Chapter 3

Sustainable Water Resources Management in the United States: Use of River Basin Commissions to Promote Economic Development, While Protecting the Environment and Improving Community Quality

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INTRODUCTION

A river is more than an amenity, it is a treasure.
It offers a necessity of life that must be rationed among those who have power over it.

Chief Justice Oliver Wendell Holmes, U. S. Supreme Court, 1931

The countries of China, Japan and the United States of America (U.S.) have growing economies and rapidly changing land uses. In the drive for a strong economy, the natural environment—particularly the water resources of all three countries have sometimes been abused. Through many examples, we are learning that a country cannot have a strong economy or healthy, vibrant communities without a protected and well-managed environment. All three—economy, environment and community—are interconnected. In the United States, successful water resource management models have emerged that embrace this interconnectedness—most notably in the Delaware River Basin, which since 1961 has been managed by a unique river basin commission. This basin in the eastern United States therefore offers many lessons in water resource management, both quantity and quality.

Key to the success of the Delaware River Basin Commission (DRBC) has been the establishment of number of programs that rely of a targeted approach to resource management. Using a goal-based watershed management approach, DRBC sets quantitative environmental goals that serve as drivers for regulatory programs, as well as watershed planning. Of course, many state government agencies have been using targeted approaches for water quality management through the setting of instream water quality criteria. The difference in the DRBC program is that while most regulatory programs look at one discharge or water withdrawal at a time, this program takes a watershed approach. Such a holistic approach allows alternatives to be assessed and environmental impacts to be incorporated in the planning process.

The aim of this paper is to highlight the increasingly successful management of river flows and water supply in the Delaware River Basin after the creation of a unique river basin commission. After a short description of the river basin, the following sections describe case studies of specific resource management issues with lessons learned—both positive and negative. Topics include: interjurisdictional management of river flows and allocations, drought management, instream flow needs, groundwater protection, and planning for the future.

1. THE DELAWARE RIVER BASIN

In the United States, the Delaware is the longest un-dammed river east of the Mississippi, extending 330 miles (531 kilometers) from the Catskill Mountains in New York State to the mouth of the Delaware Bay where it enters the Atlantic Ocean. The river is fed by 216 tributaries and drains 13,539 square miles (35,066 sq. kilometers), draining parts of the states of Pennsylvania, New Jersey, New York, and Delaware. Approximately 200 miles or two-thirds of the river length is non-tidal. (See Figures 1 & 2).

The river and its surrounding land uses are very

Fig. 1. Location of the Delaware River Basin

Source: DRBC

diverse. The upper basin is known for its natural beauty, world-class trout fishery, and rural communities. Three-quarters of the non-tidal river—about 150 miles (241 kilometers)—has been included in the National Wild and Scenic Rivers System. The system was established by Congress in 1968 to preserve the character of rivers with "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values" and to ensure that designated river stretches remain free-flowing. (P.L. 106-418, 106th Congress).

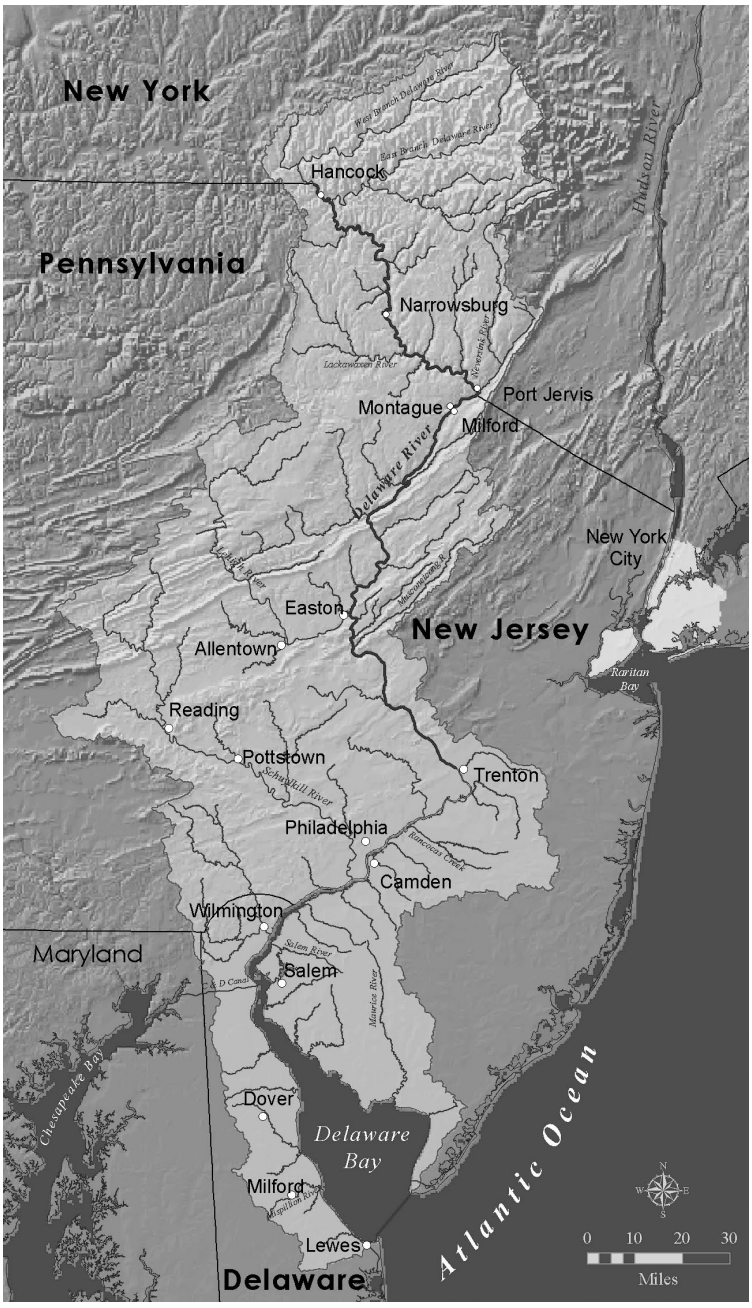
The lower, tidal portion of the Basin is quite different as it is largely developed with large population centers and ports. The Delaware River Port Complex is the largest freshwater port in the world. Philadelphia, the nation's fifth largest city with 1.3 million people, is located on the Delaware River. Even so, there are still many estuarine marshes providing habitat and nursery grounds for diverse aquatic and avian communities.

The Delaware is a relatively small river, but with a large responsibility. Even though it drains only 0.4 percent of the total continental U.S. land area, the Delaware River Basin provides water for nearly 15 million people (5 percent of the nation's population), including 8 million living outside the watershed's borders. Through an out-of-basin transfer, New York City draws up to 800 million gallons per day (mgd). The management of this water withdrawal is discussed fully in the following section.

The Delaware has always been a working river. In the 1800s, it carried rafts of tall timbers to the Philadelphia shipyards and barges of coal from the mines of Pennsylvania. In the 1900s, it became very polluted, being a waste conveyance system from steel mills and other new industries. People turned their backs on the dirty river.

Today the river is fishable and swimmable for its entire length, although there are still bacteria problems after storm events near the big cities. People again have found the recreational value of this "backyard" river and flock to its waters in canoes, kayaks, motor and sailboats. People are even paying high prices to live near the river! Old port and shipyard facilities are being converted to multi-use river centers with residential lofts, marinas, incubator industries, port-related commerce and ship building/repair centers. Although the river is much cleaner, there are still major concerns over water supply and

Fig. 2. The Delaware River Basin



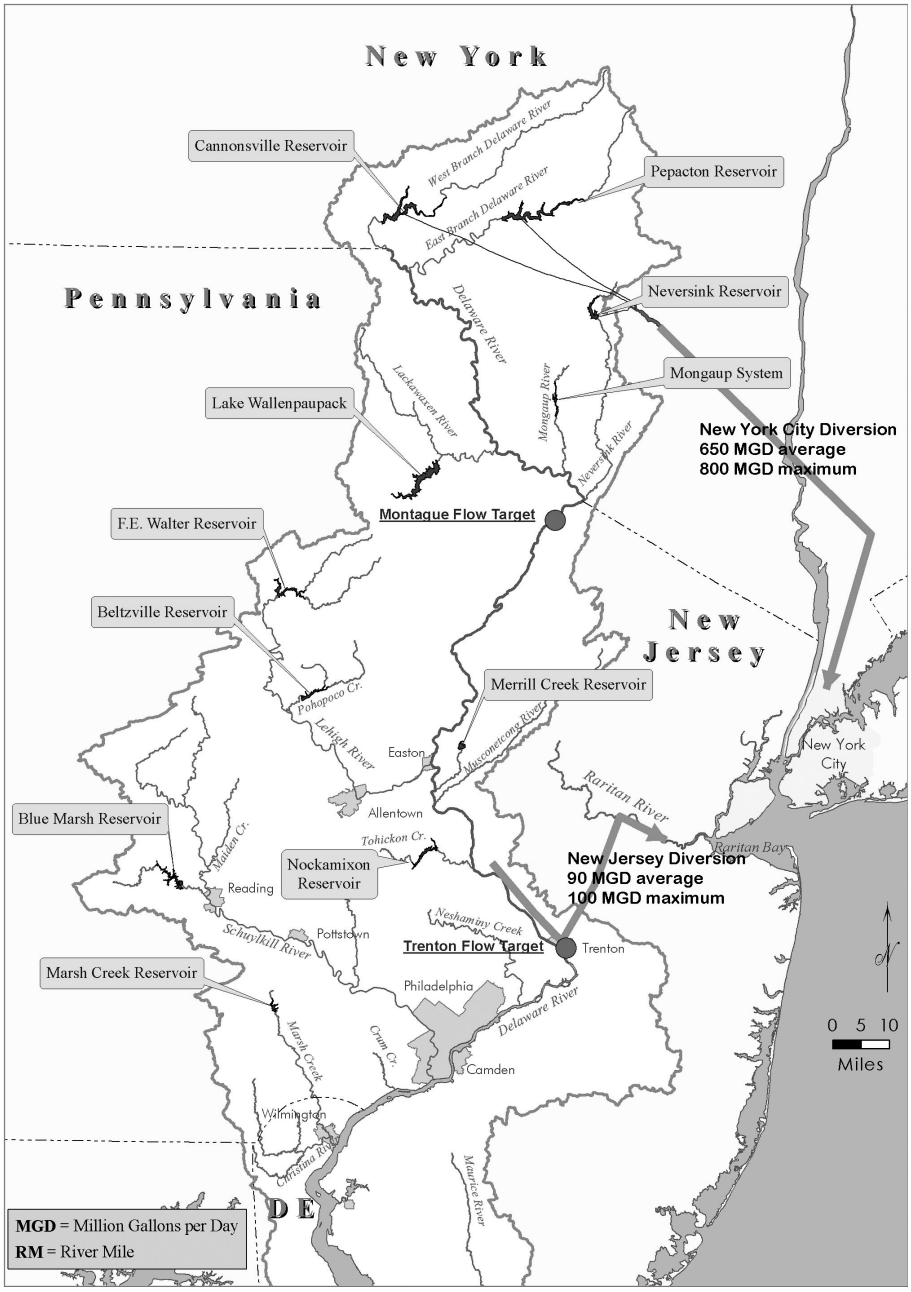
Source: DRBC

allocation, which is the emphasis of this paper.

2. Interstate Management of River Flows and Water Allocation

Even though the Delaware River Basin receives approximately 42 inches of precipitation annually, there are issues of water allocation due to the large and growing demand. Prior to the 1960s, the Delaware River Basin was an arena of interstate conflict and costly litigation over water rights. The U.S. Supreme Court had to resolve these disputes on more than one occasion during the 1900s, most recently in 1954. The basic issue of the conflict is the balancing of out-of-basin diversions to New York City with the in-basin needs for potable water and water supply for industry, power generation and agriculture. In addition, and equally important,

Fig. 3. Flow Targets and Diversions



Source: DRBC

there has to be enough fresh water flowing down the Delaware River to keep the salty waters of the Delaware Bay from inching upstream into industrial and potable water intakes in the Wilmington / Philadelphia / Camden urban area or infiltrating fresh water aquifers. More recently, attention has been placed on the allocation required to ensure instream flow needs to protect fisheries and aquatic communities.

The Supreme Court decision of 1954 allowed New York City to divert a total of 800 mgd, on average, from its three large reservoirs built on Delaware River headwater tributaries, with the condition that enough water be released into the Delaware River to meet a flow target of 1750 cubic feet per second (cfs) at Montague, New Jersey, approximately 80 miles downstream of the uppermost reservoir. This flow target is based on a formula of 0.5 cfs per square mile of drainage area above the gage point. A River Master (a hydrologist with the U. S. Geological Survey) was assigned to determine releases nec-

essary to meet the Montague flow target. In addition, the Supreme Court Decree allowed the State of New Jersey to divert up to 100 mgd out of the Basin to service growing areas in the central part of the State, (See Figure 3)

Recognizing the need for long-term water resources management and wanting a different mechanism than litigation, a breakthrough in water resources management occurred in 1961. President John F. Kennedy and the Governors of Delaware, New Jersey, Pennsylvania, and New York for the first time signed concurrent compact legislation into law creating a regional body with the force of law to oversee a unified approach to managing a river system *without regard to political boundaries.*

The members of this regional body – the Delaware River Basin Commission (DRBC) – are the Governors of the four basin states and a federal representative appointed by the President of the United States. The five members appoint alternate commissioners, with the governors selecting high-ranking officials from their state environmental agencies. Each commissioner has one vote of equal power with a majority vote needed to decide most issues. Exceptions are votes on the commission's annual budget and drought declarations, which require unanimity. Each state and the federal government have relinquished a portion of their sovereign authority to come together and manage water resources on a watershed basis.

The Delaware River Basin Compact (Compact) grants DRBC broad powers to plan, develop, conserve, regulate, allocate and manage water resources in the Basin. Unlike the strongly contested rights of first use in the western United States, the premise of both the Supreme Court decisions and the Delaware River Basin Compact is *the doctrine of equitable apportionment*. The Compact (1961, p.8) states:

> *The Commission shall have the power from time to time as need appears, in accordance with the doctrine of equitable apportionment, to allocate the waters of the basin to and among the states signatory to this compact and to and among their respective political subdivisions, and to impose conditions, obligations and release requirements ...*

This doctrine of equitable apportionment is provided as long as it does not interfere with the Supreme Court Decree allocation or be construed as a prior apportionment. The compact has a life of 100 years and can be renewed. During that time, the states involved in the Supreme Court Decree agreed to waive their rights to appeal or challenge the diversions and releases set by the Court. Changes can be made, however, if all parties to the court action agree upon the change—an issue that will be further discusses in the next section.

Commission programs include water quality protection, water supply allocation, regulatory review, water conservation initiatives, watershed planning, drought management, flood control, recreation, and education. For purposes of maintaining river flow and setting allocations, the Commission has the following programs:

2. 1 Trenton Flow Target

A flow of 3,000 cubic feet per second (cfs) at Trenton, New Jersey (head of tide) is required. Using a hydrologic model, DRBC calculated the amount of flow necessary to maintain 250 mg/l of chloride (the secondary drinking water standard for NaCl) in order to protect the potability of water in the downstream urban areas of Philadelphia and Camden.

2. 2 Regulation of Water Withdrawals and Discharges

The Compact gives the commission authority to control withdrawals in that:

> *No project having a substantial effect on the water resources of the basin shall hereafter be undertaken by any person, corporation or governmental authority unless it shall have been first submitted to and approved by the commission... (Delaware River Basin Compact, 1961,p. 11)*

DRBC project reviews that illustrate how DRBC works to control withdrawals includes:

- All surface and groundwater withdrawals exceeding 100,000 gallons per day (gpd) in any 30-day period, (10,000 gpd in the Groundwater Protected Area).
- Construction or alteration of industrial and domestic wastewater treatment facilities with a design flow of ≥ 50,000 gpd, (10,000 gpd in

the head waters Special Protection Waters).

2. 3 Water Supply Charges

DRBC charges fees for water use to any industry or municipality that withdrawals over 100,000 gallons during any three month period and additional fees for consumptive use of water. These fees are used to purchase water storage rights in two reservoirs managed by the U.S. Army Corps of Engineers, (see Figure 3). DRBC can call for release of the water during drought events.

3. Drought Management

DRBC's first challenge came with multiple years of drought in the 1960s. The drought of record ran from 1961 through 1967. It was soon obvious that in drought conditions, New York City could not withdrawal 800 mgd and still have enough water to release to the Delaware River to meet the Montague Target of 1,750 cfs.

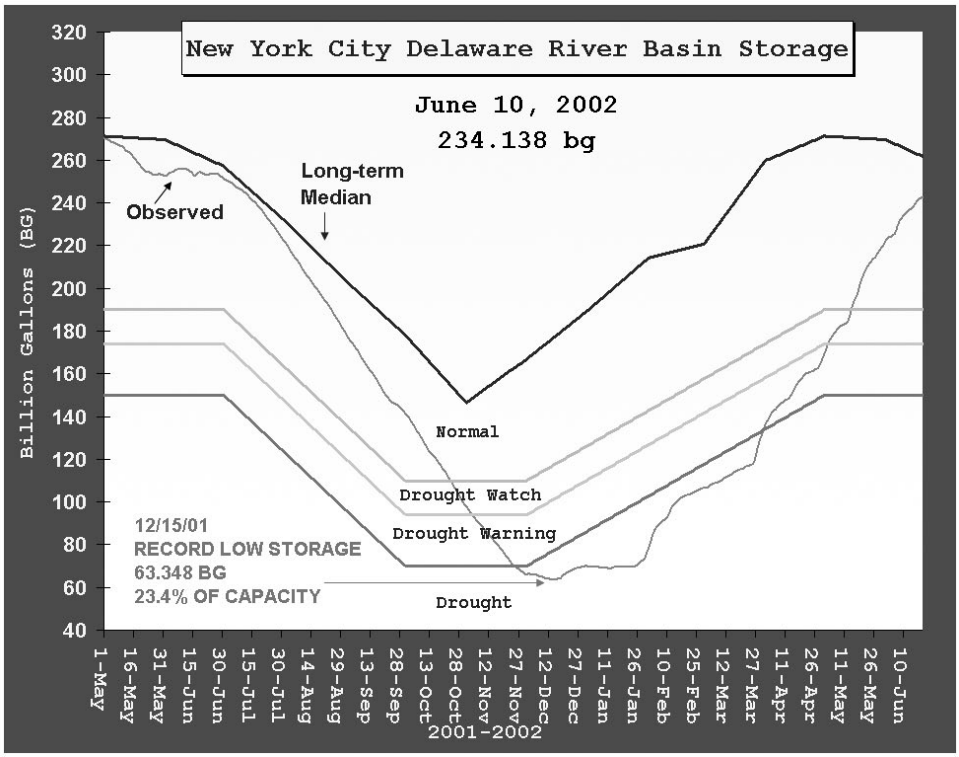
> *New York City reservoirs were nearly empty on Christmas Day in 1964, and in the following month, the anticipated spring refill did not occur. By late 1964, northern New Jersey reservoirs were at one-third of their capacity and residents were overdrawing developed supplies. Philadelphia feared that without sufficient downstream flow to repel salt water from the bay, the salt would reach its Delaware River intake at Torresdale [Pennsylvania], which supplies half the city's water. Afraid that its reservoirs would be dry by August if it continued to make mandatory releases [to meet the Montague Target], on June 14, 1965, New York City unilaterally and without warning stopped all downstream releases, while continuing to divert water to the city. Pennsylvania charged New York with "water piracy." New Jersey, then chair of the commission, began to prepare an application to the Supreme Court for a restraining order to enjoin the city from continuing its illegal diversions (Bush, 2004, p.8).*

There were two choices – the parties could make a litigious attack, or they could test the value of the Delaware River Basin Commission to develop an equitable solution. Luckily, they chose the latter alternative. Management schemes were tested in the drought of the 1960s and in 1978 through "The Good Faith Negotiations" a series of interrelated management steps were developed that could be used to respond to changing conditions in the basin. Significant aspects of drought management in the Delaware River Basin include:

3. 1 Drought Operating Program

The DRBC drought operating program is triggered by declining storage in three New York City reservoirs at the headwaters of the Delaware River. A Drought Rating Curve was developed with trigger points for Drought Watch, Drought Warning, and Drought Emergency, (See Figure 4). As water levels in the reservoirs decline, there is an agreed upon plan of water use reductions (see Table 1). Reductions tied to Drought Warning and Drought Watch are implemented as soon as the triggers are crossed; they do not require additional resolutions or Commission action. Declaring a Drought Emergency, however, requires a unanimous vote by the DRBC members. This is one of the built-in checks and balances, because in Drought Emergency the DRBC is given additional authority to call for storage and releases from private, state and federally owned reservoirs. Under this additional authority, DRBC manages an additional 69 billion gallons of storage (see Figure 5). During the drought of 2001-2002, 500 million gallons of water was conserved per day through use of the Drought Operating Program. Use of the Drought Operating Program has reduced uncertainty in the management of water supply during periods of drought.

Fig. 4. Drought Rating Curve for New York City Reservoirs Located in the Delaware River Basin



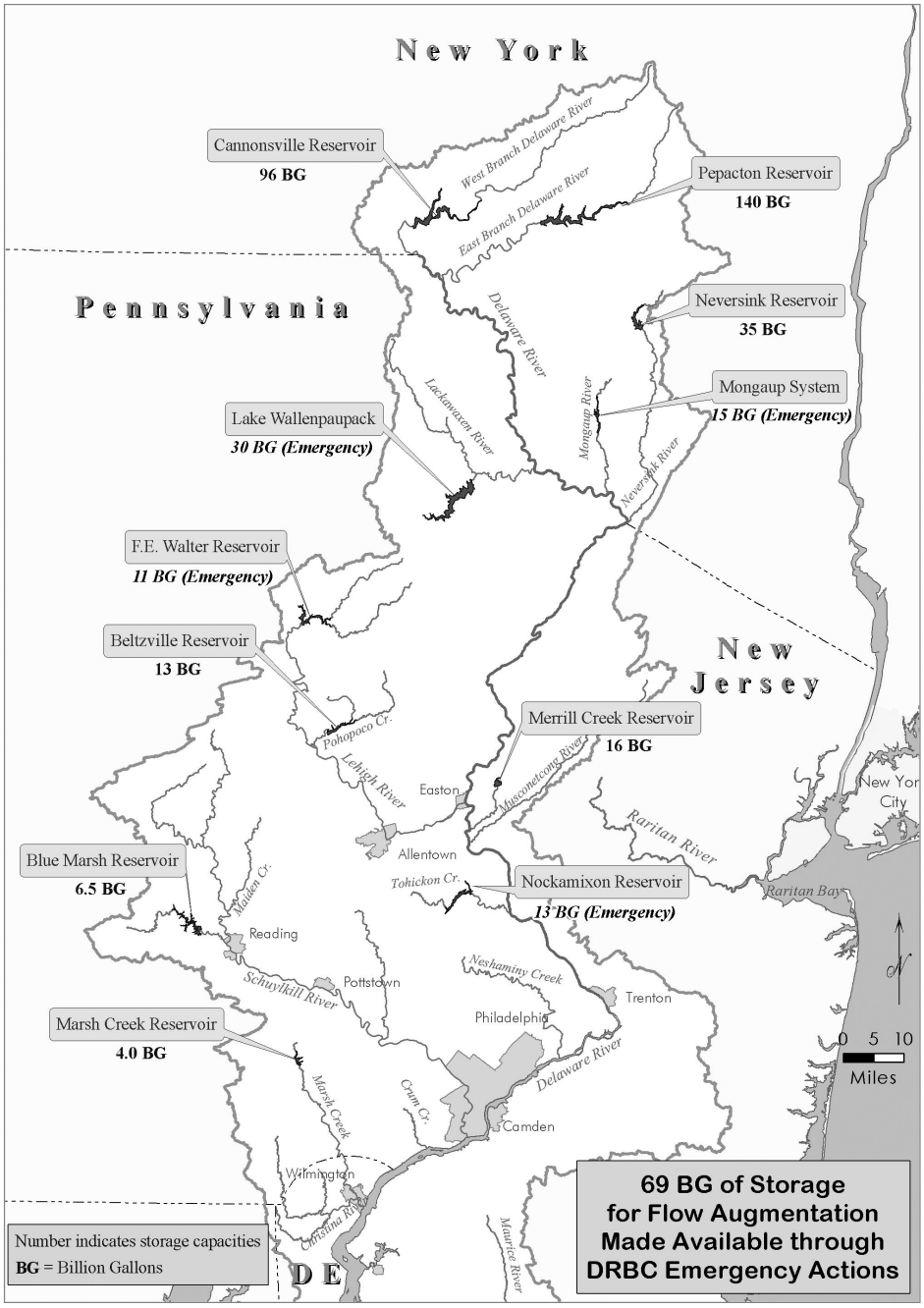
Source: DRBC

Table 1. Water Use Reductions and Flow Targets Under Differing Drought Conditions

Drought Condition	Diversion by New York City	Diversion by New Jersey	Montaque Flow Target	Trenton Flow Target
Normal Operations	800 mgd	100 mgd	1,750 cfs	3,000 cfs
Drought Watch	680 mgd	100 mgd	1,655 cfs	2,700 cfs
Drought Warning	560 mgd	70 mgd	1,550 cfs	2,700 cfs
Drought Emergency	520 mgd	65 mgd	1,100 – 1,650 cfs*	2,500 – 2,900 cfs*

** The target is dependent on the location of the 7-day 250 mg/l chloride concentration in the Delaware Estuary.*
mgd—million gallons per day cfs—cubic feet per second
Source: DRBC

Fig. 5. Drought Emergency – Additional Storage



Source: DRBC

3. 2 Water Use Reduction Plans

DRBC has the authority to require water suppliers to prepare a drought management strategy and industrial water users to prepare a water use reduction plan during times of drought. The industries must show how water use will be reduced and the ensuing impact to employment and production for a 10, 15 and 25 percent reduction. Final requirements would be based on the anticipated impact to the individual facility. (By evaluating each on a case-by-case basis, companies that have already instituted water conservation measures will not be unduly harmed). Because of the success of the other drought management efforts, DRBC has never had to ask any industry to implement the emergency water use reduction plans.

3. 3 Water Conservation Program

To have an effective water management program, both the supply and demand side must be evaluated. DRBC has an aggressive conservation program consisting of the following regulatory programs to reduce water demand:

- Water suppliers must prepare a Water Conservation Plan that, at a minimum, must include: source metering, service metering, leak detection and repair, and water conservation performance standards for plumbing fixtures and fittings.
- Applicants for water withdrawals greater or equal to one million gallons per day must also address a water conservation pricing structure and billing program (DRBC, 2001).

In addition DRBC has published educational material and encourages the public to voluntarily reduce their use of water.

3. 4 Working with State Partners in Drought Declaration

While DRBC takes the lead on the Drought Operating Program regulating river flows and reservoir releases, the States have the lead on community drought actions. Based on factors including existing stream levels, soil moisture, and ground water levels, the States will determine when a specific region requires voluntary water conservation or mandatory conservation. Activities are grouped into non-essential uses (e.g., lawn watering, car washing) and essential uses (e.g., drinking water, industrial uses). It is always extremely difficult to allocate a dwindling water supply. DRBC is guided in prioritizing water uses by the Delaware River Basin Water Code:

> *During drought emergencies, the Commission, in allocating the available water supply in the basin and its service area, will give first priority to those uses which sustain human life, health and safety, and second priority to water needed to sustain livestock. Thereafter, based on the doctrine of equitable apportionment, the remaining water will be allocated among producers of goods and services, food and fibers and environmental quality in a manner designed to sustain the general welfare of the basin and its employment at its highest practical level. (DRBC, 2001, p. 8, Section 2.5.2)*

4. Instream Flow Needs

What about the fish? In the early years of basin flow management, instream flow necessary to support fisheries and healthy aquatic communities was largely ignored. Three changes occurred in the 1980s and 1990s that promoted attention to river ecosystem health. Namely:

- With the construction of the New York City reservoirs and mandatory bottom releases of cold water to the Delaware River, a once warm water fishery was changed to a world class cold water trout fishery. The fishery became an economic driver for the rural areas of the upper basin.
- As pollution in the river was abated, people wanted to fish and took more notice of fishery impacts. There are more people recreating on the river, demanding that instream flows for fish and boating be a recognized issue.
- The general public has greatly increased its level of environmental knowledge and interest in protection of natural systems.

With this demand, DRBC has once again been asked to develop a management program that balances the court dictated out-of-basin diversions (New York City and New Jersey), the in-

basin human water needs—drinking water, industry, power generation, agriculture (and increasingly golf course irrigation)—and flows for fisheries. The following programs are addressing this need:

4. 1 Research

DRBC has many technical advisory committees one of which is the Flow Management Technical Advisory Committee. A Subcommittee for Ecological Flows (SEF) was established in 2003 to set the scientific requirements of the basin fishery, prioritizing the cold-water trout fishery in the upper basin. By the end of 2007, a number of studies will be conducted to assess aspects of flow on the fishery including average flow rate, flow variability, impact on bottom habitat, critical life stages, and impact on prey species. It has already been determined that incremental better management of reservoir releases can be achieved just by small operational changes that do not require additional water.

4. 2 Experimental Flow Program to Support Fishery

For the next three years the members of the Commission and New York City have agreed to change the reservoir release formula to include maintenance of flow targets in the tailwaters of each of the three city reservoirs, in addition to meeting the Montague Target located 80 miles downstream. At the end of this program, the scientific studies conducted by SEF and the monitoring data from this experimental program will be assessed and adjustments made to the basin operations program.

4. 3 Pass By Flow Requirements

In DRBC's regulatory review of surface water withdrawals (and groundwater withdrawals potentially impacting instream flows) a minimum pass-by flow will be required to maintain flow levels necessary to support aquatic communities.

5. Groundwater Protection

Sometimes, the Delaware River Basin Commission (DRBC), because of its unique structure and powers, is able to carry out programs that would be politically difficult, if not impossible, for a basin state to accomplish on its own. An example is the management of the Ground Water Protected Area of Southeastern Pennsylvania (GWPA or Protected Area).

The Protected Area was established after it became evident that land use development was negatively impacting ground water levels in the area. The Protected Area covers 1200 square miles, all or portions of three counties in the Philadelphia metropolitan area and includes 76 sub-watersheds – an area with a very high growth rates that is quickly changing from farmland to residential developments and industrial parks.

The goal is to prevent depletion of ground water and protect the interests and rights of lawful users of the same water source, as well as balance and reconcile alternative and conflicting uses of limited water resources in the region. Lowered water tables in the Protected Area have reduced flows in some streams and dried up others. This reduction in baseflows affects downstream water uses, negatively impacts aquatic life, and can reduce the capacity of waterways in the region to assimilate pollutants.

The review trigger for individual ground water withdrawals in the Protected Area is 10,000 gpd versus 100,000 gallons per day (gpd) in the rest of the basin. In addition, a cumulative withdrawal limit has been developed for each of the 76 watersheds based on a 1 in 25 year stream flow recurrence interval.

The Protected Area is subject to a two-tiered system of water withdrawal limits under the DRBC requirements. In addition to the maximum withdrawal limit, there is a first tier warning at 75 percent of the maximum limit, called "potentially stressed." In potentially stressed subbasins, applicants for new or expanded ground water withdrawals are now required to implement one or more programs to mitigate adverse impacts of additional ground water withdrawals. Acceptable programs include: conjunctive use of ground and surface water, expanded water conservation programs, comprehensive planning at the watershed level, programs to control ground water infiltration, and artificial recharge and spray irrigation.

In the United States, land use regulation is controlled at the municipal level (typically by county or smaller jurisdictions such as townships, towns and boroughs). Due to the small size of municipalities, there can be five or more jurisdictions within one 50 square mile watershed. The DRBC has a program that encourages municipalities within a watershed to work together to develop a multi-municipal Integrated Resource Plan (IRP). Integrated Resource Planning is a comprehensive approach to water resource management that evaluates water resources availability and demands on a watershed level. The process encourages planning to meet multiple objectives and evaluate competing uses of water resources. Under the DRBC's GWPA regulations, Integrated Resource Planning is a tool to:

(1) Evaluate and develop management objectives and strategies on a subbasin basis to ensure that ground and surface water withdrawals are managed in a manner that protects both instream and withdrawal uses in the subbasin.
(2) Evaluate the adequacy of existing ground and surface water resources to meet all existing and future needs in the subbasin, and assess options for meeting those needs.
(3) Engage stakeholders as active participants in developing effective, long-term water resource management objectives and strategies.
(4) Consider the inter-relationship of water quality and water availability for current and future water uses in a subbasin.
(5) Assist planners to better integrate water resources protection in land use planning.

Almost all land use decisions affect water resources. Growth is occurring in most subbasins of the GWPA. IRPs can assist in better managing *how* that growth occurs. By evaluating all water resources options, existing and future needs may be met while simultaneously protecting the resources and supporting other uses including instream flow needs.

5. 1 Planning for the Future

It is important to not only manage the present, but to plan for the future. DRBC just recently completed the *Water Resources Plan for the Delaware River Basin: A Common Vision for a Common Resource*, (DRBC, 2004) (Basin Plan). It sets direction, goals, and milestones for water management in the Basin for the next 30 years. Because it takes multiple organizations and levels of government to effectively manage water resources, the plan was developed through a very open process. A 40 member Watershed Advisory Council was established with representatives from industry; federal state and municipal government; environmental and watershed organizations; water and power utilities; academia, farming, and education. The development of the plan was a facilitated process based on group consensus. The Basin Plan sets a common direction that all organizations in the Basin can use as a compass. DRBC is responsible for trend analyses and will be publishing a "A State of the Basin Report" every five years to track progress. The planning exercise was not only useful to develop consensus on future goals, but to highlight data gaps and research needs that must be addressed to make progress.

The goal-based Basin Plan will guide policy and action to achieve the following results: Sustainable Use and Supply, Waterway Corridor Management; Linking Land and Water Resource Management, Institutional Coordination and Cooperation, and Education and Involvement for Stewardship. There are also 12 Guiding Principles that should be used to judge actions taken to implement the goals and objectives of the Basin Plan.The Basin Plan can be viewed on the web site: http://www.drbc.net

5. 2 Conclusions and Lessons Learned

Water is both a vital component of our daily lives and greatly impacted by our actions. It does not respect political boundaries. Yet it is very difficult to manage water resources unless there is an agency or organization with authority to manage the resource across jurisdictional boundaries. The Delaware River Basin Commission is such an entity. The path is not always easy at a River Basin Commission. Upstream and downstream agendas are often quite different and often opposing. Rural and urban needs are difficult to address through one management scheme. It is difficult for any one Commission member to leave his state or agency agenda at the door and just focus on the water resources issues. However, it has worked in the Delaware River Basin. Since the creation of DRBC, there have been no lawsuits among the states and

there has been dramatic improvement in water quality and supply allocation. Following is a list of "Lessons Learned" that will hopefully prove helpful during the development of new water resource management programs.

- An effective water resource management program must be adaptable. It is helpful to have preliminary targets established (such as the 1750 cubic feet per second flow target at Montague, New Jersey), but natural resources do not comply with static dictates. The value of a River Basin Commission is it allows the signatory parties to cooperatively set priorities and change management schemes as new science emerges, new management tools are developed, and water demands change.
- An effective River Basin Commission must have authority to succeed. Voluntary watershed organizations are good for building grass-root support, but in order to effectively manage water flows, allocations and pollution control across political boundaries requires planning and regulatory authority.
- A River Basin Commission must have equal representation from upstream and downstream governmental jurisdictions.
- No one agency can manage water resources across political boundaries. Entities that will be involved in implementation—e.g., municipal governments, industries—must be allowed to comment as the water management programs are being developed. The DRBC works because of the cooperation with its member states and federal agencies. It is important to remember that DRBC is not *above* the states and federal government, but provides a structure within which they can work together, with the help of DRBC staff, to effectively manage water resources in a way that provides stability for economic growth and healthy communities.
- Officials must be accountable for the environmental externalities associated with economic growth.
- A basin management system needs checks and balances.
- Water must be managed holistically. Water budgets must consider instream flow, water supply, wastewater, and stormwater. Groundwater and surface water are two components of the same system. Changes in water quantity can have impacts on water quality.
- What happens on the land significantly impacts water resources. Management and regulatory systems must be developed that monitor and account for the impacts of changing land use on our waters. Potential impacts to water resources must be addressed in the planning and approval stages of new developments. Stormwater impacts, both quantity and quality must be addressed. In the U.S., this means doing a better job of engaging municipal governments in water resource management.
- Good resource management must be proactive. A river basin commission can provide the scientific information and regulatory framework so new industries and residential development consider water availability when siting new facilities.
- The key to effective water resource management is a transparent process with goal-based, adaptive approaches.

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