has declined whereas water demand for power generation has increased. For public water supply, conservation efforts have helped keep demands

Figure 3: Summary of 1996 Water Withdrawals in the Delaware River Basin



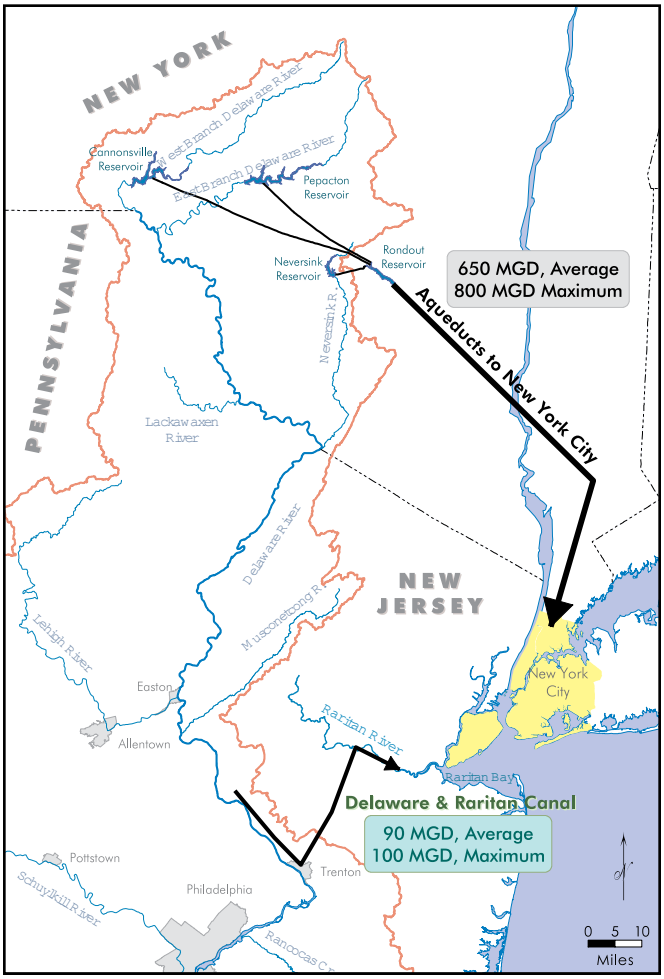
DEFINING THE APPROPRIATE SCALE FOR ASSESSING WATERSHEDS

The Natural Resource Conservation Service (NRCS) and the U.S. Geological Survey (USGS) catalogue watershed units by Hydrologic Unit Code (HUC). The Delaware River Basin is comprised of twelve HUC 8 watersheds delineated by USGS. However, at an average of over 1,500 square miles, HUC 8 watershed units are too large for the purpose of developing more than rudimentary regional assessments. NRCS has catalogued 236 HUC 11 units that average about 55 square miles in size, although they can vary from a few to more than a hundred square miles in size. Smaller units (HUC 14 scale) number in the thousands, creating a practical barrier to developing a Basin-wide coverage of water budgets at that scale in the short-term. However, knowledge of watersheds at smaller scales may be most appropriate for local planning purposes, for assessing impacts, and for supporting restoration efforts. Choosing the correct watershed size depends on the purpose of the inquiry.

stable despite a growing population.

In response to actual and projected increases in water demand for the power generating sector, Merrill Creek Reservoir was constructed in 1989. During low-flow periods releases are made from the reservoir to offset the consumptive use at facilities that have purchased storage capacity in the reservoir, thus allowing them to continue operation where cut-backs in production would otherwise have been required. Substantial capacity in the Merrill Creek Reservoir is currently unused and is thus available for future purchase to offset consumptive use at new facilities.

Figure 4: Major Water Exports



Calculating water budgets. To help improve our understanding of how much water is safely available for use we need to understand water budgets on a watershed basis. A water budget is a description of the fate of water resources in a watershed, as illustrated in Figure 5. Budget "inputs" include precipitation and imports (transfers into the system). Water inputs will become:

- Evapotranspiration into the atmosphere
- Direct flows to surface water bodies (runoff)
- Indirect contributions to stream flow through the soil and water table
- Recharge to deeper ground water aquifers
- Consumptive losses associated with human use
- Exports from the watershed

The proportion of water inputs that arrive at each destination is determined by climate; geology, soils and topography; by the land use attributes of a watershed; and the way we use water resources. Water budgets yield an average annual accounting of water volumes and do not reflect seasonal variation. Although the water budget approach has limitations, pilot studies are under way as part of state water supply studies and a USGS-DRBC partnership to assess the feasibility of using water budgets as a screening tool for watershed assessments.

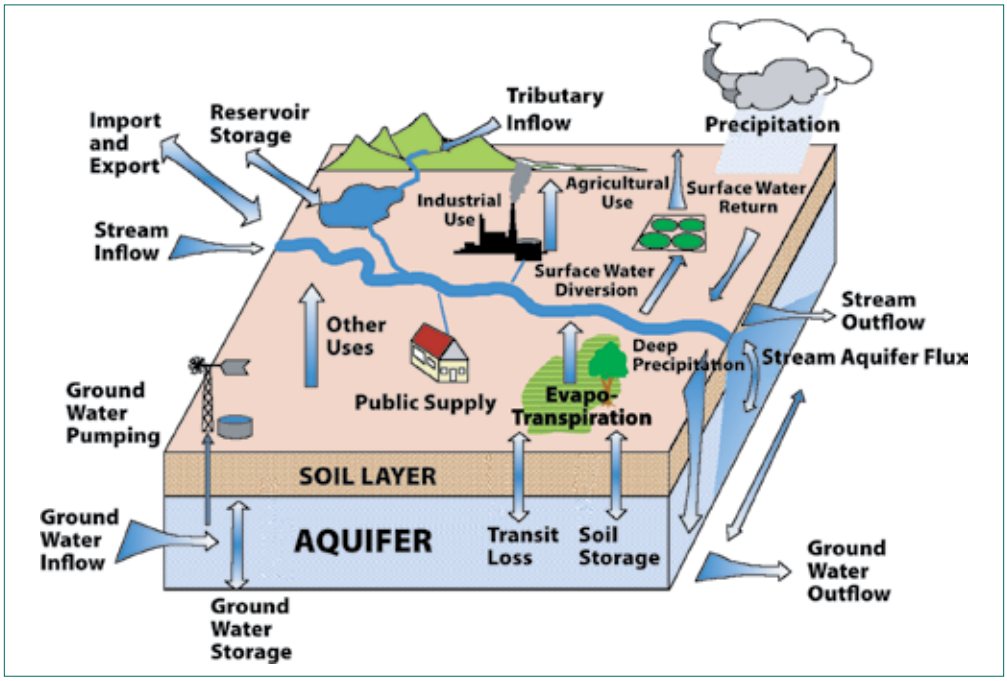
Assessing in-stream flow and freshwater inflow requirements. Understanding the needs of aquatic ecosystems is essential to several Goals of the Basin Plan, including:

- Assessing the amount of water available for allocation
- Setting standards for improving conditions in watersheds and restoring natural functions in stream corridors
- Protecting threatened and endangered species
- Improving operating plans for reservoirs
  - **Setting appropriate criteria and standards for assessment and restoration within the Basin's ecoregions are necessary to make sustainable water allocation decisions.**

Developing strategies for the allocation of water. Once both human and ecological needs are understood, the challenge of achieving an equitable balance of the multiple demands on the hydrological system can be addressed. Prudent allocation strategies may include curtailing water uses during drought conditions through allocation decisions or use restrictions, and allocating water to areas with limited water resources as determined by calculated water budgets and availability assessments. Allocation strategies also need to honor the rights of the parties defined in the 1954 U.S. Supreme Court Decree.

Developing tools for assessing ecological integrity. The development of indices of ecological integrity that integrate the physical, biological and chemical requirements of healthy aquatic and riparian ecosystems is critical for realizing restoration and enhancement goals as well as for developing appropriate water allocation strategies. Key species or characteristics that are especially sensitive to changes in water availability or quality should be identified. Understanding the relationship of

Figure 5: Conceptual Water Budget
(Source: Colorado Division of Water Resources, Office of the State Engineer)



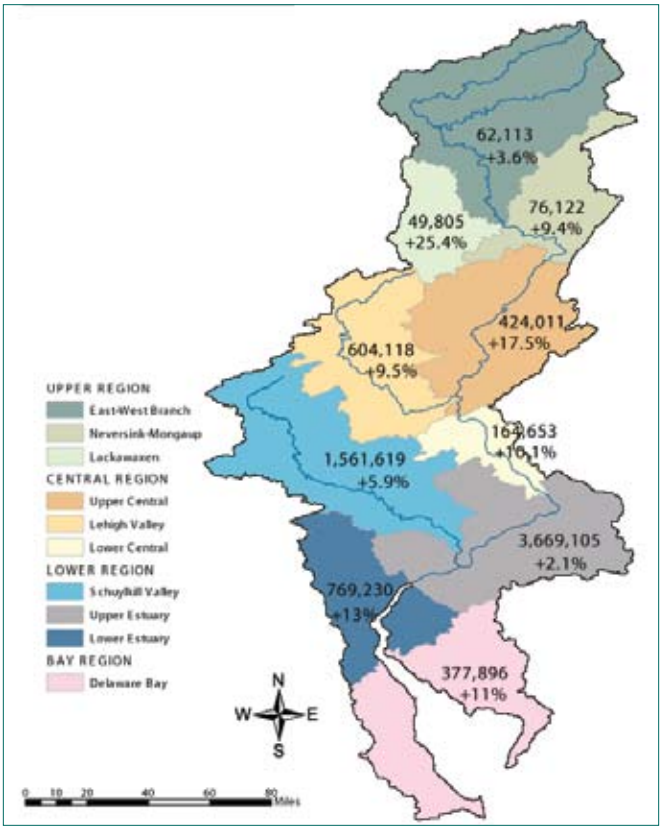
ecoregions, ecological communities, and watersheds is integral to the development and application of relevant assessment protocols.

GOAL 1.2: Ensure an adequate supply of suitable quality water to restore, protect and enhance aquatic ecosystems and wildlife resources. Aquatic ecosystems and wildlife represent important users of the Basin's waters. Protecting water quality for those uses is an integral part of the Clean Water Act, and of federal and state laws and DRBC regulations.

Identifying the freshwater needs for aquatic ecosystems and wildlife. Fresh water must be available in adequate quantities for drinking, feeding, cleansing and reproduction. Resilient, healthy ecosystems adapt to changes within a natural range of variability. Changes that push the limits of that range may cause irreparable harm to communities of water-dependent animals and plants. Therefore, it is important to understand ecosystem function, and the limits to the range of conditions that ecosystems and natural communities will tolerate.

Water availability varies with geographic location and seasonal fluctuations in precipitation and temperature. It is also susceptible to change as a result of the patterns of human settlement and water use. For example, the ways in which water is allocated to uses within and outside of the stream (public water supply, industrial, commercial, agricultural, power production, etc.) and how water is returned to the stream (when, where, in what amounts, and of what quality) can have a great influence on how streams provide for ecosystem needs.

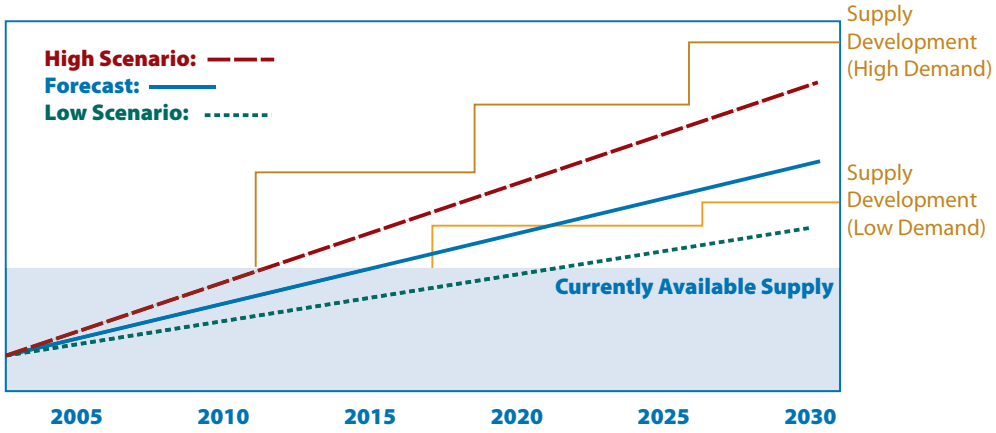
Figure 6: 2000 Population by Region Showing Percentage Change From 1990



GOAL 1.3: Ensure an adequate and reliable supply of suitable quality water to satisfy public water supply and self-supplied domestic, commercial, industrial, agricultural, and power generation water needs. Projecting demand for water for various human purposes includes identifying how much, when, and where water will be needed. Before we can ensure adequate water resources for human purposes into the future, we need to generate projections of population and sector water demand. These projections can then be compared to the water determined (through the water budget and available ground water assessments) to be available for allocation — that is, available for use without impairing the ability of the water resource base to support healthy ecosystems. This will require developing a methodology and range of assumptions to which the Basin partners are agreeable. Figure 6 shows regional population change in the Basin between 1990 and 2000.

Projecting water needs for all use sectors, must consider estimates of consumptive use, water distribution system losses and the potential effects of various water conservation programs. Projections must also take into account possible alternative future conditions. This requires making a range of projections, reflecting a variety of possible scenarios. Figure 7 illustrates how differing future water demand scenarios require different levels of water supply development. This Plan requires that a study of future water demands be undertaken to enable us to plan the necessary supplies for the next 30 years. While we can focus on what the most likely (forecast) outcome will be, we can also examine the cost and benefits of alternative (high and low) water demand scenarios and the implications for resource development. This approach also provides a method for testing the sensitivity of water use projections.

Figure 7: Schematic Representation of Scenario-based Water Demand Forecasting



Ensuring adequate supplies for future populations. This entails understanding and managing how and where growth will occur in order to fulfill expected demand and have the least detrimental impact on natural systems. If water stressed areas are identified for growth, then solutions to water supply problems need to be determined and planned. Lessons learned and legal constraints established in connection with previous decisions on water transfers should be incorporated into water resources decision-making in the future to meet state, regional and local plans for growth management as well as ecological needs.

The map in Figure 8 shows existing population density in the Basin regions as of 2000, and areas in Pennsylvania and New Jersey where special withdrawal restrictions are in effect based on concerns for ground water levels.

GOAL 1.4: Ensure adequate and suitable quality stream flows for flow-dependent recreational activities. Assessing the flows needed for recreational purposes and planning for flow management includes:

- Defining the scope of flow-dependent recreational activities
- Determining the needs of these activities
- Setting operation strategies to be applied during periods of normal and subnormal precipitation in the areas of the Basin where reservoir releases are managed

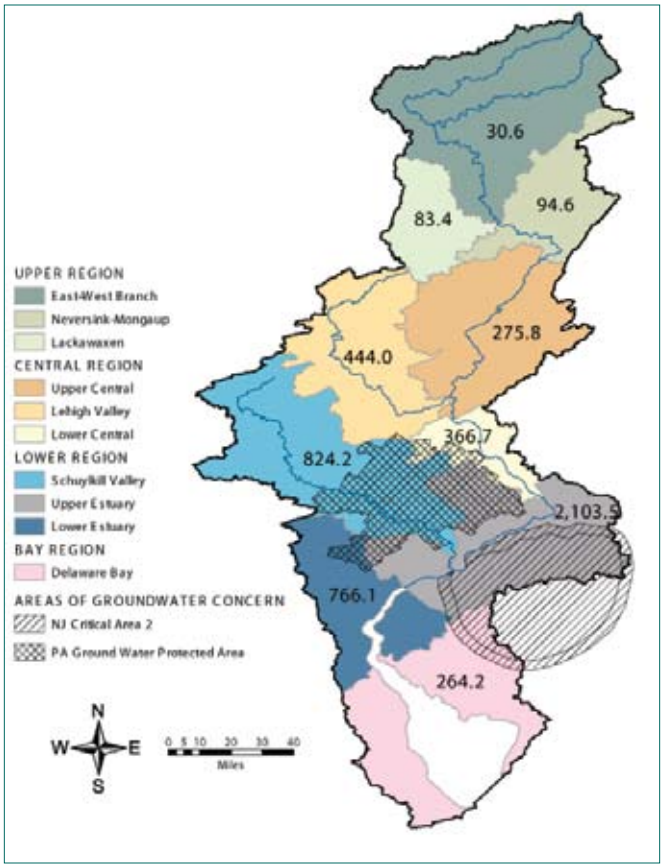
- Examining legal restrictions on the use of reservoir storage

Flow-dependent recreational activities in the Basin, such as boating, swimming and fishing, not only provide important physical, social and cultural benefits to Basin residents and visitors, but they also comprise an important sector of the Basin's economy. Tourism dollars from the boaters, canoeists, anglers, and other participants in water-dependent activities in the Basin are becoming increasingly important. Recreation uses are also protected under the Clean Water Act's "fishable and swimmable" requirements. For all of these reasons, it is important that recreational use of waterways continues to be valued and protected.

An Adequate Supply of Suitable Quality Water

The discussion thus far has focused primarily on determining and maintaining adequate supplies for human and ecosystem needs. However, a sustainable use of water resources also requires that, in using those resources, the quality be maintained at a level that is adequate, both now and into the future, for all uses. Therefore, a true measure of water availability must also include water quality. Because many human activities have the potential to impact water quality, it is necessary to understand the nature of those impacts, including those that have occurred, those that are occurring, and those that may occur in the future. Assessing the current quality of the Basin's water resources, while identifying trends and potential impacts, is an ongoing component in the process of maintaining or improving water quality.

Figure 8: 2000 Population Density, Persons per Square Mile



Assessing water quality. Ensuring that water quality meets or exceeds the needs of its intended use requires it to be assessed. To determine the actual quality of water in a stream or aquifer requires field measurements and laboratory analysis. Data must be collected over a period of time to adequately reflect the natural range of hydrologic and climatic factors which affect water quality. A significant commitment of time and resources is necessary because information needs to be collected for a duration sufficiently representative of the natural variations or changes expected to occur in natural systems.

Water quality must be monitored and assessed with sufficient frequency and consistency to determine if the water quality is being maintained, improved or degraded. Strong coordination and cooperation among Basin partners is critical to ensure the development, implementation and monitoring of a comprehensive set of criteria and indicators that define the quality of Basin waters. Specifically, Basin partners must be able to coordinate the multi-jurisdictional monitoring efforts, agree on methodologies and criteria for sampling and assessment, and provide consistent and timely advice to the water resource community.

Coordination and cooperation is also necessary to make the most efficient use of limited fiscal and staff resources, and to provide adequate and reliable data.

- **Basin partners face the multiple challenges of building on existing monitoring and indicator programs, establishing robust sets of indicators for each of the Objectives in this Plan, and implementing a coordinated monitoring network to accurately assess water quality trends in the Basin.**

Maintaining water quality. This requires setting water quality criteria and agreeing on permitting standards for discharges as well as providing tools and information that will prevent additional impacts from land development and management activities. Approaches may include:

- Anti-degradation programs (e.g. designated uses, state protections for high quality and exceptional value streams, the DRBC's Special Protection Water designations and federal Wild and Scenic Rivers designations)
- Stormwater management programs
- Water quality-based trading programs (offsetting impacts from discharges by equivalent reductions from other sources within the watershed)
  - **A major challenge is to "keep our clean water clean" in areas with expected future increases in growth and development activity.**

Improving water quality. Where standards are not being met for designated uses, regulatory and non-regulatory strategies must be developed to identify pollutant sources and to achieve the standards. Maximum Contaminant Levels (MCLs) for drinking water and ambient water quality have been set for many parameters. When monitoring reveals problems with any given substance of concern, the next step is to identify the source of the problem. For example, high levels of nitrates in well water can be attributed to a number of sources; faulty septic systems, the application of agricultural fertilizers, and livestock operations are the most likely sources in our region. Tracking the sources and taking steps to reduce or eliminate the contamination may require the participation and cooperation of health, environmental and agricultural agencies as well as property owners and managers.

The Basin states and the Commission are currently engaged in the development of Total Maximum Daily Loads (TMDLs) for certain pollutants surface water bodies in the Basin. The TMDL program is targeted at point and nonpoint sources of pollutants of concern that prevent the attainment of a water body's designated use. TMDLs are developed for each of the pollutants causing the impairments with load allocations assigned to both point sources and nonpoint sources. Changes are made to effluent requirements in the National Pollutant Discharge Elimination System (NPDES) permits based on these load allocations. Nonpoint source reductions are also identified, and the application of Best Management Practices (BMPs) can be utilized to achieve the necessary reductions. BMPs can include changes in fertilizer type and use, greenways, etc.

Depending on the pollutant of concern, other approaches to achieve the necessary pollutant reductions may also be effective. For example, a pollutant trading program, in which credit for greater reductions than required in the NPDES permit achieved at one or more point sources, may be traded to other point sources to realize the overall load reduction. Similarly, pollutant reductions in some nonpoint sources can be traded with other nonpoint or point sources to

WATER QUALITY — VALUE OF STREAMBANK STABILIZATION

Streambank stabilization to reduce erosion also removes substantial quantities of phosphorus from nonpoint sources. Phosphorus is a nutrient that contributes to unwanted algal growth and the reduction of dissolved oxygen in streams and lakes.

Reduction in the amount of phosphorus (along with sediment and nitrogen) associated with streambank stabilization provides potential economic benefit through reduced treatment costs and adverse environmental impacts.

Source: U.S. Army Research and Development Center www.wes.army.mil/el/wq

attain the required reductions. Pollutant trading programs can be more cost effective and result in reaching required reductions more quickly than traditional pollutant reduction programs.

- **The challenge to Basin partners is to utilize both traditional and innovative strategies, and to develop, implement and monitor the effectiveness of these strategies toward the desired result — the mitigation of existing water quality impairments and the prevention of future impairments from growth and development.**

Protecting source water. Ensuring adequate supplies also involves protecting source waters and ensuring against delivery disruption due to deliberate or accidental contamination or system damage. In the late 1980s, as part of the federal Safe Drinking Water program, states were required to develop Wellhead Protection Programs to protect vulnerable community supply wells. However, successful application of the generally voluntary state programs has been hampered by inconsistent municipal involvement, as well as funding and legal difficulties.

Amendments to the federal Safe Drinking Water Act in 1996 initiated the Source Water Assessment Program (SWAP) to evaluate existing and potential threats to the quality of public drinking water. By 1999, states had to delineate source water protection areas, inventory sources of contamination, and determine susceptibility of systems to contaminant sources.

Threats to national security and public welfare in the wake of September 11, 2001 have heightened awareness of the need to secure from harm the waters that serve as potable public supply and their distribution systems. As a result, security efforts have increased at many facilities. Federal requirements for Source Water Assessment Programs, include determining the vulnerability of source water supplies and taking steps to protect them. Regional coordination of contingency plans and protection measures is necessary to ensure minimal disruption of supplies in emergencies. Detection and warning systems to alert water supply managers of accidental spills or deliberate contamination of water supplies is an integral part of emergency preparedness.

Ensuring "fishable" waters. Certain chemicals and toxins bio-accumulate in the flesh of fish. When accumulation reaches levels higher than those deemed safe for human consumption, states post health advisories against eating even limited amounts of certain species from specified water bodies or stream segments. In addition to the food chain impacts and implications for human health, the quality and abundance of fish species also affects the viability of commercial and recreational fishing and associated tourism economies.

- **The presence of persistent and bioaccumulative compounds in our waters and the associated potential for human and ecological health effects is an emerging issue for water resource management. See "Key Result Area 4: Institutional Coordination and Cooperation" for more about emerging issues.**

"Key Result Area 1: Sustainable Use and Supply" encompasses the issues associated with using the Basin's waters as a sustainable resource, and the need to consider water quality, quantity and flow characteristics when managing its use. Water quality, quantity, and particularly its flows, are affected by adjoining portions of the landscape that directly interact with streams and rivers. Riparian lands, along with

the waters that flow through them, comprise the waterway corridors that provide habitat for aquatic life, recreational opportunities, flood control and a host of other benefits worthy of protection and enhancement. The next section of this Plan, "Key Result Area 2: Waterway Corridor Management," addresses the issues specific to improving the management of our waterway corridors.

Unique Aspects of the Delaware River Basin

The Delaware is the longest undammed river east of the Mississippi.

Roughly half of New York City's water comes from Delaware River headwater reservoirs. The Delaware and its tributaries supply water to Philadelphia and a cluster of other nearby riverbank cities, which collectively comprise the world's largest freshwater port.

The Delaware River winds through Pennsylvania's Lehigh Valley, where America's Industrial Revolution began.

The upper Delaware flows beneath the Roebling Aqueduct, which was engineered by John Roebling designer of the fabled Brooklyn Bridge. It is said that the aqueduct bridge is the oldest existing wire suspension bridge in the United States.

The Delaware River has attracted writers and painters. Walt Whitman discovered poetry in its commerce. Rudyard Kipling described the Revolutionary battle of Valley Forge in his verse. Thomas Eakins painted sailboats skipping over the white-capped waves of Delaware Bay.

At a riverbank ceremony in 1996, former Delaware Governor Thomas R. Carper remarked "The cleanup of the Delaware has been heralded as one of the world's top water quality success stories."

As a result of a remarkable comeback in water quality and a growing appreciation of her myriad attractions, much of the Delaware River and portions of several tributaries today are part of the National Wild and Scenic Rivers System.

The upper Delaware River watershed is home to the largest population of wintering bald eagles in the northeastern United States. This is largely due to programs to protect high water quality and preserve critical habitat.

The tidal reaches of the Delaware, along with the Delaware Bay, are part of the National Estuary Program, a project initiated in 1988 to protect estuarine systems of national significance.

The Delaware Bay is the principal breeding ground for American horseshoe crabs on the East Coast, and is among the largest staging areas for shorebirds in North America.

"A river seems

a magic thing.

A magic, moving,

living part of the very

earth itself."

Laura Gilpin

KEY RESULT AREA 2

Waterway Corridor Management

Desired Result: *Waterway corridors that function to minimize flood-induced loss of life, protect property and floodplain ecology, preserve natural stream channel stability, provide recreational access, and support healthy aquatic and riparian ecosystems.*

What does waterway corridor management mean? We recognize that our waterway corridors — streams, rivers, lakes, and their adjacent, interdependent landscapes serve multiple functions. Efforts must be integrated to manage these corridors as:

- Natural resources for conveying flood waters
- High quality waters for safe recreational enjoyment
- Cultural and historical amenities for our communities
- Habitat for diverse and productive biological communities

Why is waterway corridor management important? Traditionally, the approach to managing waterway corridors has tended towards single-issue programs: wetland protection; stream encroachment limits; structural flood reduction projects; regulation of floodplain development; and site-specific recreation and access projects. More recently, knowledge of the diverse functioning of stream corridors has improved. This better understanding of the multiple functions waterway corridors serve needs to be incorporated into our decision-making.

For example, when a transportation project to span a waterway is designed, care must be taken to ensure the structure does not negatively impact or impede the natural ability of the corridor to convey floodwaters, transport sediment, and minimize erosion. Innovations in bridge design and structural flood control, floodplain property acquisition, accurate floodplain mapping, stormwater management, streambank restoration, and floodplain regulations aimed at achieving the standard of *No Adverse Impact* all can contribute to protecting or restoring stream corridors.

Waterway corridors are necessary for flood management. Flooding occurs in all watersheds and along coastal areas. Flooding in undeveloped watersheds is part of natural hydrologic variability, and while it may be temporarily damaging, it provides benefits to the ecosystem. Floodwaters carry mineral-rich sediment, which improves soil productivity when deposited upon the floodplain. Where watersheds and floodplains are developed, flood damage is primarily due to the placement of structures and human activities within an area susceptible to flooding. Changes in land cover within a watershed frequently increase the area susceptible to flooding. Building occupied structures within a floodplain ensures vulnerability to flood hazard, property damage, and potential loss of life. Existing floodplain development has made adequate flood warning a priority in order to provide lead-time for emergency actions to prevent loss of life and property. In Figure 9, the topographic floodplain represents the uppermost limits of flood water levels associated with storm events. This level is much higher than the flood levels that maintain and shape natural stream channels, as explained below:

- The hydrologic or riparian flood level maintains riparian wetland communities (a return period of 2 to 20 years).
- Bankfull flood levels transport the majority of a stream's natural sediment load and shape the dimensions and patterns of natural streams (return period of 1 to 1.5 years).
- Stream base flows maintain the habitat of aquatic organisms during low flow periods and are entirely supported by ground water discharge.

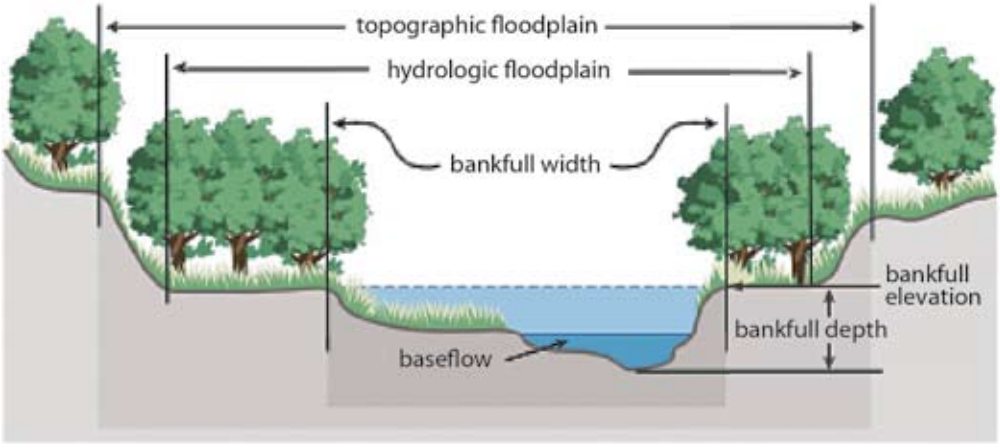
It is crucial to manage not only for extreme floods that threaten lives and infrastructure, but also for the riparian flood, the bankfull flood, and base flow conditions. Impacts of development, such as stormwater runoff and stream encroachment, can alter the frequency and energy of these more frequent floods, which in turn affect wetlands, natural channel stability, and fisheries.

The Basin's waterways are important recreation venues and community amenities. Rivers and lakes of the Delaware River Basin are located within a day's drive of about 20% of the U.S. population. The Basin includes National Wild and Scenic Rivers, the Appalachian Trail, and numerous game lands, parks, and forests.

Recreational activities range from passive (such as wildlife or landscape photography) to active (hiking, fishing, trapping, hunting, canoeing, boating, white-water rafting). It includes activities along the waterways as well as on or in the waters. Waterway use is dependent on adequate public access along the streams, rivers and the Bay. Insensitive use of the waterways, streambanks and trails can impair both the visual and functional value of the resource. Physical and visual access to water, whether for recreation or inspiration, adds dimension to our quality of life and enhances the attractiveness of our communities.

Waterway corridors provide essential aquatic and riparian habitat. Waterway corridors function as transportation networks and food sources for wildlife, and provide habitat for shelter and propagation for aquatic and terrestrial species of plants and animals. Forested buffers provide temperature control, keeping the water cool and shaded from sunlight. This helps maintain a more constant environment for temperature-sensitive species, and stabilizes dissolved oxygen levels. Vegetation also helps to stabilize stream banks, reducing erosion and minimizing disruption to aquatic habitats. Fallen trees provide woody debris that serves as a refuge for aquatic species.

Figure 9: Cross-sectional Illustration of a Waterway Corridor
(Source: Stream Corridor Restoration: Principles, Processes, and Practices, Federal Interagency Stream Restoration Working Group, 1998)



Excessive high flows and inconsiderate recreational use can physically impair waterway corridors, threatening the health

of natural ecosystems. Making our waters "fishable" means creating an aquatic environment supportive of healthy fish and wildlife, as well as having finfish and shellfish safe for human consumption.

Goals for Waterway Corridor Management

2.1 Prevent or minimize flood-induced loss of life and property, and protect floodplain ecology.
2.2 Enhance water-based recreation in the river and its tributaries.
2.3 Protect, conserve and restore healthy and biologically diverse riparian and aquatic ecosystems.

GOAL 2.1: Prevent or minimize flood-induced loss of life and property, and protect floodplain ecology. Identifying areas and structures within a community that are at risk from flooding is the single most important step in mitigating future flood damage and loss. Community planning to reduce flood damage is critical, and guidance is available from federal and state agencies to help communities in this effort. In addition, flood forecasting and warning, maintenance of flood control structures, and stormwater management are all essential elements of controlling future flood damage.

Assessing flood hazards. Flood hazard information must be made available to communities so they can identify structures at risk and develop mitigation plans. This should include methods that can help communities plan to prevent structural loss.

Developing pre- and post-development mitigation strategies. The Disaster Mitigation Act of 2000 requires municipalities and states to develop hazard mitigation plans in order to remain eligible for post-disaster mitigation grants. Pre-development strategies might include floodplain management, stormwater management, and property acquisition along stream corridors. Post-development strategies might range from maintenance of existing flood control structures to elevation or removal of buildings from the flood hazard area by property relocation or buy-out and demolition. In addition, streambank restoration could follow building relocation or demolition.

Linking flood control and stormwater management. Coordinating flood mitigation and stormwater management involves a vast array of agencies, departments, offices and programs at all levels of government. A more detailed assessment of this challenge is in "Key Result Area 4: Institutional Coordination and Cooperation."

Taking steps to minimize the ecological impacts of floods. Landscape alterations that occur with human settlement include intrusions into the floodplain — including structures, roads, bulk heading, and the filling of wetlands — that can interfere with both watershed hydrology and the floodplain's ability to convey water. Damaging erosion and deterioration of stream channels, and the associated ecological consequences, can be minimized through a combination of regulations and responsible development decisions for stormwater and floodplain management and wetlands preservation.

2

WHAT IS A WATERWAY CORRIDOR?

A waterway corridor is a stream, river, or lake, and the portion of its adjacent landscape that directly affects and is affected by its hydrology and ecology. The Basin's waterway corridors connect to create networks, enabling a variety of species to migrate between aquatic and terrestrial environments, and from one region of the Basin to another.

Stormwater control and flooding. The practice of removing stormwater from a site as quickly as possible, or controlling its peak flow rate but not its volume, combined with the extensive clearing of forested land that historically precedes human settlement, has altered the hydrology of many watersheds in the Basin, severely in some instances. The importance of stormwater management to reduce both ecosystem and property damage, along with steps to improve our current system of management, is explained in greater detail in "Key Result Area 3: Linking Land and Water Resource Management."

Enhancing flood forecasting. No matter what assessments and mitigation strategies are implemented, adequate warning with regard to impending or potential flood events remains the key to minimizing loss of life in flood events. The accuracy and reliability of hydrologic forecasting depends on adequate monitoring of precipitation and stream flow. In support of enhanced flood forecasting and warning capabilities, funding should be secured for the implementation of "Recommendations to Address Flood Warning Deficiencies in the Delaware River Basin," prepared in May 2002 by the Delaware River Basin Commission, with technical guidance from the DRBC Flood Advisory Committee.

Increasing awareness. Community leaders, residents and developers need to be informed about the natural functions of waterway corridors in flood mitigation, the risks that accompany inappropriate development in the floodplain, and the need for hazard mitigation and stormwater management plans to mitigate hazardous conditions or prevent them from occurring.

Table 1: The Benefits of Buffers
(Source: Alliance for the Chesapeake Bay, 1996)

Leaf Food	• Leaves and woody debris provide food and habitat for insects, crustaceans, amphibians and small fish
Filtering Runoff	• Buffers slow runoff and settle out sediment, nutrients and pesticides before they reach streams and lakes
Infiltration	• Rates in vegetated buffers can be 10-15 times higher than grassed turf and 40 times higher than plowed fields
Canopy and Shade	• Leafy canopies provide shade, keeping water cool, retaining dissolved oxygen, and favoring the growth of beneficial algae and aquatic insects
Habitat	• Wooded corridors provide the most diverse habitats for fish and other wildlife, especially valuable for birds
Nutrient Uptake	• Fertilizers and other pollutants are stored in limbs and roots • Bacteria in the forest floor convert excess nitrate to nitrogen gas which is released into the air

GOAL 2.2: Enhance water-based recreation in the river and its tributaries. The Basin's National Wild and Scenic Rivers, the Appalachian Trail, and numerous game lands, parks and forests can be linked to optimize recreational experiences.

Creating a Delaware Basin recreational use and access plan. The need exists for regional recreational use and access planning that provides for overall integrated management of recreation and tourism, protects water resources from recreational impacts, provides enjoyment and convenient access, and

protects the health and safety of recreational users. A Basin-wide recreation and tourism plan should include strategies to:

- Promote the Basin as a tourist destination
- Provide additional public access to waterways
- Create a linked water trail system
- Increase the scope and frequency of stream and river trash collection
- Maintain or improve recreational water quality
- Avoid impacts from recreational use
- Improve the connections of communities to their waterways

The streams and rivers of the Basin are attractive natural transportation routes. However, they are often isolated from one another, located on or very near private property, or lack access sites or safety features. Hazards abound near urban areas, in the vicinity of dams, and where high-speed roads and railroads share space with recreational users. Generally, few amenities are available to travelers along water corridors.

Inconsiderate recreational use can degrade environmental quality, especially through physical impacts to sensitive riparian ecologies. Challenges lie in understanding thresholds and, where necessary, setting limits to human use.

Coordinated efforts are needed to expand access and enhance the recreation experience of the river-using public. Numerous entities in the Basin are involved in providing recreation and tourism services, yet regional connections are lacking between towns along waterways; between user and provider communities; and between states. Implementation of recreation and tourism objectives requires a serious coordination effort by public and private entities.

Promoting visual and physical access to waterways in community development plans. This requires concerted efforts to educate developers, officials, and the public about the opportunities waterway corridors can offer for recreation, and the need to promote access through local planning. Legal barriers to increasing public access need to be investigated.

Developing operating plans for reservoirs. Public and private reservoirs serve a variety of important purposes, including public water supply, power generation, flow augmentation and flood control. They also provide recreational opportunities (both at the facilities and downstream). Facility functions can be prescribed by statute and/or subject to regulatory approvals of the Delaware River Basin Commission, the Federal Energy Regulatory Commission or other agencies, and their operating plans must reflect their prescribed functions.

GOAL 2.3: Protect, conserve and restore healthy and biologically diverse riparian and aquatic ecosystems. The health of plant and animal communities requires that flows in rivers and streams exhibit the natural range of variation in the flow regime, especially seasonally. Other physical and chemical parameters are also critical to the health of ecosystems. Understanding the range of needs for the diverse native aquatic and riparian populations within the Basin is a major challenge.

Defining flow regime and water quality criteria to support healthy aquatic and riparian communities. Ecosystem needs for flow and water quality vary seasonally with the

HOW DEVELOPMENT EXACERBATES FLOOD IMPACTS

Flood waters that would be retained in the headwaters or allowed to spread into the floodplains are quickly transported by the conduits of paved roadways or storm sewer pipes directly into the waterway. Overburdened with flood water, the water gains speed and power, picks up sediment and debris, and rushes down waterways too constricted by development to function properly. This increases scour on the sides and bottom of waterways, uprooting plants and eliminating substrate for bottom-dwelling species.

life cycles of aquatic and riparian species. Criteria are dependent on topography, elevation, and geology, and are specific to the assemblages of populations in a region, a watershed, or a stream's reach.

Additional investigation of the fresh water inflow requirements for estuarine ecosystems is needed. In the tidal portion of the Basin, present policy consists of meeting a flow target for the Delaware River at Trenton, New Jersey. The target is designed to maintain the 30 day average chloride concentration at or below 180 ppm at river mile 98 during repetition of drought-of-record conditions to protect industrial and potable supply needs. Currently a model is used to forecast salinity changes based on projected changes to the flow regime. The freshwater inflow needs of estuarine systems should be established and incorporated into flow scenario evaluations, and up-to-date information on climate change and sea level rise should be used when evaluating projected estuary conditions.

Incorporating ecosystem requirements in water quality criteria and flow targets. The Basin states are using biological and physical criteria in addition to traditional chemical criteria for assessment and protection of aquatic life. There has been increased monitoring of biological assemblages, habitat conditions, stream morphology, and riparian conditions to determine overall ecological integrity of the Basin's waters. Coordination and cooperation among agencies and non-governmental organizations is necessary to effectively assess and manage the Delaware River and its tributary watersheds. This includes establishing minimum water quality and flow criteria to support consistent designated uses throughout the Basin. These criteria will not just be the minimum acceptable for the survival of adults, but adequate to support and protect all life stages and the reproduction of aquatic and riparian communities.

Establishing a regional approach to sediment management. Sediment transport occurs when soils are eroded by moving water. Results of sediment transport can be beneficial or problematic. Floodwater deposition of rich alluvial soils can be a boon to agriculture, while sediment deposits in navigable waterways can block channels and create dangerous conditions for river traffic. Erosion of upland soils can result in the loss of tons of fertile topsoil into bays and oceans, increasing turbidity and smothering benthic habitat.

Managing sediment requires paying attention to the "source" of eroded soils as well as the "sink" or place of deposition. Management of soil sources includes a variety of practices to keep soils from eroding (see discussions on stormwater management in "Key Result Area 3: Linking Land and Water Resource Management"). Management of soil "sinks" includes dredging unwanted sediment from ports and navigable channels, removing contaminated sediments from ecological systems and removing sediments to restore habitats. Managing sediments in a systems context has not been widely practiced, but regional sediment management is being increasingly recognized as a strategy for effective ecological and economic control of sediment as a valuable resource.

A regional approach to sediment management uses sediment budgets, which include sediment sources and sinks and the identification of ongoing sediment management activities performed throughout the watershed. Sediment availability is linked with sediment needs within the system based on suitable quantity, quality,

and timing. Through planning and coordination, such varied activities as navigable channel maintenance, habitat restoration, abandoned mine rehabilitation and beach nourishment projects can all be made more efficient and economical.

Employing restoration techniques to improve impaired waters. Restoring hydrological and ecological function requires investments in research and agency support, but they can be successfully accomplished with major benefits to water resources and habitat. Environmental restoration is a relatively new field, and information needed to determine objectives and predict ecological response to restoration measures is sparse. Restoration of landscapes and waterways is presently as much an art as a science. Sharing information helps advance our understanding of restoration techniques.

Protecting riparian and aquatic ecosystems. Commercially significant species thrive on a food base of non-game mammals, birds, fish, reptiles, amphibians, mussels, and invertebrates supported by the Delaware River and Bay. It is important to identify and protect the habitat and life stage requirements of key commercial, recreational, game, non-game, threatened, and endangered species so they survive and successfully reproduce throughout their natural ranges. Water flows and quality, the absence of non-native predators or competitors for habitat and food, and the abundance of food supply are all integral to the success of our native aquatic and riparian plants and animals. Limits on harvesting may be necessary to ensure a sufficient number of reproducing adults and the abundance of commercial species for future generations.

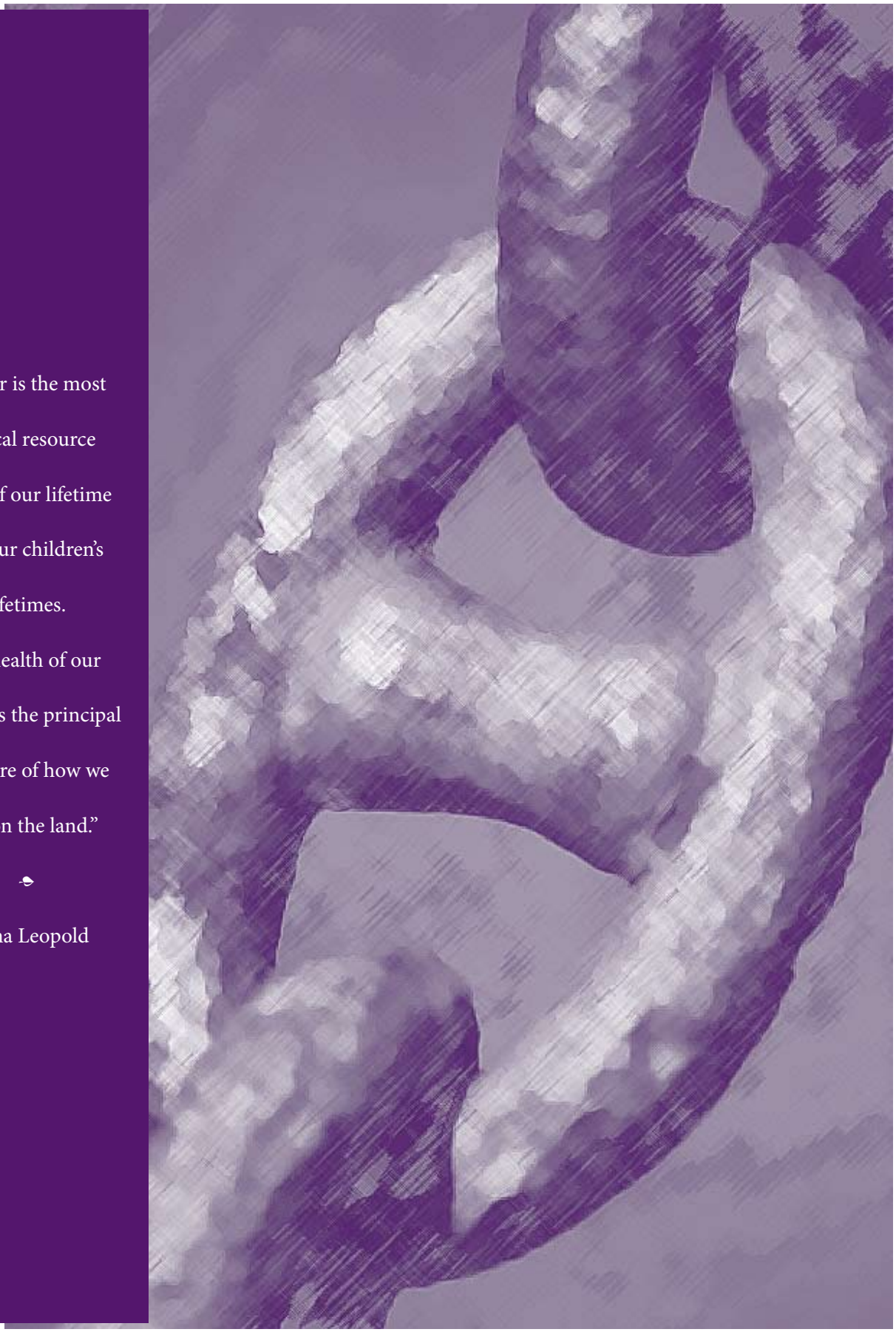
Invasive species management. Identifying invaders, their means of distribution, and methods of controlling them offers a tremendous ecological and economic challenge. It also challenges the ability of our institutions to work cooperatively, since it requires supportive efforts among agencies, organizations and individuals in the fields of science and research, environmental protection, commerce, and transportation.

- **Competition from invasive species is second only to habitat loss in its impact on ecosystem integrity.**

This Key Result Area covers the importance of waterway corridors, both as the interface between the land and surface waters of the Basin, and for the numerous functions they provide to humans and aquatic communities. The quality and quantity of our water resources are affected by conditions and activities that may occur far from the actual water bodies. "Key Result Area 3: Linking Land and Water Resource Management," looks at how the entire watershed, including its varied landscapes and land use activities, functions as a critical component of the hydrologic system, and how our management and decision-making structure can improve results for better water resource management.

"Water is the most critical resource issue of our lifetime and our children's lifetimes. The health of our waters is the principal measure of how we live on the land."

Luna Leopold



KEY RESULT AREA 3

Linking Land and Water Resource Management

Desired Result: *The integrated management of land and water resources to sustain the quality of life in the Basin; preserving, restoring and enhancing ecological resources while recognizing the community's social and economic relationships to these resources.*

What does linking land and water resource management mean? Water is a finite resource, necessary for all life and upon which our social and economic structures depend. To achieve the most efficient, protective and sustainable use of water resources, growth and development decisions must reflect the following:

- The natural properties and cycling of water
- The interconnections of land and water
- The watershed as the natural framework for integrating water resource decisions

Why is linking land and water resource management important? Integrating water resource and land management is essential for balancing growth and development needs with water resource stewardship. Linking development and land management practices with water resource considerations can help attain optimal water use, improve water quality and maintain the quality of life in our communities.

The natural properties and cycling of water. Water is a limited resource that is cyclically exchanged between the earth and atmosphere. An integrated approach to water resource management and protection recognizes this dynamic hydrologic cycle as one of constant exchange through biological, chemical and physical processes. To achieve and maintain water quality sufficient for all the uses of the Basin's waters, the cycle must be honored. Focusing on the water-to-water point sources or direct discharges of pollution through "end-of-the-pipe" regulations and standards, while very successful, is not enough. Attention to the nonpoint sources of pollution, those diffuse sources that are distributed across the landscape, is necessary. This may mean altering development patterns and practices to improve efficient use of water resources and to maintain the function of landscape elements that are integral to the quality and abundance of water resources.

The interconnections of land and water must be incorporated into decision-making. The ecological interconnections of land and water resources have been acknowledged for decades, but quantifying some of the relationships remains a challenge. Understanding those interconnections, however, has not been adequately incorporated into decision-making. As a result, decisions continue to be made with unwanted environmental consequences. While the dynamic and cyclical exchanges of water have global patterns, they are most readily experienced and understood on a watershed basis.

Linking Land and Water Resource Management

WHAT IS A WATERSHED COMMUNITY?

A watershed is the landscape that drains into a waterbody such as a stream or river. Unfortunately, political divides, patterns of commerce and transportation, and even groupings of similar ecological communities do not necessarily fall within watershed boundaries.

For the purposes of the Basin Plan, a watershed community encompasses the residents, landowners, businesses, voluntary associations and governmental units that make decisions about resources and development within a given watershed area. Members of each watershed community are both "upstream" and "downstream" stewards of their portion of the watershed.

Table 2: Examples of Point Sources, Nonpoint Sources and Potential Pollutants

POINT SOURCES	POTENTIAL POLLUTANTS
Sewage Treatment Plant and Industrial Discharges	Toxic Chemicals, Temperature, Nutrients, Organic Pollutants
Piped Stormwater Discharges	Metals, Bacteria, Garbage, Nutrients, Sediments
NONPOINT SOURCES	**POTENTIAL POLLUTANTS**
Septic Systems	Nitrates, Bacteria and Viruses, Household Chemicals
Roads and Parking Lots	Temperature, Hydrocarbons and Metals
Lawns, Farm Fields, Recreational Fields, Construction Sites	Pesticides and Herbicides, Nutrients, Sediment
Pets and Other Animals	Bacteria and Viruses, Nutrients

The natural framework for water resource management is the watershed. A watershed is the total area above a given point on a watercourse that contributes water to its flow, and includes the entire region drained by a waterway or watercourse that ultimately drains into a lake, reservoir, or bay. Watershed management recognizes the natural boundaries of water resources, the landscape elements critical to water supply and quality, and the avoidable disruptions that development and use can cause. A challenge lies in incorporating the watershed into existing decision-making structures, especially when political and natural boundaries are not aligned.

Successful watershed management planning depends on:

- Recognizing that water resources are cycled within a watershed
- Incorporating a watershed framework into our community, regional and statewide decision-making structures

A "watershed management plan" should direct comprehensive management of water and land resources within a watershed boundary. Unfortunately, political divides, patterns of commerce and transportation, and even groupings of similar ecological communities do not fall within, but more frequently cross, watershed boundaries. Given the natural and political constraints hindering the development and implementation of a watershed management plan, integrating water resource considerations into existing decision-making processes may be a more efficient way to link land and water resource management.

Since the vast majority of land management decisions are made at the community level, this Plan suggests focusing on integrating water resource considerations at the level of the watershed community. For the purposes of the Basin Plan, a watershed community encompasses the residents, landowners, businesses, volunteer organizations and governmental units that make decisions about resources and development within a given watershed area.

Linking Land and Water Resource Management

Communities that engage in watershed-based planning acknowledge their respective roles as "upstream" and "downstream" stewards of their portion of the watershed, and participate with other communities in the watershed and with partner agencies and organizations to achieve sustainable use and protect water resources. Community plans and ordinances should be adopted to reflect the common watershed goals for water resource and growth management.

Goals for Linking Land and Water Resource Management

3.1 Preserve and restore natural hydrologic cycles in the Basin's watersheds.
3.2 Maintain and restore the integrity and function of high value water resource landscapes.
3.3 Fully integrate water resource considerations into land use planning and growth management.
3.4 Encourage development and redevelopment in areas where growth can improve the economic viability of local communities while providing for the protection and enhancement of the water resources of the Basin; discourage development and redevelopment where it may impair water resources and their related natural resources.
3.5 Physically and visually emphasize and strengthen the social, historic, cultural, recreational and economic connections of communities to the Basin's waterways.

GOAL 3.1: Preserve and restore natural hydrologic cycles in the Basin's watersheds. From absorption into the atmosphere as a gas, to the eventual recharging of lakes, streams, rivers, estuaries and aquifer systems, the natural hydrologic cycle is a continuous and dynamic process in equilibrium. Human disruption alters the cycle in many ways. Mitigating these disruptions requires us to address land development practices and regulation, as well as impacts from existing development.

Approximating natural seasonal flow regimes. In addition to gauging water budgets on a reasonable watershed scale (see the sidebar on page 20 "Defining the Appropriate Scale for Assessing Watersheds") hydrographs should be established that reflect a natural range of flow variability. The goal is to develop and manage land in a manner that will approximate natural seasonal flow patterns.

Preserving soil health. Healthy soil infiltrates rainfall and enables recharge to support stream base flows and ground water supply. Disturbance or removal of soil inhibits infiltration and, if the remaining soils are compacted, may even prevent recharge from reaching water supply aquifers. Maximizing infiltration reduces runoff and thus minimizes flooding.

Maximizing natural vegetation. Vegetation helps to maintain soil stability, soil structure, and local temperature regimes (microclimates). When vegetation is removed, soil erosion and sedimentation in waterways increases. The removal of root systems can exacerbate soil compaction, affecting infiltration and recharge. A loss of vegetation also alters the amount of evaporated and transpired water to the atmosphere that normally occurs during photosynthesis, resulting in increased localized temperatures. This "heat island" effect is further intensified by large

WHAT ARE HIGH VALUE WATER RESOURCE LANDSCAPES?

- Wetlands — soils, hydrology, vegetation
- Erodible slopes — geology, soils, slope
- Floodplains — areas subject to flooding within a waterway corridor
- Ground water recharge areas — soils, geology
- Headwater streams and associated drainage area
- Potential and existing public water supply sources (surface and ground water)
- Forested areas, especially those associated with headwaters and water supply areas
- Water bodies and their associated riparian corridors, habitat and floodplains

This list is meant to be illustrative, not all-inclusive, as each watershed may contain additional elements, that perform uniquely within that watershed.

amounts of paved surfaces. Not only is the protective shade of streamside vegetation lost, but the stormwater runoff from paved, un-shaded surfaces has a higher temperature to which native stream species may not be tolerant.

Functioning Riparian Wetlands

R. LIMBECK

Replicating the natural timing and volume of stormwater. Routing runoff from paved areas directly into waterways interrupts infiltration. This can result in flooding, severe erosion, temperature and quality changes, and diminution of water availability. Impervious cover and some stormwater collection practices increase the volume and rate of runoff from storm events and may cause localized changes to ground water. Stormwater management must counter the flow and recharge alterations caused by development and ensure the recharge volumes equal those of natural conditions.

- **Wetlands play an important role in the water cycle and in habitat provision. Landscape preservation and stormwater management programs need to consider the water requirements to maintain wetland survival.**

GOAL 3.2: Maintain and restore the integrity and function of high value water resource landscapes. Certain elements of the landscape are integral to the maintenance of the quality and availability of water resources. These landscape elements play specialized roles in water cycling and renewal.

Taking inventory of landscape elements within each watershed. Landscape elements that play a critical role in water cycling and renewal; high value water resource landscapes; should be identified at the watershed level. Steps to retain their hydrological function must be taken when land use, development, and preservation decisions are made.

Incorporating the location and functional importance of high value water resource areas or landscapes into natural resource inventory elements of local and county plans. These elements are important in the local establishment of optimal land use and density, for local and regional landscape protection efforts — such as open space planning

— and for setting performance standards and management practices required for development. Community Master Plans should be revised to include current natural resource inventories inclusive of water resource landscapes, and to reflect zoning that protects high value water resource landscapes.

Including performance standards in local zoning and development ordinances. Local ordinances should incorporate plans and standards to conserve the water resource function of key landscape elements. Performance standards may differ from state to state and among regions of the Basin.

GOAL 3.3: Fully integrate water resource considerations into land use planning and growth management. Water resource considerations are the aspects of water resource use and protection that are related to land use and management. They include:

- Population and economic trends affecting water use
- Water availability and capacity of water supply systems, factoring in the need to include the protection of stressed and threatened source waters
- Availability and capacity of wastewater treatment
- Stormwater management measures needed to preserve and restore natural hydrological function within each watershed
- Protection or enhancement of the capacity of hydrological systems to assimilate point and nonpoint sources of pollution
- Direct and indirect impacts to natural systems
- Maintenance of the function of high value water resource landscapes
- The recreation potential of waterway corridors

Water resource, population and economic information should be assembled and analyzed on a watershed basis to aid discussions and decision-making for planning and permitting purposes. Water resource considerations should be integrated into the planning and growth management processes for communities and regions.

Considering water supply. Master plans, zoning and development ordinances should be consistent with the availability and capacity of local water resources. Some questions for communities to consider are:

- Are watershed communities dependent on surface or ground water supply?
- To what extent is conjunctive use of ground and surface water possible?
- Are current growth management plans and zoning realistic, given water supply availability?
- Is there a current or projected water supply deficit?
- What options exist for enhancing water supply to support expected or desired growth and what potential impacts accompany them?
    - **It is also important to consider the potential threats to source water supplies when re-evaluating zoning and growth management plans.**

Considering wastewater treatment. Plans for wastewater service provision should be consistent with the growth management plans of the watershed communities and sensitive to the condition and capacity of water resources of the watershed. Decisions relating to on-site septic versus regional collection and treatment need to consider the capacity of the receiving water body to accept waste discharge, non-

Linking Land and Water Resource Management

"Experts tell us that water management is best done on a watershed or Basin wide basis. This requires all who have a stake, whether in or outside government, to join in developing approaches tailored to regional needs."

From Madeline Albright's Earth Day 2000 Speech, "Global Water Security in the 21st Century"

discharge alternatives, plans for growth into the future, and the long-term capacity of water supply sources.

Typically, water supply planning and decisions about wastewater management are undertaken separately, often because the entities supplying the service operate independently of one another, and even independently of community plans. Many utility decisions for water and wastewater supply are made through utility commissions or boards that are not connected to community planning or to other agencies with interests in the provision of water services.

Failure to appropriately coordinate water provision and wastewater planning can lead to serious water resource issues. For example, in order to address the pollution of coastal waters large regional plants were constructed to treat and discharge effluent beyond the shallow bays and into the ocean. Coastal areas frequently rely on ground water for potable supply, often from confined aquifers with limited rates of recharge. Where permitted development depends on the capacity of the regional wastewater treatment facilities and does not consider the sustainability of water supply, communities may experience water supply issues, including shortages and saltwater intrusion into freshwater supply sources.

Respecting the assimilative capacity of hydrologic systems. Water bodies become the recipients of wastewater discharges and stormwater runoff. Healthy ecosystems tend to be resilient to some stresses, but only within limits. Understanding an ecosystem's natural limits and linking these limits to water and land management is important for planning, and for setting goals for sustainable development. Just as communities and regional agencies consider the capacity of water and wastewater treatment plants and transportation networks, they should consider the assimilative capacities of the watershed's hydrologic system. Alternatives to direct discharge to water bodies, and the establishment of water quality-based discharge standards are tools used to protect water resources.

Considering the direct and indirect impacts to natural systems. Comprehensive planning efforts examine how water is used and the direct impacts of water withdrawals, wastewater discharges, etc. Indirect impacts include issues such as:

- Increases in stormwater volume and changes in quality from expanding the amount of impervious surface
- Water quality impacts from maintenance activities, such as the application of de-icing agents on roads and parking lots or fertilizer or pesticide applications for agricultural activities, golf courses, and other recreational fields
- Lowering of ground water tables and impacts to streams and wetlands that can accompany increased pumping for irrigation or potable supply

These issues are all linked directly to land development, although they are not necessarily integrated into planning and project permitting processes.

Know your watershed. Establish what is known about local conditions by compiling an environmental inventory. The ability to accurately quantify local hydrological and ecological systems is hindered by limited data, a lack of modeling tools, and by fiscal resources. Often, a complete inventory of local conditions is necessary for improving planning and decision-making. However, there are characterization and assessment

tools available for planning purposes. Watershed communities can work together, sharing the costs associated with data collection and resource protection, just as they share the benefits of a healthy watershed.

- **There is a need for local planning tools to assess the impacts of alternative development scenarios.**

GOAL 3.4: Encourage development and redevelopment in areas where growth can improve the economic viability of local communities while providing for the protection and enhancement of the water resources of the Basin; discourage development and redevelopment where it may impair water resources and their related natural resources.
Choices about where and how development occurs, and how activities are managed on the landscape, affect the quality and availability of water resources. Prudent choices for growth and development incorporate water resource protection, and use fiscal resources efficiently. Governmental agencies, in partnership with private and non-profit organizations, can develop financial and regulatory incentives to encourage smart choices for growth, development, and redevelopment that do not impair water resources.

The following actions are necessary to accomplish this goal:

- Examine impacts and develop plans on a watershed, aquifer or regional basis
- Identify targeted areas for redevelopment to absorb growth where supporting infrastructure already exists or could be improved
- Develop criteria and incentives for coordinated review processes to facilitate development and redevelopment in appropriate areas
- Cluster new development to provide a mix of uses and activities, minimizing transportation impacts as well as landscape alteration
- Remediate contaminated sites and brownfields and return them to productive use
- Maintain current waterway and port infrastructure
- Employ regional approaches to sediment management
- Adopt ordinances and regulations designed to protect water and support natural resources through performance standards
- Incorporate natural features as functional design elements, e.g., linking constructed and natural wetland systems for stormwater and wastewater management
- Educate policy-makers, decision-makers and developers about water resources, the benefits they provide, and their community enhancement potential
- Restore the visual and physical connections of people to the waterways at every opportunity

GOAL 3.5: Physically and visually emphasize and strengthen the social, historic, cultural, recreational and economic connections of communities to the Basin's waterways.

What's the connection? Waterway landscapes appeal to all of our senses. Our history and culture are tied to our waterways. Our progress as a society has depended on water for transportation, power, commerce, recreation, and for poetic and artistic inspiration.

Linking Land and Water Resource Management

". . . the time has also come to identify and preserve free-flowing stretches of our great rivers before growth and development make the beauty of the unspoiled waterway a memory."

From President Lyndon Johnson's "Message on Natural Beauty"

Unfortunately, many people take water for granted, possibly because they are disconnected from it. Drinking water comes from a pipe or a bottle. Buildings, abandoned industrial sites, or the protective railings of the bridges that traverse rivers and streams and the roadways that hug their shores often block views of waterways.

Experience is education. Education and knowledge are the foundation for stewardship, the concept of responsible care-taking based on the premise that we do not own resources, but are managers and are responsible to future generations for their condition. Providing the opportunity for waterway experiences is critical not only to the stewardship of water resources, but for the maintenance of some of the best aspects of human culture.

- **It is important to acknowledge the historic roots of a community as well as its current and future social and cultural needs.**

Providing the opportunity to experience our waterways. Re-establish access and visual connections where suitable, especially in association with redevelopment opportunities. In urban areas, projects for the redevelopment of abandoned waterfront areas should require elements designed to restore connections and relationships to the waterfront. Providing opportunity to experience our waterways may include commuter ferries, river walks and bike trails, boat access points, fishing piers and interpretive signage. Public lands should incorporate educational elements to foster stewardship.

We need to maintain what we have and to restore what we have lost. Without the opportunity to experience our water resources — especially for sheer enjoyment and wonder — we may remain disadvantaged, missing the inspiration of water.

Annual Delaware River Sojourn

DRBC PHOTO

Linking Land and Water Resource Management

Linking land and water resources management summary. This Key Result Area involves all aspects of water resource management, landscape management, planning and growth management, cooperation and coordination, education, and stewardship. Integrating the management of land and water resources challenges us to:

- Understand the physical, chemical and biological processes that define the water-land connection within a watershed
- Recognize the management strategy options necessary to achieve positive water resource and development outcomes
- Improve communication and planning within the watershed community
- Improve regional coordination among water resource and land use agencies
- Create public, non-profit and private partnerships
- Improve our collection, analysis and distribution of water resource information
- Develop and use analytical tools for local and regional decision-making
- Commit state, regional and local entities to engage in and support growth management and resource protection on a watershed basis
- Commit financial resources to support and coordinate local and regional planning and water resource protection efforts

The first three Key Result Area sections address the human and ecological uses of water, the critical land-water interface of waterway corridors, and the watershed landscapes and management decisions that can have long-term impacts on water resources. Clearly, the human component is a critical one. Individuals, businesses, organizations, and society, have the potential to effect important changes to our water resources through the land and water management decisions we make every day. The following section, "Key Result Area 4: Institutional Coordination and Cooperation," focuses on how to manage that human component through our decision-making structures, formal and informal partnerships and agreements, sharing of information, ideas and data and, ultimately, by institutionalizing our relationships to the water resources of the Basin.

"There would be obvious advantages to bringing a unified political control over the management of a single ecosystem [or bioregion]… In the latter part of the twentieth century it appears more feasible to seek close cooperation among the agencies involved in management of a bioregion than to attempt the redrawing of political maps."

R. F. Dasmann

KEY RESULT AREA 4

Institutional Coordination and Cooperation

Desired Result: *Strong, institutionalized partnerships for the management of water resources among all levels of government, the private sector, non-governmental organizations, and individuals with an interest in sustainable water resources management.*

What does institutional coordination and cooperation mean? Integrated management requires that all the related aspects of the water resource be considered in decision-making at all levels and within many jurisdictions. Successful implementation of this Plan requires a high degree of coordination and cooperation, including horizontal and vertical integration, and partnerships institutionalizing these relationships.

Why is institutional coordination and cooperation important? Historically, water resources management has been fragmented, with different agencies and multiple players working on their own programs and agendas — often redundantly, sometimes at cross-purposes, and usually on single issues. We now understand the need for integrated management, coordination, and collaboration. The Basin Plan is the product of a collaborative planning effort by a wide range of Basin stakeholders. While it is clear that an integrated approach to managing our water resources is important, achieving and sustaining the necessary level of coordination and cooperation among the Basin's many decision-makers and other stakeholders requires that relationships among partners be reflected institutionally — how we make decisions and "do business" on a daily basis.

Horizontal integration means coordinating actions and programs among actors operating within a level of jurisdiction.

- **External:** Where two or more agencies at the same jurisdictional level have responsibility for an aspect of water resources, there is a need for consistency in the application of policy. For example, the agencies responsible for floodplain and stormwater management need to work together to achieve a uniform policy message and outcome.
- **Internal:** Departments within agencies must establish consistency among programs. For example, offices responsible for wastewater management plan approval, water allocations and facility permitting need to coordinate plan and permit review requirements. This will result in a more comprehensive overview of water resource use and can lead to streamlined review processes and greater overall efficiency.

Vertical integration involves the alignment of efforts at various decision-making levels to achieve consistent outcomes. For example, when the Federal government sets minimum standards pursuant to the Safe Drinking Water Act, the states must adhere to them (unless they adopt more stringent ones), and regional and local

Institutional Coordination and Cooperation

"The DRBC's framework for regional coordination under the federal-interstate compact mechanism appears unrivaled by any existing or proposed institutional arrangement."

Western Governors' Association Report, 1982

jurisdictions must apply these standards when exercising their permitting or management authority.

Stormwater and flood management represent another far more complex example. Stormwater involves issues of quality, quantity and timing for which policies, plans, regulations and permits must be developed and approved. Flood management shares a concern with timing and quantity, but involves event forecasting and response activities, mitigation planning, and inspection activities to minimize loss of life and property. The variety of concerns associated with stormwater and flood management are mirrored in our institutionalized approaches. An array of federal, state and local agencies are responsible for the various aspects of stormwater and flood management. The challenge lies in coordinating them to secure uniform policy and consistent outcomes.

The Value of Partnerships: Partnerships play a critical role in fostering integration management efforts. Partnerships offer:

- *A Common Focus*: Attention on a common concern or landscape draws together different interests.
- *A Level Playing Field:* In a partnership all participants regardless of their authority, financial or political interests, have an equal role in decision-making.
- *Improved Communication*: Sectors that are often isolated from decision-making can have a voice in the decision process.
- *Information Exchange*: Partnerships provide a forum for instantaneous information exchange and increase understanding of the environmental, economic and political consequences associated with the issue.

Merrill Creek Reservoir

MERRILL CREEK OWNERS GROUP

Institutional Coordination and Cooperation

Coordination and Cooperation are necessary to:

- Ensure consistency among state laws and state and local regulations, ordinances and plans
- Support the integrated management of land and water resources
- Enable multi-municipal approaches to address growth management and water resource issues in a watershed context
- Support and implement watershed-based trading
- Coordinate flood hazard mitigation planning and implementation
- Coordinate recreational planning and facility development
- Coordinate restoration activities
- Control the spread of invasive species
- Design and implement nonpoint source runoff controls
- Support effective habitat conservation and protection projects
- Support coordinated research, study, and monitoring of streams to further our understanding of ecological processes
- Develop and adopt integrated resource management plans
- Accommodate the rights of New York City and New Jersey under the 1954 Supreme Court's decree, improve water flows necessary to sustain growth in the down-Basin states and to protect fisheries and ecosystems

Goals for Institutional Coordination and Cooperation

4.1 Improve coordination and cooperation in the management of water resources in the Basin.

4.2 Increase sharing of data, information, and ideas among Basin institutions, agencies and organizations, and reduce duplication.

4.3 Secure adequate resources for programs and projects that encourage cooperative water resources planning and management.

4.4 Use water resource partnerships to support and execute water resource management in accordance with the Guiding Principles, Goals and Objectives of the Basin Plan.

4.5 Utilize the planning and regulatory powers of a regional governmental authority, the Delaware River Basin Commission, to facilitate coordination and cooperation.

GOAL 4.1: Improve coordination and cooperation in the management of water resources in the Basin. This Goal cuts across all of the Key Result Areas encompassed in this Plan. There is not one single "cookie-cutter" approach to improving coordination and cooperation among the many agencies, businesses, elected officials, non-profit organizations and individuals who play a part in managing the Basin's water resources. For each area of research, planning, policy, management or decision-making that this Plan addresses, several steps must be taken to improve coordination and cooperation. The details of how to deal with each of the issues described below varies with the particulars of each area.

Defining the key players whose efforts must be coordinated. The list may include both Federal and state agencies, local units of government, business and industry, research institutions, and citizen groups. When identifying key players, it is important not to neglect stakeholders whose perspectives may not be reflected

"Any river is really the summation of the whole valley. To think of it as nothing but water is to ignore the greater part."

Hal Borland
This Hill, This Valley

by the existing decision-making structure. Coordination must take place both as collaboration across different areas of interest (horizontally) and as alignment within a single institution or hierarchy of institutions (vertically).

Identifying the relevant policies, laws, regulations and planning or permitting processes which need to be better aligned, made more consistent, or otherwise coordinated. Conflicts among plans, laws, or regulatory regimes may reflect real differences in objectives, as well as lack of communication. This Plan and its Guiding Principles are intended to help overcome these differences.

Creating a vehicle for collaboration that can bring the key players together. Depending upon the players involved and the plans, regulations, or activities to be coordinated, this may take the form of a collaborative planning process with a defined objective and deadline e.g., a technical working group that convenes periodically or an advisory committee that reports to a lead agency. Not all players may be on an equal footing with respect to resources and responsibility. Consequently, when establishing partnerships or collaborative efforts, it is important to take into account the constraints and costs of individual contribution to ensure effective participation by all parties.

GOAL 4.2: Increase sharing of data, information, and ideas among Basin institutions, agencies and organizations, and reduce duplication of effort.

Making information available in accessible formats. Federal, state and regional agencies and non-profit environmental organizations collect a broad array of water resource-related data. This information must be available in formats that can be easily interpreted in order to implement this Plan. Maps, for example, are easy to read and can be particularly useful for policy and planning purposes when associated with GIS spatial coverages that allow the overlay of other data.

Assessing the usefulness of collected data. While basic information is usually straightforward to use, other raw data — such as daily precipitation, stream flow, or monthly water quality reporting — are not directly usable by policy and decision makers. This kind of data needs to be compiled and analyzed prior to use. In addition, some data needs to be interpreted to be of significant benefit to users.

- **The question of watershed scale is critical to our understanding of water resource issues and to the measures we develop and employ to address them. Specific problems must be understood within their local context. A regional or Basin-wide context should also be considered when evaluating alternatives.**

Identifying gaps and overlaps in data collection. Partnerships may be able to help fill gaps in data collection or eliminate duplication where efforts overlap.

Providing a forum for discussion and analysis of available information. There is a vast array of information, data, conjecture and misinformation available from many sources. Making sense of this information requires the opportunity to share, discuss, debate, learn and solve problems. Issue-based forums provide networking opportunities, forge partnerships, and enhance the stewardship of water resources.

GOAL 4.3: Secure adequate resources for programs and projects that encourage cooperative water resources planning and management. Always a necessity and a challenge, targeted, strategic provision of resources is necessary to address the Goals of the Basin Plan.

Identifying existing resources. Many state, regional, and local programs are actively engaged in promoting, protecting, and enhancing water resources. An initial assessment of current or planned activities and programs can be compared with the Plan Objectives to determine which issues require special attention and cultivation of resources.

- **Explore additional resource opportunities to support investigation, monitoring, planning, assessment and implementation activities.**

Identifying and increasing opportunities to leverage federal and state funds for water resource planning, protection, and restoration. Create opportunities that encourage multi-jurisdictional approaches for programs and projects that encourage cooperative water resources planning and management.

GOAL 4.4: Use water resource partnerships to support and execute water resource management in accordance with the Guiding Principles, Goals and Objectives of the Basin Plan. This Plan was developed with input from individuals representing federal, state, and local government agencies, businesses and non-governmental, non-profit organizations. Implementation of this Plan will require the continued efforts of these partners and others.

Engaging a cross-section of Basin stakeholders to implement the Basin Plan. While the DRBC will have primary responsibility for compiling data relevant to measuring milestones and indicators, Basin partners need to continue to provide input and oversight.

The 13,539 square miles of Basin territory is too large and its conditions too varied to engage local participants effectively on a Basin-wide scale. However, effective engagement of local contributors from the 838 municipalities, 42 counties, and myriad watershed associations is essential. Watershed regions, defined by grouping adjacent watersheds, perhaps those of the HUC 11 scale (see "Key Result Area 1: Sustainable Use and Supply," and the "Water Regions of the Delaware River Basin" map) offer a means of addressing local and regional issues and effectively engaging participation. Several regions have already successfully organized such as the collaborative efforts established for the Lehigh and the Schuylkill Rivers.

GOAL 4.5: Utilize the planning and regulatory powers of a regional governmental authority, the Delaware River Basin Commission, to facilitate coordination and cooperation.

Coordinating federal and state agencies within the Basin. The Delaware River Basin Commission is a federal-interstate agency, established by compact to manage water resources within the Basin. One purpose of the Commission is to coordinate the management of a common regional resource that was previously subject to administration by 43 state agencies, 14 interstate agencies and 19 federal agencies.

Institutional Coordination and Cooperation

EXAMPLES OF COOPERATIVE WATERSHED PLANNING

Schuylkill Watershed Conservation Plan, PA 2001 (www.schuylkillplan.org)

Final River Management Plan for the Upper Delaware Scenic and Recreational River, National Park Service — NY-PA 1986 (www.nps.gov/upde)

Watersheds: Integrated Water Resources Plan for Chester County, PA 2002 (www.chesco.org/water/index.htm)

White Clay Creek and its Tributaries — Watershed Management Plan, National Park Service-DE-PA 1996 (http://mercury.ccil.org/~wcc_ws)

Clean and Plentiful Water: A Management Plan for the Rancocas Creek Watershed, NJ 2003 (www.co.burlington.nj.us/rancocas)

Rain-Swollen Delaware River, October 30, 2003

C. D. RUPERT

Managing water resources pursuant to a comprehensive plan. The compact authorizes the Commission to develop and adopt, after public hearing and with input from the states and their political subdivisions, a comprehensive plan for the immediate and long-range development and use of the water resources of the Basin. The Commission should use its Comprehensive Plan to coordinate the goals and activities of government agencies, and to guide and where appropriate, regulate private activities.

Using the Commission's multi-faceted authority to assist and administer water resources in an integrated manner. The Commission is uniquely placed to integrate and provide consistency among federal, state and regional water resource programs. The Commission's Compact grants broad powers in areas of water supply, pollution control, flood protection, watershed management (including soil conservation and fish and wildlife habitats), recreation, hydroelectric power and surface and ground water withdrawals and diversions.

Leading by example and guidance as well as through regulation. The Commission should use its planning authority and leadership to educate, partner with other public and private entities, and demonstrate how water resources can be wisely managed. Where coordinated efforts are important, the Commission should explore utilizing regulatory mechanisms such as setting performance standards that allow states, political subdivisions and private parties maximum flexibility to select the methods to meet the standards.

Emerging Challenges

An ongoing challenge for resource managers and decision-makers is responding to changing conditions and uncertainty. This includes keeping abreast of new information on current problems as well as being aware of emerging issues. The Guiding Principles that preface this Plan serve as a foundation for the development, analysis and application of alternative solutions to water resources issues. They direct us to consider the links among the physical, biological, chemical and hydrologic systems as well as the economic, political and social consequences of potential actions as a part of integrated management efforts.

Information sharing, coordinated analysis and collaborative actions are all integral to success in dealing with emerging issues. Many of these issues are especially daunting due to the potential magnitude and range of their impacts and the uncertainty of our predictions.

Climate Change: In 1998, the U.S. Global Change Research Program and federal agencies sponsored regional assessments to determine the potential consequences of climate variability and change for 16 regions. "Preparing for a Changing Climate: The Mid-Atlantic Overview", published in March 2000, presents the initial results for the region that includes the Delaware River Basin. The assessment is based on the convergence of climate model projections that the region will become somewhat warmer and perhaps wetter, with potentially more variability in climate. Overall, the report indicates greater heat-related impacts to human health and substantially greater negative impacts on coastal zones, biodiversity and ecological functioning.

The assessment suggests that climate change poses diverse and potentially large risks to the region's ecosystems. This is due to lingering effects from earlier degradation that are compounded by continuing pressures on many of the region's ecological resources at a time of growing societal demand for ecological resource protection, both for its own sake and for recreational uses. Although there may be a slight increase in available water, *water quantity* may be slightly more variable due to droughts and floods.

The three most important actions identified by the assessment are:

1. Use a watershed perspective to reduce flood damages and protect water quality
2. Remove incentives for practices that place people, investments and ecosystems at greater risk, e.g., promoting building in areas vulnerable to erosion and flooding
3. Set up communication, learning tools and programs that help the regional community's identify how they can capitalize on benefits and reduce damages from climate change

- **Monitoring and analyzing conditions, discussing and agreeing on strategies to minimize impacts, and making decisions to confront the damages that might occur from sea level rise and climatic change requires the involvement of all agencies and partners. It challenges our flexibility and resolve.**

Invasive Species Management: As mentioned in "Key Result Area 2: Waterway Corridor Management," competition from invasive species is second only to habitat loss in its impact on ecosystem integrity. An invasive insect, plant, or animal may have a very solitary and silent introduction into its new environment. As it

"Anything else you're interested in is not going to happen if you can't breathe the air and drink the water. Don't sit this one out. Do something.""

Carl Sagan

reproduces, it may successfully compete for food and habitat and displace native species, or simply create a new niche for itself. There may not be any predators to keep its populations in check. Most frequently, individuals remain unnoticed. It isn't until we observe the destruction of its food source or its competition that we are alerted to the invader.

The challenge of invasive species involves identification, knowledge of foraging and reproductive cycles to determine the safest method of control or eradication. It is also necessary to understand the route of introduction in order to impede or prevent the importation of additional members. Invasive species threaten the health and diversity of our ecosystems and many of our commercial enterprises. Multiple agencies need to share information and work cooperatively to develop elegant responses to control or eradicate harmful invasive species.

Emerging Water Quality Challenges: We continue to improve our ability to detect ever smaller amounts of substances in our water. The EPA currently establishes water quality standards for many of them, including man-made chemicals, naturally occurring contaminants and pathogens. In addition, new chemicals are continually developed for use in agricultural production, as additions to animal feed for improving growth, and as supplements and medications for promoting human health. Via stormwater or wastewater, many of these compounds enter the environment and the water supply. Our understanding of the long-term effects of many of these substances is poor compared to their widespread use.

Advances have been made to understand the effects of some substances, such as DDT and PCBs, banning their use and managing known sources on the landscape. However, there is a growing list of potential contaminants, and a increased concern for the potential ecological and human health effects. For many substances in our water, there is incomplete information on long-term effects. The impact of complex

White Clay Creek

DAVID L. MILLS

mixtures of chemicals is poorly understood. The ability of some substances to mimic hormones and affect reproductive ability and outcomes also needs further study.

Improved institutional coordination and cooperation to develop new management strategies and alternatives will be relied upon to deal with the challenge of climate change, water quality and other emerging issues. Ultimately, the decisions made by institutions are based upon our collective knowledge and appreciation of the complexities of our water resource systems and how our actions can both positively and negatively affect them.

The following section, "Key Result Area 5: Education and Involvement for Stewardship," focuses on the need to foster a sense of stewardship through education, outreach, and opportunities for action. Improving our understanding of our relationship to water, and embracing our role as stewards of this critical resource is essential for ensuring the sustained productivity of both the ecological cycles of nature and the economic and cultural viability of our society.

Institutional Coordination and Cooperation

Prior to 1930
First Philadelphia Intake on the Delaware (1850)

1930 to 1934
Corps of Engineers 308 Plan, First Comprehensive Water Resources Plan for the Delaware Includes Proposal for Tocks Island Dam

May 1931
U.S. Supreme Court Decree Supports NYC Diversion Rights

May 25, 1931
U.S. Supreme Court grants New York City the right to withdraw 400 million gallons a day (mgd) from two reservoirs to be built on headwater tributaries feeding the Delaware main stem.

1936
Three Basin states, New Jersey, New York, and Pennsylvania, create the Interstate Commission on the Delaware River Basin (INCODEL), an advisory body which establishes water quality standards and begins taking measures to meet them. The State of Delaware joins in 1938.

30's

40's

December 1941 to August 1945
WW II

June 7, 1954
An amended 1931 U.S. Supreme Court decree permits New York City to increase its withdrawal rate to 800 mgd, contingent on the city's construction of a third in-basin water supply reservoir, and on the city's consent to release from its three upper-basin reservoirs sufficient water to assure adequate stream flows down river. The decree also permits an out-of-basin diversion to central and northeastern New Jersey through the Delaware and Raritan Canal.

July 1955
Governors Meet to Discuss Regional Watershed Management

August 1955
Record Flooding in Basin

Summer 1955
NYC's Pepacton and Neversink Reservoirs Become Operational

1956 to 1960
Corps of Engineers Comprehensive Study of Delaware River Basin

July 1955 to December 1960
The Basin state Governors look at ways to put regulatory muscle behind INCODEL, creating a regional body with the force of law to oversee development and control of the river system. The worst flood in the Basin's recorded history — a flood that takes 99 lives — leads Congress to direct the U.S. Army Corps of Engineers to develop a comprehensive physical plan for the Basin. The Corps' December 1960 report calls for 58 water control projects to be built over a 50 year period. The largest dam in the plan is for the main stem of the river at Tocks Island.

September 1961
President Kennedy signs the Delaware River Basin Compact, creating the Delaware River Basin Commission (DRBC), and marking the first time in the nation's history that the federal government and a group of states had joined together as equal operating partners in a river basin planning, development, and regulatory agency.

1962
Authorization of First Mainstem Dam at Tocks Island

1961 to 1967
Record Setting Drought Grips Basin

1965
Cannonsville Reservoir Becomes Operational

1969 to 1974
National support for environmental protection leads to legislation requiring environmental impact statements, the establishment of the US EPA, and federal programs for expanded water quality protection. The Basin states establish departments of environmental protection and conservation.

60's

4

Water Resource Management Highlights

70's

1970
Adopted National Environmental Policy Act (NEPA)

1971, 1972
Tocks Island Dam Construction Delayed; Environmental Issues Unresolved

1972
Federal Water Pollution Control Act Amended (Clean Water Act (CWA))

1974
Federal Safe Drinking Water Act (SDWA)

1975
Commission Votes Against Construction of Tocks Island Dam

1976
DRBC Begins Level B Study to Identify and Resolve Water Resources Issues

1978
Upper and Middle Delaware Scenic and Recreational River Established

1979
Good Faith Negotiations Begin

80's

1978 to 1983
A record drought during the 1960s, followed by opposition to plans to dam the Delaware at Tocks Island, led the DRBC to examine alternative ways to provide adequate water supply during droughts. Five years of deliberations among the 1954 Supreme Court decree parties result in a "Good Faith Agreement" which includes 14 recommendations focusing on drought management. The foundation for the Agreement, the Level B Study released in 1981, identified a preferred plan of action for water resources management through 2000.

1980
Southeastern Pennsylvania Ground Water Protected Area Established

May 1981
Level B Study Released

1983
Good Faith Agreement Adopted

1988
Delaware Estuary Awarded Status in the National Estuary Program

June 1989
Dedication of Merrill Creek reservoir that replaces consumptive losses from power generation, part of the Good Faith Agreement.

1986 to 1992
Water conservation program established by DRBC for Pennsylvania's portion of the Basin.

1996
Comprehensive Conservation Management Plan (CCMP) Adopted for the Delaware Estuary

1998
Withdrawal limits set for Southeastern Pennsylvania Ground Water Protected Area established in 1980.

April 1999 to September 1999
DRBC leads Basin-wide effort to determine public opinion on water resource related issues. Results were advanced in the "Flowing Toward the Future" report released in September 1999.

September 29, 1999
Governors of the four Basin states sign the "Resolution on the Protection of the Delaware River Basin" and call for the development of a new comprehensive water resources plan for the Basin.

October 2000
Lower Delaware River and White Clay Creek joined the Upper and Middle Delaware River and the Maurice River as part of the national Wild and Scenic River system.

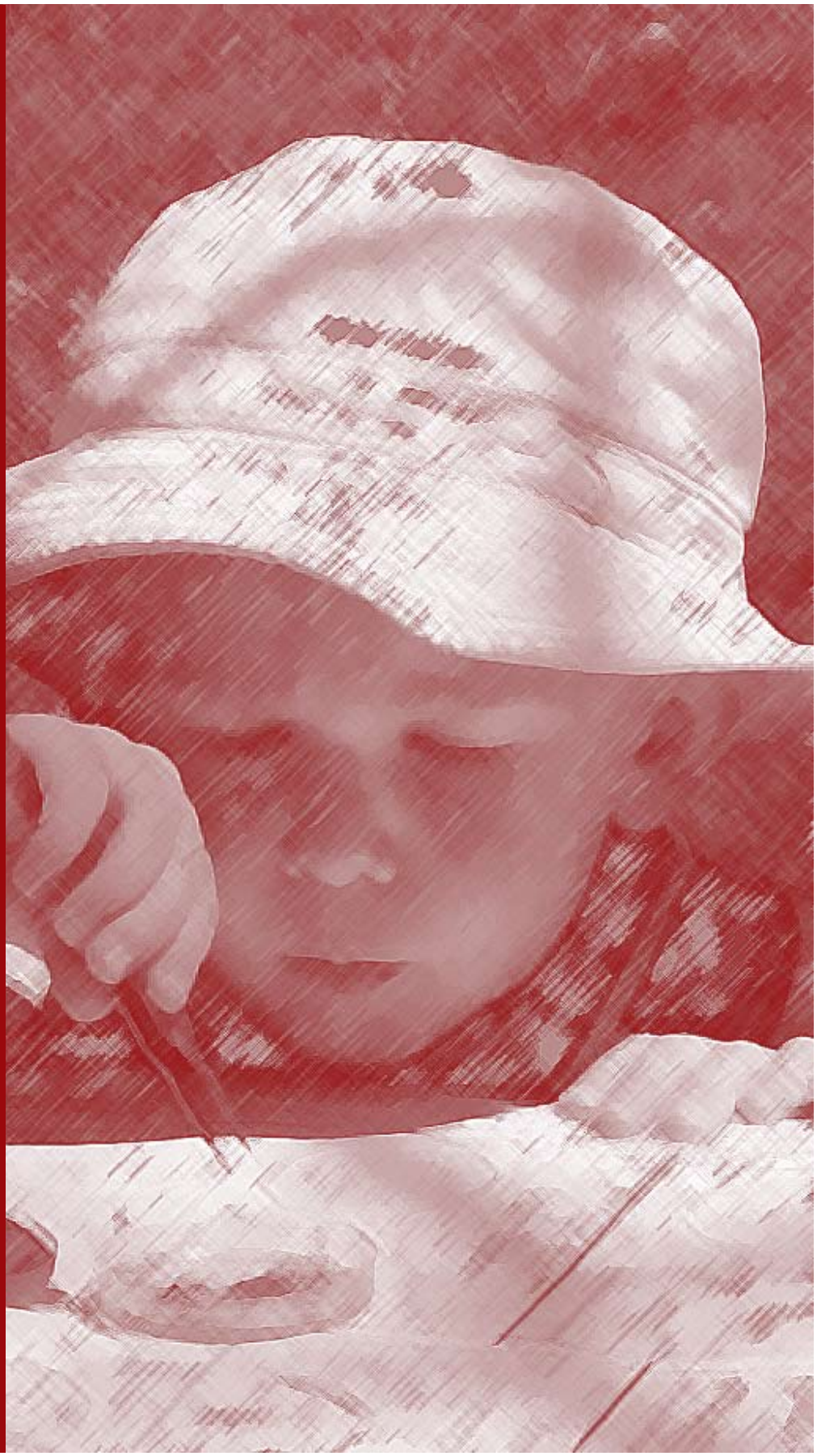
December 2003
TMDLs Established for PCBs in Tidal Portions of the Delaware River

Figure 10: Basin Events Timeline (Sources: *Damming the Delaware: The Rise and Fall of Tocks Island Dam* by Richard C. Albert, and DRBC documents.)

"Ultimately, a water ethic is about sharing — both with nature and with each other."

Sandra Postel

Last Oasis



KEY RESULT AREA 5

Education and Involvement for Stewardship

Desired Result: *The Basin community shares a collective understanding and appreciation of the Basin's water resources and a commitment to their restoration, enhancement, and protection. This community values the water resources and understands the personal responsibilities needed to protect the resource.*

What does education and involvement for stewardship mean? The protection and prudent use of the water resources of the Basin depends on every resident, each company, and all organizations involved with activities related to or relying on water. Improving our sense of individual and collective stewardship is critical for achieving the Goals and Objectives of this Plan.

Why is education and involvement for stewardship important? The goal of stewardship is to promote good management of land and water resources through increased understanding and awareness. Knowledge and communication of information is a key foundation of stewardship.

A basic premise of water resource stewardship is to learn two things — that we live in a watershed and that we understand how to live within the limits of our water resource system. Good water resource education programs establish and enhance such awareness.

Four elements of water resource education* are:

1. *Water Resource Awareness* — Raising and promoting basic awareness and an understanding of water resources gives people the tools to investigate avenues for change
2. *Personal Stewardship* — Educating citizens about the individual roles they play in water resource stewardship communicates specific messages about positive and negative behavior, inspiring personal action
3. *Professional Training* — Educating decision-makers in the private and public sectors about opportunities to apply water resource protection tools, operations management for pollution prevention, maintenance methods, etc.
4. *Engagement* — Providing opportunities to actively engage in protection and restoration activities

An important part of education for stewardship is providing individuals, corporations, government officials, and other stakeholders with opportunities to actively engage in protection, outreach and restoration activities.

**Note: This section is based on watershed stewardship programs found in Rapid Watershed Planning Handbook, 1998, published by the Center for Watershed Protection, Ellicott City, MD.*

Education and Involvement for Stewardship

"We are still in transition from the notion of man as master of the earth to the notion of man as part of it."

Wallace Stegner

Goals for Education and Involvement for Stewardship

5.1 Establish a Basin-wide sense of place.
5.2 Increase student and youth awareness, understanding and active participation in water resources issues.
5.3 Increase private sector awareness, understanding, and active participation in water resources issues.
5.4 Increase local public officials' awareness, understanding, and active participation in water resources issues, needs and management strategies.

GOAL 5.1: Establish a Basin-wide sense of place. Creating awareness and understanding of the river and its watershed resources to encourage stewardship.

- **Motivate Basin residents, businesses and officials to identify with their watershed address and to take responsibility for their behavior with respect to watershed resources.**

Water resource management requires an active and informed citizen commitment — to participate in local watershed activities and to make "water smart" lifestyle choices.

Expanding the use of web-based and mass media resources. In conjunction with other agencies and organizations in the Basin, the DRBC already links many existing sites from a central home page. Enhancing these capabilities and expanding information coverage will facilitate the acceptance and implementation of the Basin Plan. (See also "Key Result Area 4: Institutional Coordination and Cooperation," Goal 4.2.) The mass media can play an important role in educating the public about water resource issues and the importance of conservation and other good practices. Workshops for reporters, editors and other media professionals can play an important role in ensuring the dissemination and consistency of critical messages. Projects that rely on volunteers, such as streamside restoration and planting, need to be advertised well in advance; print and radio media are critical elements.

- **Establish a Basin-wide clearinghouse and inventory of watershed projects, programs and contacts to create a more formal link among non-governmental groups involved in water resource issues.**
- **Employ mass media coverage of water resource issues to expand outreach.**

Increasing opportunities for participation. Expanding the number of projects, activities, and programs for citizens to participate in increases their exposure to water resource issues and to stewardship opportunities. Successful expansion of participation opportunities must include an appreciation for the increasing ethnic diversity of the Basin. Outreach efforts should include minority populations and their interests and concerns about water resources. Messages about lifestyle management must reflect sensitivity toward cultural and religious practices.

Implementing signage programs. "It's your/my/our watershed!" Providing geographic reference to streams and their drainage systems for the Delaware River Main Stem and all major tributaries that cross interstate and state highways can help convey this message. Signs telling motorists they are entering a particular watershed or crossing a stream are already beginning to appear along roadways. This "watershed addressing" technique educates visitors as well as increasing residents' awareness

of where they live and travel in relationship to their home watershed and to other watersheds in the Basin.

GOAL 5.2: Increase student and youth awareness, understanding and active participation in water resources issues. We must take several steps to offer age-appropriate activities and curricula about water resources and the Delaware River Basin to the next generation of decision-makers. An integrated, sequential, K-12 science curriculum focused on the Delaware River Basin and emphasizing service in partnership with the community can provide districts and educators with some of the tools needed to expand water resource education in our schools.

Providing outdoor experiences to engage students in learning about their watershed. Nothing makes a watershed lesson more fun and interesting than actual participation in an outdoor experience. This is when theory becomes alive and engaging. Students can learn about important water resource educational elements by applying science concepts directly to a local watershed, monitoring their local watersheds through field studies, learning about the impacts of water resources in their communities, and restoring watersheds through community needs-based projects.

Supporting educators by providing information. A web-based clearinghouse can provide timely, local aspects on water resource issues useful for curricula and activity development.

The A. J. Meerwald is a sailing classroom promoting ecological and historical awareness of the Delaware Bay region.

BAYSHORE DISCOVERY PROJECT

Education and Involvement for Stewardship

"If there is magic on this planet, it is contained in water."

Loren Eiseley, "Four Quartets", *The Immense Journey*

GOAL 5.3: Increase private sector awareness, understanding, and active participation in water resources issues. Water resource protection and enhancement is a salient business issue. The challenge is to create opportunities to form and firm the partnerships that produce positive results in water resource issues and sustain commerce in the Basin.

Encouraging private businesses to adopt water resource stewardship as part of their mission. A long-term corporate commitment to stewardship protects water resources for future generations in many ways. While adopting water resource-friendly policies at physical plant and office locations, corporations can advise their customers on how to handle or operate their products and inform them of any changes of regulations. The private sector can also partner with non-profit and local associations to promote community water resource programs.

Disseminate information about water resource issues to the commercial community; describe water resource linkages with their commercial products and properties, and suggest partnership opportunities. Highlight demonstration projects that showcase innovative and progressive commercial projects. These models serve as examples for other private sector interests as well as good public relations for water resource management.

GOAL 5.4: Increase local public officials' awareness, understanding, and active participation in water resources issues, needs and management strategies. As emphasized throughout this Plan, better local land use decisions are the key to protecting water resources. Public officials at the county and municipal levels make most of these decisions. Outreach to these officials is critical, because state and federal regulations do not and cannot provide a range of protection adequate to address all the potential impacts of land management decisions on water resources.

Targeting elected officials and local leaders for education and assistance. Local leadership is essential for local action. Leadership within the decision-making process can be especially effective to forge the critical link between land use and water resource management.

- **The watersheds of the 13,539 square-mile Basin include all or portions of 838 towns, townships, boroughs and cities in 42 counties.**
- **The political and legislative structure of three states and a commonwealth dictate differences in roles, responsibilities and authority among those entities.**
- **Political cycles determine changes in community management occurring with great frequency — potentially every one to four years. Dedicated commitment is required to provide education and technical resources as each new team of leaders takes office.**

Providing technical assistance to watershed communities. To incorporate changes in land use plans and regulations, watershed communities require technical information that is scientifically sound and legally defensible. Broad-based information about the role of planning in water resource management is a critical element of this education and outreach.

- **Generally, communities are hesitant to take action on an issue if it makes them vulnerable to legal action. Education and assistance programs must be developed to**

address this issue. Water resource protection needs to be easy and relatively effortless for successful local adoption and application. Model ordinances can facilitate this.

Fostering partnership and communication among communities within each watershed. It is important for each jurisdiction to understand its role within a watershed. (See "Key Result Area 3: Linking Land and Water Resource Management" for a discussion on watershed community). Watershed communities should be encouraged to share information, collaborate on similar issues and agree on desired water resource outcomes. Non-profit organizations such as local watershed alliances can help facilitate this collaboration.

Addressing the upstream and downstream roles of the community as part of outreach to public officials. Programs to educate and encourage stewardship among public officials should help them to understand how their community fits into the larger picture of the watershed, and where their watershed fits into the Basin.

- **Most officials have a good understanding of the political landscape in their county and state. The 'waterscape' needs to become just as salient to accomplish improved water resource results.**

Making funding and other resources available for watershed communities to prepare and implement water resource-oriented plans and ordinances. Making resources available with a minimum of fuss and hassle can make a big difference at the local level. A dedicated fund to improve the water IQ of local decision-makers is especially valuable and practical.

One of the purposes of developing this document is to provide a management tool for addressing the many water resource-related issues facing the Delaware River Basin. Through the narrative sections of this Plan, a direction has been set and Goals have been identified to achieve the Desired Results. The following section is a Matrix of Goals and Objectives. The identified Objectives lead to successfully reaching the Goals. Accomplishing the Objectives requires applying the integrated management concepts described throughout the Basin Plan.

Matrix of Goals and Objectives

Building on the issues from each Key Result Area, sets of Objectives have been defined as necessary components to achieve the Goals of the Basin Plan. The following Matrix contains these groups of Objectives by Goals within Key Result Areas. Each Goal and its corresponding Objectives has an identification number relating it to a principal Key Result Area. The number is strictly for convenience and reference and does not imply any priority within the Plan.

The Matrix also includes proposed milestones, dates and outcomes for each Objective, and suggested time frames for interim and long-term results. Dependent on local and regional issue prioritization, program adjustments, and resource availability, these dates are subject to change.

The final column cross-references other Goals with which a given Objective is associated, because many Objectives relate to more than one Goal. These interrelationships underscore the need for an integrated approach to water resource management and highlight the application of integrated management, a major theme of this plan.

Responsibilities for taking action to meet the milestones and desired outcomes of the Objectives are incumbent upon a wide range of participants. In the final section of the Plan, "Moving from Plan to Action," roles and responsibilities are suggested for each governmental level, private for-profit and non-profit organizations, and for individuals.

Setting policy direction, assembling Goals and Objectives, noting potential milestones and suggesting roles and responsibilities, does not mean this Plan overlooks the progress achieved in water resource protection and management over the last three decades. Rather, its purpose is to engage a wider audience, a larger cast of actors to work in collaboration and make even greater strides in water resource protection and management over the next 30 years, the time horizon of this Plan.

Matrix of Goals and Objectives

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
GOAL 1.1: Equitably balance the multiple demands on the limited water resources of the Basin, while preserving and enhancing conditions in watersheds to maintain or achieve ecological integrity.				
1.1.A	Develop an integrated resource management strategy to determine amount of water available for allocation considering: 1) Water budget 2) In-stream flow needs 3) Ground water availability 4) Assessment tools 5) Degree of hydrologic/biologic disruption	By 2005: Ground water availability and water budget pilot studies completed	Use of tools in policy evaluation	1.1, 1.2, 1.3, 4.2
		By 2006: Assessment tools developed		
		By 2007: Water budgets completed for all watersheds at appropriate scale		
1.1.B	Assess the ecological integrity of watersheds and integrate the criteria into water allocation strategies	By 2007: In-stream flow needs established, criteria developed	Improvement of monitored biologic and hydrologic criteria	1.1, 1.3, 1.4, 3.1, 3.2, 4.2
		By 2007: Natural hydrograph established at appropriate scale		
		By 2008: Ecological needs incorporated into reservoir operations and allocation decisions		
1.1.C	Discourage and where necessary manage any expanded or future transfers of water and wastewater into or out of the Basin to minimize and mitigate environmental or other negative impacts, while giving consideration to feasible alternatives, the water needs of the sending basin, and the efficient use in the receiving basin of available resources	By 2006: Criteria developed for evaluating interbasin transfers	Environmental and other negative impacts of interbasin transfers minimized	1.1, 1.2, 1.3, 1.4, 2.3, 4.1
1.1.D	Assess existing transfers of water and wastewater into or out of the Basin in light of changes, such as new water resource management strategies, technologies, storage, planning, and/or demand	By 2005: Include as part of docket, permit review, etc.		
1.1.E	Manage future and expanded transfers of water and wastewater among watersheds to minimize and mitigate environmental or other negative impacts, while giving consideration to feasible alternatives, the water needs of sending watershed and the efficient use in the receiving watershed of available resources	By 2010: Guidelines developed for balancing needs among watersheds	Watersheds accommodate planned growth with minimal environmental impacts	1.1, 1.2, 1.3, 1.4
1.1.F	Assess existing watershed transfers of water and wastewater in light of changes, such as new water resource management strategies, technologies, storage, planning, and/or demand	By 2007: Include as part of docket, permit review, etc.		

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
1.1.G	For future droughts ensure the equitable allocation of water supplies for essential domestic, commercial, industrial, power generation, and agricultural uses, while maintaining ecological integrity of aquatic ecosystems	By 2006: Agreement on principles for water use curtailment during droughts	Reduced environmental and economic severity of drought impacts	1.1, 1.3, 1.4, 4.1
GOAL 1.2: Ensure an adequate supply of suitable quality water to restore, protect and enhance aquatic ecosystems and wildlife resources.				
1.2.A	Integrate in-stream flow and estuary fresh water inflow requirements for the support of healthy aquatic ecosystems into water resource regulations and decision-making	2005 - 2010: Criteria developed for use in allocation and operation strategies	Improvement of monitored biologic criteria	1.2, 1.3, 2.2, 2.3, 3.1
1.2.B	Where water quality meets or is better than standards for the protection of aquatic life and wildlife, implement anti-degradation regulations, policies and/or other mechanisms to maintain or improve existing water quality	On-going: Agreement on necessary anti-degradation measures By 2008: Develop criteria and a strategy to ensure water quality suitable to protect aquatic life and wildlife	No measurable degradation of water quality from standards in river and tributaries designated to support aquatic life and wildlife	1.2
1.2.C	Where water quality is not sufficient to protect aquatic life and wildlife, employ strategies to provide protection through the implementation of TMDLs and other regulatory and non-regulatory means	Varies: Meet TMDL schedules	Improvement in parameters of concern	1.2
		By 2008: Develop criteria and a strategy to ensure water quality suitable to protect aquatic life and wildlife	Improvement in metrics for wildlife health	
GOAL 1.3: Ensure an adequate and reliable supply of suitable quality water to satisfy public water supply and self-supplied domestic, commercial, industrial, agricultural, and power generation water needs.				
1.3.A	For normal hydrologic conditions ensure supplies for projected public and self-supplied domestic, commercial, industrial, agricultural, and power generation demands through 2030	By 2006: Water use projections completed	No reported supply shortages under normal conditions	1.1, 1.2, 1.3, 1.4. 4.1
		By 2008: Agreement on strategies to meet future need		
1.3.B.	Plan under drought of record conditions, to provide adequate supplies for projected public and self supplied domestic, commercial, industrial, agricultural, and power generation demands through 2030	By 2006 : Water use projections completed	No reported supply shortages under drought conditions	
		By 2008: Agreement on strategies to meet future need		
1.3.C	Ensure maximum feasible efficiency of water use across all sectors, prioritizing efforts based on the existence of watershed transfers and/or substantial consumptive use; including promoting water conservation technology and habits, leak detection and repair, pricing incentives, etc.	By 2008: Set efficiency measurements by sector	Measurable and improved efficiency of water use	1.1, 1.4
1.3.D	Increase the beneficial reuse and recycling of reclaimed water	By 2020: 250 mgd (or need to be determined based on projected demand)	Increase in beneficial reuse	1.1, 1.3, 1.4

Matrix of Goals and Objectives

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
1.3.E	Where water quality meets or is better than standards for the protection of drinking water, implement anti-degradation regulations, policies and/or other mechanisms to maintain or improve existing water quality	On-going: Agreement on necessary anti-degradation regulations	No measurable degradation of water quality	1.3
1.3.F	Where water quality does not meet standards for the protection of drinking water, employ strategies to achieve standards through the implementation of TMDLs and/or other regulatory and non-regulatory means	Varies: Meet TMDL schedules	Improvement in parameters of concern	1.3
1.3.G	Protect the quality of public and industrial water supplies by preventing the isochlor from exceeding 180 ppm at river mile 98	On-going: No salinity impacts to public and industrial users	Salinity @ RM 98, stays below 180 PPM	1.1, 1.2, 1.3
1.3.H	Develop flow and transport models and tools to track large scale accidental and intentional contaminant releases to 1) Assess the impacts to water intakes and basin water resources and 2) Direct emergency response actions	By 2006: Initial models and tools developed By 2008: Models and tools refined; mock Disaster drill developed	Successful implementation of emergency response tools during a mock disaster drill	1.1, 1.2, 1.3
1.3.I	Develop water supply contingency plans to address critical water needs in the event of the loss of usable source water and water intake or distribution infrastructure	By 2006: Initial water supply contingency plans for highest priority systems By 2008: Water supply contingency plans for next highest priority systems	Workable, completed water supply contingency plans	1.1, 1.3
GOAL 1.4: Ensure adequate and suitable quality stream flows for flow-dependent recreational activities.				
1.4.A	Integrate consideration of flow regimes to support water-based recreation in the river and tributaries into allocation and management decisions	By 2006: Recreational flow needs quantified	Improved flows for water-based recreational activities	1.5, 2.2
1.4.B	Where water quality meets or is better than standards for the protection of recreational uses, implement anti-degradation regulations, policies, and/or other mechanisms to maintain or improve existing water quality	On-going: Agreement on necessary anti-degradation regulations	No measurable degradation of water quality	1.4
1.4.C	Where water quality does not meet standards for the protection of recreational uses, employ strategies to achieve standards through the implementation of TMDLs and/or other mechanisms	Varies: Meet TMDL schedules	Improvement in parameters of concern	1.4
GOAL 2.1: Prevent or minimize flood-induced loss of life and property, and protect floodplain ecology.				
2.1.A	Upgrade and modernize flood warning and forecasting capabilities	By 2010: Completion of work plan steps as outlined in report: Recommendations to address Flood Warning Deficiencies, May 2002	Online availability of Advanced Hydrologic Prediction Service (AHPS)	2.1

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
2.1.B	Characterize flood damage risks; prioritize and implement actions to reduce risk and losses, and address human induced ecological impacts of hydromodification	2005 - 2010: Completion of state and county flood mitigation plans	Compliance with Disaster Mitigation Act of 2000	2.1, 3.4
		By 2010: Integrate flood mitigation and stormwater management in watershed communities	Removal of streams from impaired list (303(d)) for reasons of hydro-modification	
GOAL 2.2: Enhance water-based recreation in the river and its tributaries.				
2.2.A	Develop a recreational water use and public access plan for the Basin that provides for: 1) Increased public access 2) Improved recreational experiences for all users through signage, guides, provision of destination points, linkage to other recreational opportunities, etc. 3) Increased availability of pump-out facilities, etc	2006: Partnerships formed and funding sources identified	Basin-wide Recreation Plan developed, with regional segments, 2006 - 2030	2.2
2.2.B	Develop identified recreational facilities and amenities per Basin-wide Recreation Plan	By 2010: 25% of identified facilities and amenities completed	Increased recreational use of waterway corridor amenities	2.2
2.2.C	Create a continuous network of water trails for the river, tributaries and lakes	By 2010: 25% of trail network completed	Continuous network of water trails along tributaries, connected to main stem	2.2
		By 2020: Trail network completed		
2.2.D	Reduce or prevent generation of debris and trash and expand clean up programs in river and tributaries	Establish Baseline: 10% annual increase in debris collected and a decrease in reported debris accumulation	No unsafe conditions on river and tributaries • No flood damages due to debris	2.2, 5.2, 5.4
		On going: 10% annual increase in volunteer river cleanup programs	Ongoing programs adequately staffed and funded	
2.2.E	Develop an inter-state campaign to promote the Basin as a recreation and tourist destination	By 2007: Strategy developed to promote assets defined in Basin-wide Recreation Plan	Increase in Basin recreational advertisements	2.2
2.2.F	Ensure that recreational uses do not impair the ecological integrity of aquatic and riparian ecosystems	By 2006 Baseline: Recreational impacts identified	Reduction in pollution inputs from recreational uses	2.3, 1.2
		By 2010: Development of recreational BMP manual	Recreation impacts reduced	
2.2.G	Support and encourage watershed communities to incorporate water-based recreational assets in planning and management, including requirements in subdivision ordinances	By 2006: Workshops provided for public officials and building industry	Increased recreational access and support for local waterway corridor use and protection	2.2, 3.5
		By 2010: Requirements such as public access included in local ordinances		

Matrix of Goals and Objectives

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
GOAL 2.3: Protect, conserve and restore healthy and biologically diverse riparian and aquatic ecosystems.				
2.3.A	Implement conservation plans for populations, assemblages and communities of indigenous aquatic and terrestrial plants and animals (Consider habitat needs for water quality and availability, reproduction, food supply and refuge from predation)	By 2008: Define critical habitat and food sources	Locally optimal measures of diversity, richness, balance, abundance, integrity and resilience	2.3
		By 2010: Set criteria for protection and restoration	Locally optimal measures of habitat	
		By 2015: Plans developed for key species or communities	Refer to DELEP indicators	
2.3.B	Implement fisheries management plans to sustain commercially and recreationally important species of the Basin	Dates per management plans: Targets met for key species: shad, oysters, horseshoe crabs, etc.	An indicator per relevant management plans in place	2.3
2.3.C.	Increase the quality, diversity and function of wetlands throughout the Basin.	By 2005: Set assessment criteria	20% increase in functioning wetland acres, 2007 baseline, by 2030	2.3, 3.3
		2007 - 2015: Watershed-based assessments of wetland function, protection and restoration opportunities		
2.3.D	Implement strategies to protect critical riparian and aquatic habitat	By 2006: Critical habitats identified, mapped and prioritized	20% increase in critical habitat protection and restoration by 2030	2.3
		By 2008: Protection and restoration strategies developed and adopted		
2.3.E	Implement invasive species management throughout the Basin	By 2008: Management plans developed	Plans implemented 2008	2.3
2.3.F	Employ regional approaches to sediment management to improve the beneficial use of dredged materials in habitat restoration	By 2008: Plans developed	Plans implemented	2.3
2.3.G	Prioritize and remove impediments to fish passage	By 2008: 5% increase in miles/ acres of streams opened to migratory species, such as river herring	Maximum stream miles without impediments	2.3
2.3.H	Stabilize stream channels based on systemic analysis of causes of instability	By 2006: Identify areas of instability and causes	Miles of steams with natural stability	2.3, 2.1, 3.3
		By 2008: Prioritize restoration opportunities in a watershed framework	20% increase over 2006 baseline by 2030	
GOAL 3.1: Preserve and restore natural hydrologic cycles in the Basin's watersheds.				
3.1.A	Encourage and support land use designs that maintain pre-development response to storm events with respect to infiltration and runoff volume, velocity, and quality	By 2007: Watershed-based stormwater management plans developed and adopted that maximize infiltration, while avoiding ground water mounding, and minimize site disturbance	Surface waters are less impacted from storm events • Floods, erosion and sedimentation are minimized • Stream base flows are maintained or restored with water quality improvements	3.4, 1.2, 1.3, 2.1, 2.3

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
3.1.B	Address adverse effects from existing land use practices	By 2006: Criteria developed for land management practices 2008 - 2015: Watersheds evaluated and prioritized for remediation efforts	Targeted watersheds receive priority • Water quality improvements in watersheds	3.4
3.1.C	Discourage land use and stormwater management practices that exacerbate hazardous conditions, e.g. sinkholes, flooding, etc	By 2006: Areas especially vulnerable to impacts from development (e.g., karst geology) identified. By 2007: Standards established to protect areas and prevent hazardous conditions	Watershed communities adopt protection standards	3.4, 2.1
GOAL 3.2: Maintain and restore the integrity and function of high value water resource landscapes.				
3.2.A	Map high value water resource landscapes and assist watershed communities in prioritizing these resources for protection	By 2008: Priority areas protected or managed in plans and ordinances	Functions of high value water resource landscapes are maintained	3.3, 2.1, 2.3, 4.1, 4.2
3.2.B	Develop guidance for performance standards that protect the function of high value water resource landscapes	By 2010: Performance standards established for high value water resource landscapes	Development of appropriate performance standards for local conditions • Ordinances and regulations include appropriate performance standards for high value water resource landscapes	3.3, 4.2, 2.1, 2.3, 4.1, 4.2, 4.4
3.2.C	Encourage and assist watershed communities to prioritize high value water resource landscaping for land preservation programs	By 2006: Landscapes of water resource value identified and prioritized for preservation By 2010: High value areas included in land preservation programs	Watershed communities preserve acres of valuable water resource landscapes	3.3, 4.1, 4.2, 4.4, 5.2, 5.3, 5.4
3.2.D	Minimize contamination threats to drinking water supplies utilizing information from source water assessment programs	By 2008: Protection efforts prioritized and funded	Source water protection plans implemented	1.3, 3.1, 3.3
GOAL 3.3: Fully integrate water resource considerations into land use planning and growth management.				
3.3.A	Develop watershed assessments to identify priority water resource issues that should be considered in community land use plans and ordinances	By 2008: Watershed assessments are accessible via web By 2010: Issues prioritized by regions and watersheds	Watershed assessments completed and water resource issues prioritized	1.1, 3.1, 4.2
3.3.B	Encourage and support watershed communities working together on regional planning and growth management	By 2008: Watershed assessments used for water resource protection and planning	Growth management and land use planning approached on a watershed basis • Multi-municipal plans adopted	3.1

Matrix of Goals and Objectives

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
3.3.C	Ensure availability of land and water resources data, analytical tools, and models to guide local and regional land use and growth management planning and decision-making	By 2008: Data tools and models on the internet with instructional workshops offered	Watershed communities use available data and tools to assess alternative development scenarios with communities incorporating conservation design ordinances	3.1
3.3.D	Adopt and implement plans and ordinances that incorporate scientifically sound and legally implementable provisions for the protection and enhancement of water resources (States to support and encourage; local and county government to implement; private and non-governmental organizations to partner)	By 2008: Model water resource elements for ordinances developed	Plans and ordinances updated with water resource elements • Watershed communities adopt ordinances (e.g. low impact and conservation design)	3.1
3.3.E	Integrate water resource elements into local, multi-municipal, regional, and state agency and authorities' plans, regulations, and decision-making processes	By 2008: Concurrent planning for water and wastewater infrastructure through coordination among water resource agencies, environmental programs and community planning	Water resource issues are addressed through coordinated planning efforts with all water resource regulatory entities	3.1
GOAL 3.4: Encourage development and redevelopment in areas where growth can improve the economic viability of local communities while providing for the protection and enhancement of the water resources of the Basin; discourage development and redevelopment where it may impair water resources and their related natural resources.				
3.4.A	Identify and prioritize areas that would benefit environmentally and economically from redevelopment	By 2005 - 2010: Appropriate areas identified and prioritized for improvements and redevelopment	Redevelopment will be located in appropriate, targeted areas	3.2
3.4.B	Develop criteria and incentives for coordinated review processes that facilitate development and re-development consistent with the goal	By 2008: Incentives and criteria for review are established • A coordinated review process is implemented	Encourage growth in areas with adequate infrastructure	3.2
3.4.C	Develop criteria and disincentives to be applied during coordinated review processes that discourage development, and redevelopment inconsistent with the goal	By 2008: Disincentives and criteria for review are established • A coordinated review process is implemented	Encourage growth in areas with adequate infrastructure • Discourage new development in inappropriate areas	3.2
3.4.D	Maintain and make necessary and prudent changes to existing navigable waterways and ports and use regional approaches to manage dredged materials	Ongoing management of current waterway and port infrastructure	Safe and efficient waterways and ports	

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
GOAL 3.5: Physically and visually emphasize and strengthen the social, historic, cultural, recreational and economic connections of communities to the Basin's waterways.				
3.5.A	Encourage waterside re-development, that emphasizes public access as well as aesthetic, historic, recreational, economic and cultural values	By 2006: Waterside redevelopment areas prioritized	Waterside properties are revitalized	2.2, 3.1, 3.5
		By 2008: Plan for infrastructure improvements as necessary	Public access, cultural, historic, recreational and educational design elements are emphasized for the community	
		By 2008: Public-private partnerships established for urban waterside redevelopment projects		
3.5.B	Create waterway transit opportunities for residents, commuters and visitors	By 2006: Assessments of transit opportunities	Increased use of waterway transit	3.5
		By 2008: Public and private investment in waterway transit modes		
GOAL 4.1: Improve coordination and cooperation in the management of water resources in the Basin.				
4.1.A	Achieve consistency in the implementation of water quality standards that apply to the shared waters of the Basin	Baseline 2005, 3 year reviews: Development of a common set of water quality criteria for shared waters	Maintenance of water quality to meet criteria	1.2, 1.3, 1.4, 4.1
4.1.B	Ensure at state boundaries that downstream state water quality standards are attained	Baseline 2005, 3 year reviews	Maintenance of water quality to meet criteria	
4.1.C	Achieve comparable monitoring, documentation and accurate reporting of data that involve the basin-wide water resources of the Basin	By 2006: QA/QC protocols and reporting methods are compatible for water resource assessment purposes		1.1, 1.2, 1.3, 1.4, 2.3, 4.1
4.1.D	Achieve consistency in protection of public health in regard to consuming fish and shellfish, due to chemical contamination, in regard to the shared waters of the Basin	By 2006: Share data and monitoring results • Consistent message to public for shared waters • Public awareness program is implemented		4.1
4.1.E	Achieve consistency in content and communication of advice for primary contact recreational use of shared waters	By 2006: System created for developing and communicating consistent advice regarding primary and secondary contact in shared waters to protect human health and safety	Advisories issued when necessary to protect human health (e.g., from bacteria) and safety (e.g., high flows and debris)	1.4, 4.1

Matrix of Goals and Objectives

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
4.1.F	For future drought conditions, improve exchange of hydrologic information, drought status reports, and drought restrictions among DRBC, states, and public	By 2005: Continued refinement of drought indicators and reporting	Up-to-date web page on drought conditions and restrictions	1.1, 4.1
			DRBC and states set consistent drought declaration and water use advice, states on record then will act independently as to criteria which trigger declarations and will issue their own water conservation initiatives	
4.1.G	Foster communication among state and local watershed programs and processes	By 2008: Uncomplicated exchange of information and data among local watersheds and state agencies	Water resources information is easily accessible and current	3.3, 4.1
4.1.H	Improve coordination of stormwater management programs and practices	By 2008		
4.1.I	Encourage communication for water resource planning among the watershed communities and counties within a watershed	By 2010: Integrated water resource plans are used as planning tools		3.3, 4.1, 5.4
4.1.J	Improve coordination among State Coastal Zone Management programs	By 2010: Basin Plan Objectives and CZM programs coordinated		3.4, 3.5, 4.1
4.1.K	Improve coordination for invasive species management	2005 - 2010: FEMA, NRCS, Corps coordinate funding for compliance with Disaster Mitigation Act 2000	Single source of information for federal flood mitigation funding	1.1, 2.3, 4.1
4.1.L	Evaluate and coordinate funding for flood mitigation			2.1, 3.1, 4.1
4.1.M	Support and implement watershed-based trading, where appropriate, as a tool to complement traditional approaches to water quality management and improvement	2005 - 2006: Pilot study determining need, opportunities, and potential constraints completed		
		2006 - 2007: Pollutant trading ratios, project control measures and responsibilities suggested		
GOAL 4.2: Increase sharing of data, information, and ideas among Basin stakeholders and reduce duplication of effort.				
4.2.A	Complete framework data layers for the entire basin plus several selected GIS layers accessible via the internet	By 2005: Completion of basin-wide database	Number of Internet hits and user surveys	3.3, 4.2
4.2.B	Make digital data layers and water-related databases available to view and download, integrated across political boundaries	By 2006	Number of Internet hits and user surveys	3.3, 4.2
4.2.C	Develop a database of ongoing management activities to foster partnerships and reduce duplication of efforts	By 2006: Water resources programs and network / clearing house is operational	Benchmark and pilot efforts are tracked and available for review	3.3, 4.2, 5.2, 5.3, 5.4

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
4.2.D	Improve methods of communication with and among local governments on water resource issues and provide adequate opportunities for discussion of key issues			
4.2.E	Increase opportunities for the sharing of ideas, data, technology and information among public and private sector professionals involved in water resource issues			
4.2.F	Increase opportunities for technology transfer among water resource professionals	By 2006		
GOAL 4.3: Secure adequate resources for programs and projects that encourage cooperative water resources planning and management.				
4.3.A	Inventory existing resources and identify gaps to implement Basin Plan Objectives	By 2005 (1 year post-adoption): Inventory completed 3 year reviews, including resource availability: All baseline tasks completed within timeframes	Effective and efficient range of funding sources that support water resource plans throughout the Basin	4.3
4.3.B	Explore additional resource opportunities	2005 baseline; 3 year reviews	Effective and efficient range of funding sources that support water resource plans throughout the Basin 3 year assessments of implementation, include resource availability	4.3
4.3.C	Increase opportunities to leverage federal, state and other funds for water resource planning, protection and restoration		Integration of Basin Plan activities with federal and state program funding.	4.1
GOAL 4.4: Ensure that water resource partners support and execute water resources management in accordance with the Guiding Principles, Goals and Objectives of the Basin Plan.				
4.4.A	Create or enhance formal partnerships for the purpose of implementing the Basin Plan Objectives	2005 baseline, 3 year reviews: MOUs, joint work plans, Commission resolutions	# MOUs, joint work plans, and resolutions developed to implement Basin Plan Objectives • # Federal, state and local projects consistent with Basin Plan	
GOAL 4.5: Utilize the planning and regulatory powers of a regional governmental authority, the Delaware River Basin Commission, to facilitate coordination and cooperation.				
4.5.A	Enhance DRBC Comprehensive Plan to promote coordination and achievement of the Basin Plan Objectives	By 2005: Basin Plan adopted 2005 - 2006: Comprehensive Plan updated	State of Basin Report 2005 Tri-annual reporting on implementation progress	4.5

Matrix of Goals and Objectives

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
GOAL 5.1: Establish a Basin-wide sense of place.				
5.1.A	Create awareness and understanding of the river and associated resources so that citizens, businesses and officials are motivated to describe their home or place of business in terms of their watershed	By 2006: Establish mechanisms on education and involvement to instill awareness of and pride in the Basin		
5.1.B	Create awareness and understanding of the river and associated resources so that citizens, businesses and officials are motivated to act in ways that help protect and restore the watershed	On-going		
5.1.C	Continue and expand the use of Internet and mass media resources to educate the public about water resources use, waterway corridor management, land management for water resources protection, institutional cooperation and coordination for water resource management, and education for water resource management and stewardship	On-going: More exposure of water resource topics and events in media • Provide focused workshops for watersheds, state officials' conservation groups, etc.	Increased participation in water resource programs and activities and increased coverage of water resource issues in the media	4.1, 4.4, 5.2
5.1.D	Maintain a clearinghouse for information on local watershed efforts, such as river conservation plans, restoration and preservation efforts – and opportunities for financial and technical assistance	By 2005: Web-based data base for watershed activity in the DRB	More effective and efficient watershed planning efforts	3.1, 4.1, 4.2, 4.3, 5.2
5.1.E	Make education and outreach a priority to achieve public awareness and personal involvement on behalf of the Basin and local watersheds	By 2006: Regular educational and outreach releases to the media	Increased requests from public about water resources and improved water quality	4.2, 5.2
5.1.F	Increase participation in volunteer water resource projects and programs in the Basin	By 2010: 25% increase of volunteers for Basin water resource projects	Tracking system for Basin volunteers and projects	5.2
5.1.G	Increase the number of projects, programs and opportunities for citizen participation in water resources management protection and enhancement by 25%	By 2010: Tracking system for volunteers and projects in place with a 25% increase in opportunities for participation and in Basin volunteerism	Number of projects and number of volunteers	4.4, 5.2
5.1.H	Engage under-represented populations in water resource issues and stewardship	By 2005: Under-represented groups included in planning, events, and promotions	Diverse population participating at events, programs and in decision-making	5.2
5.1.I	Implement a watershed signage program for the main stem Delaware River and all of its major tributaries and on state and interstate highways in the Basin	2005 - 2010: Signs for sub-basins and major tributaries at appropriate road crossings and boundaries	Increased awareness of watershed boundaries	5.2
5.1.J	Provide information to enhance the ability of citizen and community groups to participate in restoration activities on their property and in their local watersheds	By 2007: Distribution networks refined and operating	Improved water quality from nonpoint sources and an increase in watershed activities	5.2

#	OBJECTIVES	MILESTONE	DESIRED OUTCOME	SUPPORTS GOAL
GOAL 5.2: Increase student and youth awareness, understanding, and active participation in water resources issues.				
5.2.A	Develop and initiate a strategy to incorporate watershed curricula in the education standards of the four Basin states	By 2008: All school districts and private schools integrate watershed material in curricula with materials available for home schooling	All students in Basin know their watershed address	5.1
5.2.B	Provide a water resources related outdoor experience for every student in the watershed before high school graduation	By 2010: Every student will have a hands-on outdoor experience by high school graduation	Students will know about water resources and land use	5.1
5.2.C	Continue to promote and expand school programs that provide active participation in watershed protection, restoration, monitoring and awareness building	On-going: Every school district has an annual snapshot-like event and science clubs have a water resources related project	Every school district has a watershed or stream project	5.1
5.2.D	Maintain a web-based clearinghouse specifically for educators	By 2005: Expanded Ed-Web capacity and content	Increased hits on Ed-Web	5.1
GOAL 5.3: Increase private sector awareness, understanding, and active participation in water resources issues.				
5.3.A	Collect and disseminate to members of the commercial community information about water resources issues	By 2007: Materials developed and distributed	Private sector participation in water resource programs increased	5.3
5.3.B	Highlight demonstration projects that provide technology and information transfer to commercial interests in the Basin	By 2007: Private sector demonstration project in each sub-basin	Improvement in local watershed; transferability to other watersheds	5.3
5.3.C	Encourage private sector funding and participation in partnerships, initiatives and enhancement endeavors	On-going		
GOAL 5.4: Increase local public officials' awareness, understanding, and active participation in water resources issues.				
5.4.A	Provide outreach and technical assistance programs targeted at local public officials, professional staff and consultants	By 2005: Examples of watershed communities' innovative programs available	Local ordinances protect water resources with watershed communities working together	3.1, 5.4
5.4.B	Work with local governments to identify small watersheds where community-based actions are essential to meeting DRB preservation and restoration goals	By 2007: Watershed communities are working on water resource issues	All levels of government work together to improve watershed management	3.1, 4.4, 5.4
5.4.C	Work with watershed community officials and organizations, and supply resources to develop effective water resource programs	By 2008: Watershed communities are adopting and implementing effective programs	Watershed communities addressing shared concerns	3.1, 4.2, 4.3, 4.4, 5.4
5.4.D	Enhance funding for locally based programs that pursue restoration and protection projects	By 2007: Increased availability of federal, state and private funds	Additional dollars available for localities	

Moving from Plan to Action

Roles and Responsibilities

The direction has been set for improving water resource management, now it's time for action. Roles and responsibilities will become clearer once specific management strategies, based on regional and local priorities, have been set. All governmental agencies, private and non-profit organizations, and individuals — have a role to play and responsibilities.

Government: Many of the actions needed to meet the Goals and Objectives of this Plan can be taken under the authority of the myriad federal, state, regional and local agencies, authorities and commissions that operate within the Basin and its watersheds. These entities are responsible for:

- Water quality
- Water supply planning and management
- Wastewater planning and management
- Stormwater management
- Environmental resource protection
- Public health
- Flood control
- Economic development
- Transportation network planning
- Construction and maintenance
- Oversight of development and construction standards
- Land use planning and growth management
- Research and data management
- Education, outreach and training

Federal Government: There are many federal agencies with authority in water resource related issues. These include: Environmental Protection Agency; National Park Service and U.S. Geological Survey within the Department of the Interior; Forest Service and the Natural Resources Conservation Service within the Department of Agriculture; Army Corps of Engineers in the Department of Defense; National Oceanic and Atmospheric Administration within the Department of Commerce; and the Federal Emergency Management Agency within the Department of Homeland Security. Suggested actions for these agencies are:

- Supply data and information to improve regional water resource management
- Fund cooperative efforts among state and regional agencies to secure agreement and unified action to protect and improve water quality and critical habitat, and to plan for sustainable water use and supply
- Promote cooperation and communication among federal government agencies with shared jurisdiction and authority for water resources
- Eliminate redundancy; streamline federal agency decision-making and funding where considerable federal, regional and state cooperation is currently demonstrated

Man — despite his artistic pretensions, his sophistication, and his many accomplishments — owes his existence to a six inch layer of topsoil and the fact that it rains.

Author Unknown

State Government: State agency mandates, responsibilities, and names differ among the four Basin states. State agencies, departments, commissions, boards or programs that have responsibility and authority for one or more areas related to water resources, as noted in the general government section, should work to fulfill the following duties:

- Collect and supply data and information to improve water resource management at the basin, regional and watershed scales
- Support educational and outreach efforts to improve water resource stewardship
- Maximize use of existing linkages, such as those of the Cooperative State, Research, Education, and Extension Service, to enhance outreach, communication and information flow
- Fund cooperative efforts among state and regional agencies and the private sector to secure agreement and unified action to protect and improve water quality and critical habitat, and to plan for sustainable water use and supply
- Enable and support growth management efforts and water resource planning and management by state agencies, counties and municipal authorities on a watershed basis
- Coordinate efforts among state agencies responsible for water resource related programs, regulations and oversight

Regional government — counties, commissions, councils, districts, etc. The Delaware River Basin Commission plays an essential role in improving coordination and collaboration among these entities. The 1961 Compact granted the Commission broad planning and regulatory powers in the areas of water supply, pollution control, flood protection, watershed management (including soil conservation and fish and wildlife habitats), recreation, hydroelectric power, and surface and ground water allocations and diversions. These powers should be used to educate as well as to regulate; to demonstrate the principles of integrated water resource management; and to foster partnerships with and among other public and private entities to achieve the outcomes articulated in this Plan and the collective stewardship of shared resources. A principal role of the Commission is to coordinate policy and actions among the state and federal agencies involved with water resource protection and management within the river basin. The Commission's implementation of the Basin Plan occurs through modifications to its Comprehensive Water Resources Plan and the exercise of its planning and regulatory authority.

There is a wide variety of other regional organizations within the Basin that develop and implement policy, plan and manage, or have oversight responsibility for water or related resources. Examples include, but are not limited to: the Delaware Estuary Program, Soil Conservation Districts throughout the Basin, and the Delaware Valley Regional Planning Commission, fostering regional cooperation among nine counties in the greater Philadelphia-Camden-Trenton area. Consortia like the Schuylkill Action Network, formed to coordinate actions to protect the integrity of the Schuylkill River as a drinking water source, are other examples of regional cooperation. There is also, the Upper Delaware Council, a oversight body responsible for overseeing the coordinated implementation of the "River Management Plan for the Upper Delaware Scenic and Recreational River." While

each regional organization has a unique mission and membership, they serve a common function of improving communication and cooperation within their area.

Actions that regional entities should be involved in include:

- Coordinate with states and other regional entities
- Collect, analyze and supply information and data to improve water resource management at the basin, regional and watershed scales
- Lead and support watershed-based water resource planning and management at local and regional level

Municipal government — the authority and responsibility of minor civil divisions, including boroughs, towns, townships, cities, etc., varies among the Basin states, but land use planning, zoning and development permitting is generally the concern of local governments. The Basin Plan advocates the full use of authority vested in local governments to improve water resource planning and management and improve the outcomes of development projects and water resource use and protection. Examples include:

- Use supplied water resource information to improve water resource management and land use decision-making in communities and watersheds
- Collect and supply data to appraise progress toward water resource goals as necessary
- Lead and support growth management efforts
- Engage in multi-municipal planning and include water resource considerations in local planning and development regulations
- Exercise vested authority, including adopting the official map, to incorporate resource protection into local planning
- Work with down-stream and up-stream neighbors for the improved management of stormwater, water supply and wastewater, waterway corridors, habitat, recreation and protection of landscapes critical to water resources.

Private and non-profit sectors and individuals. A host of non-governmental organizations are stakeholders in the Basin, and their actions complement those of the governmental sector. These include, but are not limited to: providers and users of water resources; engineering, planning and technical consultants; watershed associations; civic associations and citizen action groups; foundations that support water resource research and protection; academic and research institutions; professional associations; and associations of municipal leaders.

The private and non-profit sectors. The private for-profit and non-profit sectors bring another dimension of interests and resources to forge strong and effective partnerships for improved water resource management. Organizations such as the League of Women Voters, the Riverkeeper Network, and the Partnership for the Delaware Estuary, keep water resource issues in the news and gain public support and private resources for protection and management efforts. Others groups, including the Pennsylvania Environmental Council, the Association of New Jersey Environmental Commissions, the Delaware Nature Society, and the Bayshore Discovery Project focus efforts on education, outreach and improved

In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time.

Leonardo da Vinci

decision-making. Conservancy organizations like the Rancocas Conservancy, the Heritage Conservancy, the Trust for Public Lands, and the Nature Conservancy work to protect or restore the function and integrity of environmentally significant landscapes. Private for-profit and non-profit agencies can:

- Forge regional and local private-public partnerships to collectively improve water resource management
- Work with partners to select, collect and report on appropriate indicators

For example, for-profit corporations can engage in partnerships with governmental and non-profit groups to restore and protect significant landscapes and mitigate environmental impacts from projects that provide power or other necessary public goods. Industry professionals that develop or use cutting-edge, water-friendly practices can serve as examples, leading to the faster transfer of new techniques and technologies. The Delaware River Water Resources Association and regional chapters of the American Water Works Association, and similar organizations, are integral to the transfer of technology and data through their meetings, publications and annual conferences. They also contribute significantly to the development of policy through their involvement in government agency advisory committees. In addition, associations and partnerships between and among the governmental and non-governmental sectors are a powerful way to gain and keep momentum for improving water resource planning and management, and an important element for institutionalizing coordination and cooperation.

Individuals: Individuals who work, raise families, and enjoy the Basin's recreational opportunities are the ultimate stewards and users of the Basin's water resources. Their actions are important. Each small action, has a cumulative effect. Individuals are encouraged to make a positive difference:

- Participate in regional and local decision-making and governance
- Volunteer in local efforts to monitor, assess, protect, and restore local resources
- Learn about water resources and share that knowledge
- Consider the water resource consequences of actions and choices
- Play a leadership role in local resource protection
- Lead by example and foster a sense of stewardship in future generations

Measuring Progress

Assessing a baseline condition means determining the status or condition of a resource attribute using a measure or indicator. In the context of the Basin Plan, a baseline is the condition or set of conditions at one point in time; the starting point against which conditions in succeeding years can be measured.

A target or reference condition is aspired to, a condition which actions are intended to produce. For example, a degraded wetland might undergo restoration efforts to return it to a better or *target* condition, one closer to that of a "reference" or unimpaired wetland.

Much has been accomplished since the initial passage of national and state pollution control and environmental legislation in the second half of the last century. States have established environmental protection and conservation agencies, adopted rules and standards to govern withdrawals from and discharge

to their streams and rivers, and begun developing criteria for the protection of human and aquatic ecosystem health. Each state has developed programs and set priorities, making varied progress across an array of water resource issues. This Plan sets a structure for taking stock of these achievements and for identifying areas still needing action.

Existing programs and plans form the foundation of progress already made in the water resource arena. We will build on this foundation, and measure progress from this baseline. Measuring progress toward achieving the Basin Plan's Goals and Objectives rests on the ability to:

- Assess baseline conditions
- Monitor and report on those critical indicators when combined signal the improvement or deterioration of conditions in the Basin's watersheds

The item or thing selected for measurement is called an *indicator* and relates to the condition of the resource or system or the efficacy of a program. An indicator can be selected to measure the actual *condition*, such as the amount of dissolved oxygen in a river; a *pressure* on the resource, such as additional water users per year; or an *outcome*, such as the number of waterways no longer listed as impaired. Programmatic measures may be less obviously linked to actual water resource conditions, but are important to assess the efficiency and efficacy of regulatory, planning and grant programs. For example, the amount of flood insurance claims could be tracked to determine the effect of community flood mitigation planning. Grant programs might track the number of projects and associated improvements, such as miles of stream buffer planted in new vegetation, as well as the dollars spent. In many cases, an indicator needs to measure a pressure, condition or outcome on a Basin-wide basis. In other cases, the most appropriate indicators may assess conditions on a smaller regional, watershed or community scale.

Ideally, indicators selected will be relevant, sensitive to change, easy to measure with low measurement error, and cost effective.

Capturing a comprehensive set of indicators requires the participation of federal, state, regional and local representatives. It requires a commitment to monitoring and reporting within agreed timeframes so that the abundance of water resource-related information collected across the Basin can be collated, assessed and presented in a *State of the Basin* report issued via the Delaware River Basin Commission. Developing the most meaningful and appropriate indicators for measuring progress, and setting realistic time frames for accomplishing Objectives is a critical next step. It requires continued, careful assessment of conditions and the identification of strategies appropriate to physical, political and fiscal circumstances. It also requires the coordinated effort of all partners.

The Basin and its watersheds are the focus of our efforts. Positive outcomes will be measured and failures will be felt most acutely. Our quality of life depends on our success.

Glossary

The terms in this glossary are defined for their intended use and purpose in the Basin Plan. There may be other definitions for these terms, particularly IF they are used for other planning or regulatory purposes. Additionally, there may be other terms in use to define these or similar concepts.

Acronyms

AHPS	Advanced Hydrologic Prediction Service
BMP	Best Management Practices
CCMP	Comprehensive Conservation and Management Plan
CZM	Coastal Zone Management
DELEP	Delaware Estuary Program
DRBC	Delaware River Basin Commission
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FISRWG	Federal Interagency Stream Restoration Working Group
GIS	Geographic Information System
HUC	Hydrologic Unit Code
mgd	Million Gallons per Day
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	National Resources Conservation Service
PCB	Polychlorinated Biphenyls
ppm	Parts Per Million
QA/QC	Quality Assurance/Quality Control
SCD	Soil Conservation District
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey

Adequate Supply: A supply that is dependable and sufficient in both quantity and quality to meet the requirements of its users, even through periods of drought. The term can be used relative to human or ecosystem needs.

Aggradation: The long-term, persistent rise in the elevation of a streambed by deposition of sediment.

Algae: Chlorophyll bearing nonvascular, primarily aquatic species that have no true roots, stems, or leaves. Most algae are microscopic, but some species can be as large as vascular plants.

Allocation: See water allocation.

Ambient: Describes the surrounding environment (especially temperature and pressure) of an object or experiment. In particular an environment which affects the object or experiment but is not affected by it.

Anthropogenic: Occurring because of or influenced by human activity.

Anti-Degradation: A programmatic term meaning actions taken to maintain existing uses and water quality in the nation's waters. The concept and policy were created by the Department of the Interior in 1968 and have been included in

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EPA's water quality standards since 1975. The basic concept of anti-degradation is to promote the maintenance and protection of existing water quality and protection of existing uses for all surface waters because it recognizes that existing water quality and uses have inherent value worthy of protection and preservation.

Aquatic Ecosystem: The living and non-living natural components of a stream or other water body.

Aquifer: An underground geological formation of rock, sand or gravel, capable of storing water within cracks and pore spaces, and that yields water to springs and wells. The water contained in the aquifer is called ground water.

Assimilative Capacity: The amount of contaminant load that can be discharged into a water body without exceeding water quality standards or criteria. Assimilative capacity is used to define the ability of a water body to naturally absorb and use a discharged substance without impairing water quality or harming aquatic life.

Base Flow: Sustained, low flow in a stream; ground water in-flow is the source of base flow in most places. Base flow constitutes all the natural dry-weather flow.

Baseline Tasks: Inventory, characterization, and assessment activities providing data that support management strategies and decisions.

Basin: The drainage area of a river and its tributaries. See also Delaware River Basin

Basin Transfer: The transfer of water or wastewater into or out of the river Basin.

Benthos: Refers to plants or animals that live on the bottom of lakes, streams, or oceans.

Bioaccumulation: The biological sequestering of a substance at a higher concentration than it occurs in the surrounding environment or medium. Bioaccumulation is also the process whereby a substance enters organisms through the gills, epithelial tissues, dietary, or other sources.

Biological Diversity: An ecological concept that incorporates both the number of species in a particular sampling area (richness) and the evenness with which individuals are distributed among the various species.

Biological Integrity: The ability of an ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region.

Best Management Practice (BMP): Methods, measures, or practices determined to be reasonable and cost-effective means to meet certain, generally nonpoint source, and pollution control needs. BMPs include structural and non-structural controls and operation and maintenance procedures.

Buffer: An area situated between two areas in possible conflict. The objective of establishing a buffer zone is to reduce the possibility of adverse impacts of land use upon water quality.

Channelization: Modification of a stream, typically by straightening the channel, to provide better uniform flow. Channelization is often employed for flood control or to improve drainage or irrigation of agricultural land.

Coastal Zone: The lands and waters adjacent to the coast that exert an influence on the uses of the sea and its ecology, or whose uses and ecology are affected by the sea. Coastal Zone refers to the area under the influence or responsibility of state or federal coastal zone management programs.

Conjunctive Use: The coordinated use of surface water and ground water, which derives from the recognized interconnection between both resources.

Conservation Pricing: A schedule of water charges designed to encourage conservation by pricing water to reflect its scarcity and economic value.

Consumptive Use: The quantity of water that is effectively removed from surface or ground water resources because it has been evaporated, transpired, or incorporated into products, or plant or animal tissue as a result of human intervention in the water cycle.

Criterion: A standard rule or test on which a judgment or decision can be based. Water quality criteria is based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish and aquatic life production, or industrial processes.

Delaware River Basin: The drainage area of the Delaware River and its tributaries. See also Basin.

Degradation: (1) a decline in the viability of ecosystem functions and processes; (2) a geologic process by which streambeds and floodplains are lowered in elevation by the removal of material. Severe forms of non-natural degradation are associated with land disturbance and urbanization, including channel incision, down cutting, widening, and associated floodplain abandonment and habitat loss.

Designated Uses: Those water uses identified in state, federal and DRBC water quality standards that must be achieved and maintained as required by the Clean Water Act. Uses include aquatic life, fish consumption, recreation, agricultural and industrial use and potable water supply.

Ecological Integrity: The presence of structural, compositional, and functional characteristics throughout the natural range of variability for a particular ecosystem. Ecological integrity can be assessed by comparing biological, chemical, and physical structures and functions to those of unimpacted, least impacted or representative ("reference") systems or sites within a region. Ecological integrity requires both the integrity of the individual chemical, biological and physical components of the ecosystem, as well as integrity of the functional relationships among those components. Biological and hydrological integrity describe some of those important relationships. In assessing the ecological integrity of an ecosystem or region, it is important to address both biological and hydrological integrity.

Ecoregion: An area of similar climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

Ecosystem: The interacting populations of plants, animals, and microorganisms occupying an area, plus their physical environment.

Encroachment: Any physical object placed in the floodplain that hinders the passage of water or otherwise affects flood flows, such as fill, excavation, storage of equipment and materials, or buildings.

Environmental Inventory: Identification and assessment of natural and human-related features of the land and hydrologic system, such as geology, land use, water use, demographics, habitat, plants, and animals that provide a unifying framework

E

for making comparative assessments of the factors that govern water quality, water quantity, and biological conditions among study areas.

Erosion: The process whereby materials of the Earth's crust are loosened, dissolved, or worn away and simultaneously moved from one place to another.

Estuary: Brackish-water area influenced by tides where the mouth of a river meets the sea.

Eutrophication: The process by which water becomes enriched with plant nutrients, most commonly phosphorus and nitrogen, which cause increases in plant and algal growth. Such increases reduce clarity and the availability of oxygen for other organisms. During eutrophication, a lake or reservoir may become so rich in nutritive compounds that algae and other microscopic plant life become superabundant, decreasing oxygen for other aquatic life and thereby "choking" the lake or reservoir.

Evapotranspiration (ET): A collective term that includes water lost through evaporation from the soil and surface water bodies and by plant transpiration.

Export: Water or wastewater originating from one watershed or basin, but ultimately discharged in another, is termed an export from the sending watershed or basin.

Feasibility: The level to which an appropriate and desirable action can be accomplished without having to overcome onerous practical, technical or economic obstacles that might cause undue negative repercussions. The measure of feasibility changes over time, and from one situation to another, because it requires weighing the relative advantages and disadvantages of a proposed action.

Floodplain: The relatively level area of land bordering a stream channel and inundated during moderate to severe floods.

Floodplain Function: The ability of riparian zones to convey and filter flood waters, dissipate flood energy, and provide in-stream and streamside habitat in the absence of encroachment or obstruction. Natural vegetative cover along stream banks and riparian land, riparian open space, strong floodplain regulations, and stormwater management enhance floodplain function.

Flow Regime: The magnitude, timing, duration, rate of change and frequency of flows.

Freshwater Inflow Needs: The quantity and timing of freshwater delivery to an estuary, which is fundamental to its health.

Geographic Information System (GIS): A system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data. Spatial features are stored in a coordinate system (latitude/longitude, state plane, etc.), which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS can be used for scientific investigations, resource management, and development planning.

Greenway: A corridor of open land that provides one or more of the following benefits: (1) protection and management of natural and cultural resources; (2) provision of recreational opportunities; and (3) enhancement of the quality of life and the aesthetic appeal of neighborhoods and communities.

Ground Water: In general, any water that exists beneath the land surface, but more commonly applied to water in fully saturated soils and geologic formations.

Growth Management: Deliberate public efforts to induce, restrain, or accommodate development and redevelopment in any geographic setting. Growth management addresses the problems that can accompany growth through an integrated system of administrative, financial and regulatory programs.

Habitat: The part of the physical environment where plants and animals live. Aquatic habitat includes all nonliving, or physical, aspects of the aquatic ecosystem. Some living components such as aquatic plants and riparian vegetation also provide structural habitat for aquatic biota.

Headwater Streams: The source and upper part of a stream. All first order streams that are delineated as a blue line on a 1:24,000 7.5 minute United States Geologic Survey quadrangle maps, up to and including their point of origin, such as seeps and springs along with their adjoining riparian corridors including perennial and intermittent.

Heat Island: The area of increased temperatures, and sometimes increased wind turbulence, that is formed over cities and other highly developed areas.

High Value Water Resource Landscapes: Areas of the landscape determined to be of great importance, Basin-wide or locally, for the maintenance of quality and availability of water resources. For more discussion, see "Key Result Area 3: Linking Land and Water Resource Management."

Hydric Soils: Soils at or near the surface that are saturated (by flooding or high ground water tables) frequently and long enough to promote the development of anaerobic reducing conditions that affect plant growth and promote the establishment of erect (self-supporting) plants that prefer such soils.

Hydrologic Cycle: The circulation of water from the sea, through the atmosphere, to the land, and back to the sea by overland and subterranean routes.

Hydrological Integrity: A condition under which streams actively function to transport, store and remobilize water, sediment, and nutrients in ways that provide for natural changes in fluvial landscapes and riparian habitats over time. Streams with hydrological integrity have short-term fluctuations in flow and have annual water yields, annual mean flows, timing of peak and low flows, and magnitudes of peak and low flows that approach natural conditions.

Hydrological Modification: Any alteration of the terrain, such as construction of dams, levees, channels, stream crossings or paving, that results in change in movement, distribution, flow or circulation of surface or ground water.

Hydrograph: Graph of variation of water flow intensity over time.

Impervious Surface: A paved or compacted land surface that prevents infiltration of precipitation through soils and into the ground water. Impervious surfaces exacerbate stormwater runoff, reduce water availability, contribute pollutants to water bodies, and short circuit the natural hydrologic cycle.

Imports: Water or wastewater originating from one watershed or basin, but ultimately ending up in another, is termed an import for the receiving watershed.

Infiltration: Movement of water, typically downward, into soil or porous rock.

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Instream Flow Needs: Use of water taking place within the stream channel (instream use) for such purposes as fish and aquatic life propagation, recreation, water quality improvement, hydroelectric power generation, and navigation.

Integrated Management: Acknowledging links between topics or concerns and combining or incorporating this consideration when assessing options, and developing policy and management plans. For application of the concept of integrated management in water resource management, see Guiding Principles and related discussion in the narrative for each Key Result Area.

Interstate Waters: Waters that form the boundary between two or more states; flow from one state into another state; or are tidal tributaries of interstate waters.

Invasive Species: Any species that may aggressively and negatively alter the functioning of an existing ecosystem. Exotic invasive species include any non-native plant, animal, or other viable biological material that enters an ecosystem beyond its historic range.

Isochlor: The "salt front" or 7 day average location of the 250 milligrams per liter chloride concentration; used in drought operation rules for reservoir releases and maintenance of flow objectives at key locations along the Delaware River.

Karst: A type of topography that results from dissolution and collapse of carbonate rocks such as limestone and dolomite, and characterized by closed depressions of sinkholes, caves, and underground drainage.

Mitigation: Actions taken to avoid, reduce, or compensate for the effects of environmental damage. Among the broad spectrum of possible actions are those that restore, enhance, create, or replace damaged ecosystems.

Morphology, Stream or River: The dimensions, forms and patterns of channels and landforms created by rainfall and runoff.

Natural Flow Regime: Equivalent to a natural hydrograph, which shows the variation in stream discharge (or river stage) that exists in the absence of any human alteration, over a specific time period. A natural flow regime is fully and optimally supportive of native biota and ecosystem functions.

Natural Stream Channel Stability: A stream that over time (in the present climate) transports the sediments and flows produced by its watershed in such a manner that the dimension, pattern and profile are maintained without either aggrading or degrading.

Natural Variability: Refers to the variation or changes in natural systems expected to occur under normal conditions. This variability can be measured in a variety of time frames. Between seasons, for example, there is a range of expected variation in temperature and precipitation. However, within the expected range of variability, more severe events can occur. Periods of extreme temperature and precipitation (or lack of precipitation) are inevitable over time and can stress natural and human-created systems. One challenge in managing water resources is to protect against disruption to human activity caused by extreme events (such as flooding and drought) while minimizing disruption to the natural systems.

No Adverse Impact: A floodplain management policy to ensure that the action of one property owner does not adversely impact the rights of other property owners,

as measured by increased flood peaks, flood stage, flood velocity, and erosion and sedimentation.

Nonpoint Source: A pollution source that cannot be defined as originating from discrete points such as pipe discharge. Areas of fertilizer and pesticide applications, atmospheric deposition, manure, and natural inputs from plants and trees are types of nonpoint source pollution.

Nuisance Plant Growth: Overabundance of aquatic vegetation and algae usually resulting from eutrophication in a water body. Nuisance plant growth can cause fish kills, taste and odor problems in potable water supplies, navigation and recreation hazards, and water quality violations.

Nutrient: Element or compound essential for plant and animal growth. Common nutrients in fertilizer include nitrogen, phosphorus, and potassium.

Open Space: Land or water areas in a mostly natural, essentially unimproved or undeveloped state that are set aside, dedicated, designated or reserved for the protection of natural resources, farmland or rural character; or for the prevention of potentially conflicting land uses. Open space may include parkland, green spaces or greenways; ecologically sensitive areas important to water resource protection such as wetlands, recharge areas and reservoirs; sites of exceptional flora and wildlife habitat; and landscapes of scenic, historic and cultural value. Such lands may afford public outdoor passive recreational opportunities.

Polychlorinated Biphenyls (PCBs): Mixtures of synthetic organic chemicals with the same basic chemical structure and similar physical properties. PCBs have been demonstrated to cause a variety of adverse health effects in animals including cancer, and effects on the immune system, reproductive system, nervous system, and endocrine system. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs.

Performance Standard: A statement of general criteria that defines a desired result without specifying the techniques for achieving that result. Synonym: performance-based standard.

Pesticide: A chemical applied to crops, rights of way, or lawns, to control weeds, insects, fungi, nematodes, rodents, or other 'pests.'

Point Source: A pollution source that can be defined as originating from discrete points such as pipe discharge, drainage ditch, tunnel, well, concentrated livestock operation, or watercraft.

Pollutant: Any substance that, when present in a hydrologic system at sufficient concentration, degrades water quality in ways that are or could become harmful to human and/or ecological health or that impair the use of water for recreation, agriculture, industry, commerce, or domestic purposes.

Pollutant Load: Refers to a material or constituent in solution, in suspension, or in transport; usually expressed in terms of mass or volume.

Pollutant Loading: Refers to the rate of transport of a pollutant load; usually expressed in terms of mass or volume per unit time.

Pollutant Sink: Areas where pollutants such as sediment, nutrients, and bacteria accumulate and concentrate. Common pollutant sinks include depositional areas of streams and rivers, reservoirs, and storage or sequestration areas.

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P

Public Water Supply: Under the Safe Drinking Water Act (SDWA), public water supply systems are defined as those regularly serving at least 25 people or having more than 15 piped connections. Systems providing water to the public may be publicly or privately owned.

Range of Variability: An approach for setting stream flow-based river ecosystem management targets. Derived from aquatic ecological theory concerning the critical role of hydrological variability, and associated characteristics of timing, frequency, duration, and rates of change, in sustaining aquatic ecosystems.

Recharge: Water that infiltrates the ground and reaches the saturated zone.

Recharge Area: An area of land where there is a net annual transfer of water from the surface to ground water; where rainwater soaks through the earth to reach an aquifer.

Reclaimed Water: See reuse.

Redevelopment: The reuse of an existing structure or previously developed land.

Resilience: The ability to rebound or recover from stress and trauma. Resilience in a natural system is related to the proper functioning of its components and to the state of its diversity. Diversity is the degree of variation and interconnections within a plant or animal community. Generally, systems with greater diversity are more resilient. A mature forest is more diverse than a field of corn or a lawn, for example, and a forest is expected to recover from a prolonged drought with less damage than a non-irrigated farm field, orchard or lawn. One of the reasons to maintain diversity in natural systems is so they can recover from extreme events and continue to provide their important functions.

Restore: To re-establish, to an approximation of a reference condition, the chemical, physical, and biological components of an ecosystem that have been compromised by stressors such as point or nonpoint sources of pollution, habitat degradation, hydromodification, etc.

Restoration: Return of an ecosystem or a site to a close approximation of its presumed condition prior to disturbance.

Retrofit: To modify a facility or a site to meet new environmental requirements or to enhance its function for improved environmental outcomes. Especially, the addition of a pollution control device on an existing facility or installation without making major changes to the original facility or installation.

Reuse: The terms "wastewater reuse," "recycled water" and "reclaimed water" are used to refer to water which, as a result of treatment, is suitable for a direct beneficial use. An example is wastewater treatment plant effluent used directly for irrigation use, replacing a new withdrawal.

Riparian: Areas adjacent to rivers and streams.

Riparian Zone: Three-dimensional zones of direct interaction between the terrestrial and aquatic ecosystems. Boundaries of riparian zones extend outward to the limits of flooding and upward into the canopy of streamside vegetation. Riparian zones contain a high density, diversity, and productivity of both wetland and upland plant and animal species. These areas have high water tables and support plants that require saturated soils all or part of the year.

Runoff: That part of precipitation, snow melt, or irrigation water that is transported to streams or other surface water by overland flow, tile drains, or ground water.

Runoff can cause water quality problems in receiving waters and/or physical changes to stream corridor morphology.

Sediment: Particles derived from rocks or biological materials that have been transported by a fluid or other natural process, suspended or settled in water.

Shared Waters: Interstate surface waters that form the boundary between two or more states.

Source Water: An aquifer or surface water body from which water is taken either periodically or continuously for off-stream uses.

Source Water Assessment Plan: A plan to assess the susceptibility of public drinking water supplies to pollution, as part of the Source Water Assessment Program (SWAP) required of all primacy states by the 1996 amendments to the Federal Safe Drinking Water Act. The assessment program is used as a basis for building voluntary, community-based protection efforts to ensure safe drinking water.

Standard: State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. Standards include the designated use of the water body and the water quality criteria that must be met to protect the designated use or uses.

Stormwater Runoff: Runoff generated by a storm event. See runoff.

Suitable Water Quality: Water quality that protects existing and designated uses.

Surface Water: An open body of water such as a lake, river, or stream.

Solids, Dissolved: Amount of minerals, such as salt, that are dissolved in water. Indicates salinity or hardness of water.

Solids, Suspended: Also suspended sediment, dependent upon the sampling method. Particles of rock, sand, soil, and organic detritus carried in suspension in the water column. In contrast with solids or sediment that moves on or near the streambed.

Steward: A careful and responsible manager of something entrusted to one's care.

Stressor: Any agent, cause or active power that causes physical, biological or chemical stress to an organism or system.

Sustainability: Refers to the use of a resource in a manner that meets current needs without compromising the ability to adequately meet the needs of future generations. Sustainability means making choices to use a natural resource base in a manner to ensure that yields in economic prosperity, social improvement, environmental quality and natural beauty will go on — tomorrow and forever — to be passed on to our children and subsequent generations.

Total Maximum Daily Load (TMDL): The sum of the individual wasteload allocations (WLA's) for point sources, load allocations (LA's) for nonpoint sources and natural background, plus a margin of safety (MOS). TMDL's can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Toxic Substances: Substances, such as pesticides, plastics, heavy metals, detergent, solvent, or any other natural or man-made materials, that are poisonous, carcinogenic, or otherwise directly harmful to human health and the environment.

T

Unstable Stream: Any stream that is unable to maintain natural hydrologic and hydraulic function (dynamic equilibrium) due to loss of balance between interrelated controlling variables. Instability is a loss of equilibrium associated with streambed degradation, aggradation or lateral channel migration. Causes include localized upstream changes in sinuosity, slope, resistance of bed materials; increased flood frequency, magnitude, or duration; increase or loss of sediment transport capacity; floodplain development; stream channel confinement or widening; and loss of streamside vegetation or riparian buffers. Instability impacts habitat and biological function in streams.

Water Allocation: Generally, a regulated withdrawal of water from a ground or surface source on the basis of total volume and/or rate of withdrawal. This term is also applied to designated amounts of storage in a reservoir, including the amount to be released to protect fisheries and recreational uses. This is not to be confused with the terms load allocation or waste load allocation which are permitted discharges regulated as part of a TMDL. See Total Maximum Daily Load.

Water Budget: A water budget is an account of all the water inflow, outflow, and storage changes in a watershed. It describes and quantifies the pathways water takes as it moves through the hydrologic system, including precipitation, infiltration, run-off, evapotranspiration, consumptive use, recharge, etc.

Water Quality-Based Trading: Watershed-based trading arrangements among point source dischargers, nonpoint sources, and indirect dischargers. 'Buyers' purchase pollutant reductions at a lower cost than what they would spend to achieve the reductions themselves. Sellers provide pollutant reductions and may receive compensation. The total pollutant reduction must be the same or greater than what would be achieved if no trade occurred. The U.S. EPA considers trading as an efficient, market-based approach to pollution reduction that encourages innovation in meeting water quality goals, with commitment to enforcement and compliance responsibilities under the Clean Water Act.

Water Quality Criteria: Numeric or narrative value designed to protect and support a designated use of a water body.

Water Quality Standards: Includes the designated uses, criteria, and anti-degradation policy that define the water quality goals of a water body.

Water Supply: This term is typically used to describe the sum of all water sources available for use. It can be understood in the context of balancing available water supply (what we have) with water demand (what we want). It is distinct from the term Public Water Supply that refers to a specific category of water use.

Water Trail: A continuous stretch of waterway for canoeing, including such amenities as special access points and informative signage.

Watershed Transfer: The movement of water or wastewater across a watershed boundary or divide from one (source) watershed for use within another (receiving) watershed.

Water Resource Considerations: The aspects of water resources relating to their use, quality and value that should be taken into consideration when making land use and growth management plans and decisions. These aspects include, but may not be limited to: water supply availability; wastewater treatment availability and capacity; direct and indirect impacts to water quality; water use and its related

impacts to hydrological and ecological systems; impacts upon High Value Water Resource Areas; recreational potential.

Watershed: The total area above a given point on a watercourse that contributes water to its flow; the entire region drained by a waterway or watercourse that drains into a lake, reservoir or bay.

Watershed Community: The group of residents, landowners, businesses and the units that use, govern, and make decisions about resources and development within a watershed.

Waterway Corridor: A stream and the portion of its adjacent landscape that directly affects and is affected by, its hydrology and ecology.

Wellhead Protection: Involves the delineation of the area contributing water to the point of extraction (withdrawal) of ground water and steps taken to mitigate potential contaminant sources in that area. The development of wellhead protection programs to protect public ground water sources from contamination is required of states under Section 1428 of the Safe Drinking Water Act. In most states, the local adoption of wellhead protection measures is voluntary.

Wetlands: Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation

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