Lower Delaware River Eligibility Determination for DRBC Declaration of Special Protection Waters

Delaware River Basin Commission
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Introduction

On November 19, 1999, the U.S. Senate passed S. 1296, the Lower Delaware Wild and Scenic Rivers Act. Congress passed the bill in October 2000 (see **Appendix A**), designating segments of the study area as a recreational river, to be managed in accordance with the Lower Delaware River Management Plan. On November 1, 2000, the President of the United States signed the Act. Federal Wild and Scenic designation now covers most of the 197-mile non-tidal portion of the Delaware River. Wild and Scenic status serves a basic requirement in Delaware River Basin Commission (DRBC) rules for declaration of the higher of two Special Protection Waters (SPW) protection levels: Outstanding Basin Waters (OBW). The lower protection level, Significant Resource Waters (SRW), may be declared for any water body meeting SPW criteria.

The DRBC Lower Delaware Monitoring Program (LDMP) operates in support of the Lower Delaware River Management Plan, produced by the Lower Delaware River Wild and Scenic River Study Task Force and the National Park Service (1997). Goals of the Management Plan are shown in the text box on the next page. The first goal of the Management Plan is to "**maintain existing water-quality (EWQ) in the Delaware River and its tributaries from measurably degrading and improve it where practical.**"

The "maintain EWQ" objective requires Special Protection Waters status in order for anti-degradation policy to take effect in DRBC water quality standards. On January 28, 1998, the DRBC passed Resolution No. 98-2, which endorsed the Lower Delaware River Management Plan and resolved to "…take such action as it deems appropriate to implement the goals of the plan commensurate with available resources." DRBC staff interpreted this to mean that DRBC should manage water quality to prevent degradation where EWQ is cleaner than standards and to improve water quality where it does not meet standards. In areas of good water quality, requirements include setting and agreeing on permitting standards for discharges as well as providing tools and information that will prevent additional impacts from land development and for management activities. "Keeping clean water clean" is a major challenge in areas such as the Lower Delaware where increased growth and development activity are expected. 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.

The National Park Service (1999) surveyed river-corridor landowners, finding significant support for river corridor protection. 98% felt that water quality should be preserved, and 90% support land use regulations and programs to preserve and protect the river.

Water Resources Plan for the Delaware River Basin

In June 2004, DRBC issued the Water Resources Plan for the Delaware River Basin (Basin Plan). The Basin Plan was created through the efforts of numerous agencies, organizations, industries, and other interested parties of the Delaware Basin. A Watershed Advisory Council composed of these interests provided overall Basin Plan direction, and agreed that water quality conditions must be monitored with sufficient frequency in the main stem and the tributaries to track water quality maintenance, improvement, or degradation. Under Basin Plan goals relating to meeting ecosystem, recreational, and off stream water needs, specific objectives of the Basin Plan include:

1. Where water quality meets or is better than standards for the protection of aquatic and wildlife, off stream uses, or recreational needs, implement anti-degradation regulations, policies and/or other mechanisms to maintain or improve existing water quality.

2. Where water quality is not sufficient to protect aquatic life and wildlife, off stream uses, or recreational needs, employ strategies to provide protection through the implementation of Total Maximum Daily Loads (TMDL) and other regulatory and non-regulatory means.

According to the Basin Plan, approaches may include: 1) Anti-degradation programs (e.g. state protections for high quality and exceptional value streams, the DRBC's Special Protection Water designations and federal Wild and Scenic Rivers designations); 2) Stormwater management programs; 3) Water quality-based trading programs (offsetting impacts from new or expanded discharges by equivalent or greater reductions from other sources within the watershed).

Lower Delaware River Management Plan Goals

National Wild and Scenic Study Report (NPS 1999, p. 59-60)

Goal 1: Water Quality
Maintain existing water quality in the Delaware River and its tributaries from measurably degrading and improve it where practical.

Policies:

- Achieve the highest practical state and federal water quality designation for the river and its tributaries.
- Manage point discharge and storm water non-point runoff to minimize degradation of the river.
- Encourage the use of Best Management Practices in the agricultural areas within the river corridor to minimize water quality degradation from storm water runoff.
- Encourage the use of Best Management Practices for activities other than agriculture that could result in water quality degradation from storm water runoff.
- Discourage inappropriate development in floodplains, wetlands, steep slopes and buffer strips along the lower Delaware River and its tributaries.

Implementation Strategies:

General

- Pennsylvania DEP, New Jersey DEP, and the Delaware River Basin Commission should jointly develop a river corridor water quality management plan describing the highest level of water quality protection consistent with the water quality goal of this management plan, and the monitoring, research, modeling and regulations needed to insure protection of that level of water quality.
- An enhanced water quality monitoring program should be implemented for the lower Delaware River and its tributaries under the leadership of the Delaware River Basin Commission.
- The regional cooperative environmental monitoring plan prepared for the Delaware Estuary Program should be expanded and adopted to cover the entire river corridor. The environmental monitoring plan is focused on the key areas of water quality, toxics, living resources, and habitat/land cover/land use.
- The current system of monitoring septic/sewage systems should be improved and property owners should be educated.
- Public education programs to protect water quality.
- The NRCS and states should encourage farmers to develop farm management plans in accordance with Best Management Practices.
- Periodic water quality announcements and/or advisories should be issued by DRBC.

Delaware Riverkeeper Petition

In April 2001, the Delaware Riverkeeper Network, an affiliate of the American Littoral Society, petitioned the DRBC to classify the Lower Delaware River as Special Protection Waters. DRBC staff replies to the petition are shown in **Appendix B**. The petitioner specifically asked:

1. That the entire reach of Delaware River main stem from River Mile 209.5 (downstream boundary of the Delaware Water Gap National Recreation Area) to River Mile 133.4 (Head of Tide) be designated as a Special Protection Water;

2. That those sections of the proposed Special Protection Waters that are now components of the National Wild and Scenic Rivers System due to the enactment of Public Law 106-418 cited as the "Lower Delaware Wild and Scenic Rivers Act", be classified by the Commission as Outstanding Basin Waters;

3. That those sections of the proposed Special Protection Waters that are not components of the National Wild and Scenic Rivers System be classified by the Commission as Significant Resource Waters;

4. That the Commission adopt the Lower Delaware River Management Plan, as cited in Public Law 106-418 and dated August 1997, into its Comprehensive Plan as provided for in Compact Section 3.1;

5. That the Commission, in cooperation with the States of New Jersey and Pennsylvania, initiate the development of the bi-state water quality management plan called for in the Lower Delaware River Management Plan, said plan to be focused on preserving and/or improving existing water quality;

6. That the Commission make the development of the bi-state water quality management plan for the Lower Delaware River a specific and high priority task of its pending Comprehensive Planning activity; and

7. That the Commission adopt interim measures during the third quarter of 2001 that protect existing water quality from changing in the Lower Delaware while all necessary planning is being conducted. These measures should include interim definitions of existing water quality derived from all currently available data and effluent requirements based upon Best Demonstrable Treatment technology or facsimile as defined in the Special Protection Waters regulations.

Furthermore, the petitioner requested:

8. That the Commission comply with Section 3.10.3A.2e.3) of its regulations. This section of the Commission's water quality standards required the Commission to prioritize watersheds in the currently designated Special Protection Waters drainage area (Middle and Upper Delaware) by February 1996. The petitioner noted that this deadline was not met. Priority watersheds are watersheds where non-point source control plans were to be developed by the Commission no later than 2001. This deadline was not met either. The petitioner suggested that the February 1996 deadline be extended by Commission action to a date in 2003 that corresponds to the release of a draft new or updated Comprehensive Plan and that said plan contain the information and recommendations required by Section 3.10.3A.2e.3).

9. That the Commission prioritize the watersheds draining to the Lower Delaware River simultaneously with its prioritization of upper basin watersheds. This prioritization is necessary for the development of the bi-state water quality management plan as described above. Moreover, performing the prioritization activity as part of an overall Comprehensive Planning process insures that all future activities are directed at the highest priorities.

Lastly, the petitioner suggested:

10. That the Commission's Comprehensive Planning program consider using the Special Protection Waters boundary and interstate control point approach as its basic framework for developing policies and managing all water resource issues in the Basin – to the extent applicable. The control point approach establishes specific goals, objectives, and measures of success on an individual watershed and location basis as well as at Basin level. This allows specific goals and objectives to be established, distinct priorities and activities to be developed, and explicit actions to be assigned to specific organizations and agencies rationally within an overall Delaware River Basin planning context.

Special Protection Waters Eligibility Determination

When the Delaware Riverkeeper petitioned DRBC in 2001, no immediate water quality determination could be made because of very limited data availability. Analysis of the historical monitoring network revealed that the data record was insufficient to describe the status and trends of Lower Delaware River water-quality, and without more data, existing water quality could not be numerically defined. Refer to the technical water

quality report "Lower Delaware Monitoring Program: 2000-2003 Results and Water Quality Management Recommendations " (DRBC 2004) for detailed water quality results of the Lower Delaware Monitoring Program. The report describes creation of the LDMP monitoring network based upon the Control Point Approach, and presents results of four years of a five-year monitoring effort. It also describes initial year 2001 results of the Delaware River Biomonitoring Program, under which DRBC monitors benthic macroinvertebrates and river habitat conditions for the entire non-tidal portion of the Delaware River.

What is Existing Water Quality?

Traditionally and historically, water quality standards and criteria have been developed to protect certain uses of the water resource. Conventional numeric criteria have been oriented toward effect levels upon these uses, where negative effects upon human health, aquatic life, recreation, or suitability for water supply are likely to occur. There is a gap in water resource protection created by this approach. Poole et al. (2004) determined that while conventional standards have proved valuable, regime-based standards are better structured to address human caused imbalances in dynamic, natural water quality. In very high-quality waters, typical concentrations of water quality constituents are far better than effect levels. EWQ is the typical range of concentration levels of all measurable constituents of ambient waters, as defined over a specific time period. EWQ is defined either by design or by summary of historical data, and these water quality levels are used in combination with antidegradation policies to protect water quality. The main objective of such "no measurable change" policy is to protect defined water quality from degrading from current high quality levels.

Declaration of Special Protection Waters by DRBC is a major statement of antidegradation policy, or a declaration of intent that the waters of the Delaware shall be managed to maintain water quality at EWQ levels and not allow change toward effect-level criteria or worse. Of course, natural water quality may vary widely throughout the course of the day and the season, so monitoring must be as comprehensive as practicable so that the natural range of variation is captured. Once sufficient data are collected to describe EWQ with confidence, the natural range of EWQ is statistically expressed either non-parametrically in terms of median, 10^{th} and 90^{th} percentiles; or parametrically in terms of mean and 95% confidence limits. Once EWQ is defined, the monitoring focus then shifts to determine whether water quality is changing (and why) over time using the statistically expressed range of variability to detect "measurable change."

Development of Measurable Indicators from DRBC Narrative Rules

In order to determine eligibility of the Lower Delaware River for Special Protection Waters status, "**evidence must be shown that these waters are considered to have exceptionally high scenic, recreational, ecological, and/or water supply values"** (DRBC Water Quality Standards, 1996).

In DRBC water quality regulations, the rule language provides no quantitative criteria to judge "exceptionally high" values. Measurable indicators for SPW determination were derived by parsing the statement from DRBC rules into measurable component parts. As the focus of this investigation, water quality was measured in terms of ecological, recreational, and water supply values. As an indicator of "exceptionally high" value, water quality was compared with the most stringent criteria chosen from among DRBC, Pennsylvania, or New Jersey water quality standards. Water quality of the river was also compared with that of designated EV, HQ, or C1 waters. Federal guidelines were used where no criteria exist. For ecological value, further consideration was given to measures of biological integrity. Measurable biological traits include taxonomic richness, diversity, balance, pollution intolerance and physical habitat value.

Scenic and recreational values are discussed at length in the Lower Delaware Management Plan (1997) and the National Park Service Lower Delaware Wild and Scenic Study (1999) as federal designation categories judged under specific criteria. Selections are presented in **Appendix C**. The Lower Delaware River offers a variety of recreational uses which include boating, fishing, canoeing, tubing, swimming, wildlife watching and tourism at numerous historical and cultural sites along the river. Visitors to the Delaware Water Gap National

Recreation Area at the head of the Lower Delaware exceed 4.5 million per year and partake in activities along and in the Delaware. Recreational use along the Lower Delaware River is substantial. On hot summer days, the canoe liveries send hundreds of canoes and tubes on day trips. An average season for these liveries provides access to 15,000 people per livery (Bucks County River Country, personal communication 2004). Delaware River Biomonitoring Program observers (unpublished DRBC field notes, 2001-2003) typically recorded about 40 boats, canoes, tubes or waders per hour passing Lower Delaware biomonitoring sites, but flotillas of up to 220 per hour have been noted. This is in addition to the substantial number of people who enjoy the river along the numerous public access points. Fishing pressure is heavy, particularly when the American Shad and River Herring are running in the spring. The Shad Festival at Lambertville, NJ and New Hope, PA with attendance over the two day festival exceeding 30,000 people, centers upon the annual return of these migratory species. Events like this are culturally and economically significant to the region where river centered recreation and tourism is of increasing economic importance. Opportunities abound for wildlife watching. DRBC staff commonly note the presence of snakes, turtles, salamanders, otters, bears, deer, hawks, owls, osprey, bald eagles, herons, egrets, and many types of songbirds. River-centered recreation and tourism is of increasing economic importance, and its resource value must be protected.

In terms of ecological value, the river's geological variety and flow regime provide suitable and heterogeneous habitat for a diverse, rich and abundant aquatic community. The Lower Delaware is a generally wide, shallow, gravel and cobble-bottom river that flows through a very diverse landscape. Geological features such as the Piedmont's Triassic Rock outcrops and boulder-field remnants of two glaciers, combined with numerous islands, riffles, pools, aquatic vegetation beds, back-channels, and forested riparian canopy provide a wide range of habitat types for biological activities such as feeding, reproduction and refuge. The Delaware River's continuity of diverse habitat is much reduced or absent in nearly all other large rivers of the eastern U.S., where dams, levees, and channelization have fragmented the river continuum. The free-flowing nature of the Delaware River is unique and exceptional. The Delaware River Biomonitoring Program has sampled habitat and benthic macroinvertebrates since 2001, and early results are quite positive. All of the first year samples have shown that the benthic assemblage is rich, diverse, well balanced, and intolerant of pollution – scoring as well as or better than the Special Protection Waters of the Middle and Upper Delaware. DRBC and USGS river biologists find that a high-quality biological community exists in the Lower Delaware River, which also indicates high water quality.

As additional evidence of the ecological value of the Lower Delaware, **Appendix C** contains selections from the Lower Delaware National Wild and Scenic Study Report (NPS, 1999). Natural resource values of the Lower Delaware have been recognized and designated by the states and the federal government. These include geological features, vegetation and critical habitat, fisheries, wildlife, Delaware River islands, and wetlands.

Under Pennsylvania DEP water quality standards, the Lower Delaware is classified as a Warm Water Fishery. Warm water fishes such as bass, perch, white suckers and many other species are abundant year-round; and the fish community is supplemented annually by major migrations of American Shad, American Eel, and River Herring. Owing to its free-flowing character and good water quality, the Delaware River is a major sport-fishing draw for anglers who seek these migratory species. Fisheries provide economic and quality of life benefits to the region.

Water supply value may be the most critical and vulnerable resource issue relevant to SPW designation. The Lower Delaware certainly can be described as an exceptional value water supply resource. Sayers (personal communication, 2004) related that as of 2004, an estimated 2.9 million people directly depend upon water supplied by the Lower Delaware. Public water supply withdrawals taken directly from the Lower Delaware River total 131.6 million gallons per day. These public water suppliers serve 1.1 million customers:

City of Easton;
North Penn and North Wales Water Authorities, via the Point Pleasant water diversion;
New Jersey Water Supply Authority, via the Delaware and Raritan Canal diversion;

Pennsylvania American Water Company, Yardley District;
Morrisville Borough; and
Trenton Water Works.

Industrial and power generation water supply is also significant within the Lower Delaware. Chief among these in water use are four major power generation facilities: Portland, Martins Creek, Gilbert, and Limerick Nuclear, which is also fed by the Point Pleasant Diversion. Every river town contains some industry, though this use of the water resource is not as intensive as in years past.

Additional downstream water suppliers are also dependent upon water quality of the Lower Delaware as freshwater inflow to the upper Delaware Estuary. Downstream withdrawals total 219.8 million gallons per day, serving about 1.8 million people. Customers of the Philadelphia Water Department; Lower Bucks County Joint Municipal Authority; New Jersey American Water Company Delran Intake; Bristol Borough and Burlington City are dependent upon fresh and clean water that flows through the Lower Delaware.

Control Point Monitoring Concepts

Historical DRBC monitoring programs have been designed for very specific purposes, such as the 1987 and 1999 bacteria surveys for primary contact recreation suitability assessment, or synoptic surveys used for the 305b assessment to determine compliance with water quality standards. The design of the LDMP is different in that the results are expected to be used not only for compliance with standards, but also to create targets for protection of existing water quality. Such management includes:

- Establishment of baseline EWQ for future comparison;
- Setting targets for maintenance of water quality where standards are met;
- Setting targets for improvement of water quality where standards are not met;
- Setting geographic and water quality priorities to meet the targets; and
- Monitoring long-term so that DRBC can consistently perform its 305b assessment, monitor trends, prioritize agency management activities, and assess effectiveness of strategy implementation.

In order to meet these purposes, the design was created to address some questions about the Lower Delaware:

- How does water quality change from the Delaware Water Gap to Trenton?
- Which tributaries produce such changes?
- Where should restoration or protection resources be devoted for water quality benefit?

Certain terms are associated with the way DRBC evaluates water quality data. Since DRBC evaluates its data along the geographical boundaries of a longitudinal river corridor, it is necessary to segment the river so that changes from upstream to downstream can be documented at particular locations. The points on the Delaware River where changes to water quality are assessed are known as **Interstate Control Points (ICP)**, since these are located along the river which is the boundary between states. Delaware River bridges are typical locations of ICP sites, chosen for reasons of safety, economy, and ease of access. Interstate Control Points are placed between major inputs of water to the Delaware River. A common approach to impact assessment for water resource scientists is the "upstream-downstream" evaluation, where water quality is assessed upstream of an input or point source, at the point source itself, and the combined effect is assessed downstream of the confluence of the upstream and point source inputs. Each tributary is considered a discrete input or point source to the Delaware River. The LDMP monitors these **Boundary Control Points (BCP)** near to their confluence but away from backwater influence of the Delaware River. To evaluate the effects of each tributary upon the Delaware River, it is necessary to monitor the tributary BCP and to relate the resulting information to the nearest upstream and downstream ICP. **Table 1** lists LDMP ICP and BCP sites where existing water quality was defined using the 2000-2003 data set.

Any criteria or targets created using the control point approach are site-specific. Site-specific targets can be monitored at a high accuracy level with the ability to detect water quality changes. In addition, the control point approach allows for creation of watershed-specific water quality targets, where effects of each tributary upon the river are differentiated and requirements for maintenance or restoration of water quality can be modeled and quantified. The site-specific control point approach has advantage over the reach-wide target approach in current DRBC rules in that if measurable change in the Delaware River or tributary is detected, it is possible to determine the source of change and take appropriate action at smaller relative cost and effort.

Table 1. Lower Delaware Monitoring Program ICP and BCP Sites

Site Name	River Mile	Drainage Area (mi2)	Control Point Type	State Designated AntiDegradation Waters	Physiographic Province
Delaware River at Portland Footbridge	207.40	4,165.0	Interstate CP	-----	Valley/Ridge
Paulins Kill, Warren Co., NJ	207.00	177.0	Tributary BCP (major)	-----	Valley/Ridge (limestone)
Delaware River at Belvidere Bridge	197.84	4,378.0	Interstate CP	-----	Valley/Ridge
Pequest River, Warren Co., NJ	197.80	157.0	Tributary BCP (major)	-----	Valley/Ridge (limestone)
Martins Creek, Northampton Co., PA	190.80	45.5	Tributary BCP (major)	-----	Valley/Ridge (limestone)
Bushkill Creek, Northampton Co., PA	184.10	80.0	Tributary BCP (major)	PA HQ-CWF	Valley/Ridge (limestone)
Delaware River at Easton, PA.	183.82	4,717.0	Interstate CP	-----	Valley/Ridge
Lehigh River, Northampton Co., PA	183.66	1,364.0	Tributary BCP (major)	-----	Valley/Ridge
Pohatcong Creek, Warren Co., NJ	177.40	57.1	Tributary BCP (major)	NJ C1	Valley/Ridge
Delaware River at Riegelsville Bridge	174.80	6,328.0	Interstate CP	-----	Valley/Ridge
Musconetcong River, Wrrn/Hntdn Co., NJ	174.60	156.0	Tributary BCP (major)	-----	Valley/Ridge
Cooks Creek, Bucks Co., PA	173.73	29.5	Tributary BCP (major)	PA EV	Valley/Ridge
Delaware River at Milford Bridge	167.70	6,381.0	Interstate CP	-----	Piedmont
Nishisakawick Creek, Hunterdon Co., NJ	164.10	11.1	Tributary BCP (minor)	NJ C1	Piedmont
Tinicum Creek, Bucks Co., PA	159.90	24.0	Tributary BCP (minor)	PA EV	Piedmont
Tohickon Creek, Bucks Co., PA	157.00	112.0	Tributary BCP (major)	-----	Piedmont
Paunacussing Creek, Bucks Co. PA	155.60	7.9	Tributary BCP (minor)	PA HQ-CWF	Piedmont
Delaware River at Bulls Island Footbridge	155.40	6,598.0	Interstate CP	-----	Piedmont
Lockatong Creek, Hunterdon Co., NJ	154.00	23.2	Tributary BCP (minor)	NJ C1	Piedmont
Wickecheoke Creek, Hunterdon Co., NJ	152.50	26.6	Tributary BCP (minor)	NJ C1	Piedmont
Delaware River at Lambertville Bridge	148.70	6,680.0	Interstate CP	-----	Piedmont
Pidcock Creek, Bucks Co., PA	146.30	12.7	Tributary BCP (minor)	-----	Piedmont
Delaware River at Washington's Crossing	141.80	6,735.0	Interstate CP	-----	Piedmont
Delaware River at Calhoun St. Bridge	134.34	6,780.0	Interstate CP	-----	Piedmont

In the Lower Delaware scenic rivers legislation, there are undesignated gaps between the designated river segments of the Lower Delaware (**Figure 1**). These are typically river segments located in the vicinity of urban and industrial centers, where such uses as industrial supply and water supply are important. It is not possible to allow water quality degradation in undesignated segments without expecting water quality to degrade in designated segments. For consistent management, antidegradation policy must be applied without regard to artificial or political boundary lines along the longitudinal corridor. For this reason, the control point approach was not created to be consistent with federal scenic rivers-designated segments described in the legislation.

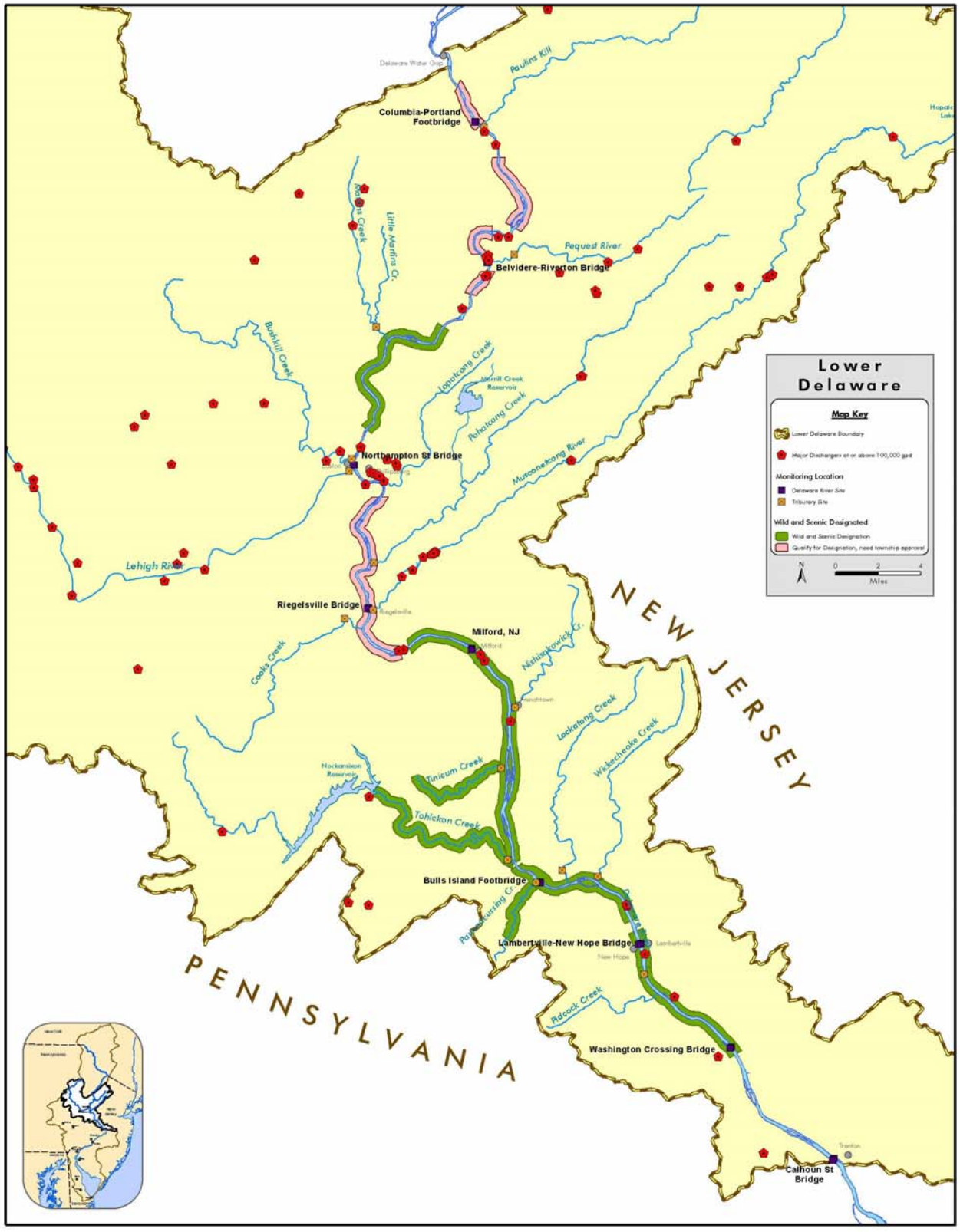

Figure 1. Lower Delaware Scenic River Segments, Dischargers, and Monitoring Locations.

State and federal program managers have agreed with the control point approach and site-specific, quantitative water quality targets. During program design, NJ and PA state agency representatives on the LDMP Technical Advisory Committee noted their utility for state monitoring and management planning.

The control point approach should result in efficient management of water quality. If a problem is detected at an ICP site but not at its upstream neighbor site, it is simpler to intensively survey a 10-mile reach than a 75-mile reach. Once BCP targets are created, they will provide measurable targets for state managers to fund projects in priority watersheds and to quantify water quality effects of completed restoration or protection projects. BCP and ICP existing water quality targets can also be used in combination with long term monitoring to improve agency reaction time for abatement of water quality degradation. Presently, correction of effect-level criterion violations is often an economically burdensome effort to improve degraded water quality. Note state experiences with Total Maximum Daily Loads (TMDL) as illustration of this point. Rarely, if ever, are water quality improvements realized to levels that are better than minimally acceptable standards. Use of BCP and ICP targets should enable more rapid and inexpensive response to water quality changes before a TMDL becomes necessary. Thus, water quality corrections may be realized before it's too late to act on a small scale; and before water quality degrades from very good to minimally acceptable. Existing Water Quality thus becomes a tool to measure water quality relative to the water quality standards. If water quality improves, EWQ targets can be periodically upgraded to realize long-term water quality improvement.

Based upon the LDMP 2000-2003 data set, existing water quality was defined at each of 9 ICP monitoring locations and compared with the most stringent criteria available. **Table 2** describes how EWQ fared versus criteria at each location and for each parameter monitored. Detailed results are described in the accompanying technical water quality report "Lower Delaware Monitoring Program: 2000-2003 Results and Water Quality Management Recommendations " (DRBC 2004).

In addition, Lower Delaware biological metrics were calculated from the 2001 biological data set and compared with the most stringent targets from the Upper Delaware Special Protection Waters and with New Jersey's criterion for definition of a pollution intolerant macroinvertebrate assemblage. The DRBC's Delaware River Biomonitoring Program gathers sufficient physical, chemical, and biological information to serve the following purposes:

- Implement SPW regulations for the Upper and Middle Delaware River.
- Define EWQ and implement anti-degradation protection of the Lower Delaware River.
- Develop a Benthic Index of Biological Integrity (B-IBI) for the non-tidal Delaware River.
- Provide biological assessment information for the Delaware River 305B report.
- Increase the base of ecological knowledge of large free-flowing rivers.

Eligibility Determination

Does the Lower Delaware meet DRBC or State water quality standards?

Delaware River results indicate that existing water quality is better than criteria levels, with the exception of bacteria. Of 153 possible comparisons of EWQ to most stringent criteria (9 ICP sites, 17 parameters), 94% showed that EWQ is better than criteria.. 74% were better at all times, 20% met criteria about 90% of the time, and 6% never met criteria. For most sites and parameters, EWQ based targets would provide protection for maintenance of existing good water quality. Enterococcus bacteria concentrations are the single major problem. Fecal coliform and E. coli bacteria concentrations were problematic during storms. Phosphorus concentrations were relatively high but did not render the Lower Delaware unsuitable for aquatic life use. At certain locations, pH and TDS were naturally divergent from criteria levels, indicating that perhaps the criteria themselves need revision. As shown in **Table 2**, EWQ targets will provide additional water quality protection by establishing targets for 10 more parameters without currently established criteria.

EWQ Better	EWQ is better than criteria
EWQ Better Except for High Flow	EWQ is better than criteria except during high flow events (E. coli, Fecal coliform bacteria)
Criteria exceeded by natural conditions	EWQ is evidenced to be naturally higher than criteria (TDS, pH)
TP criterion exceeded but use not limited	EWQ higher than NJ 0.1 criterion, but suitable for designated uses (Total Phosphorus)
EWQ Exceeds Criteria	EWQ Exceeds Criteria for >10% of Samples
Not Assessed	Not Assessed

Parameter	Del @ Portland	Del @ Belvidere	Del @ Easton	Del @ Riegelsville	Del @ Milford	Del @ Bulls Island	Del @ Lambertville	Del @ Washington Xing	Del @ Trenton	Most Stringent Criterion
Bio - EPT (N=1)										UPDE EWQ
Bio - HBI (N=1)										NJ 4.0
Bio - Diversity (N=1)										UPDE EWQ
Dissolved Oxygen										5 (all)
pH										6.5-8.5 (NJ)
Water Temperature F										Seasonal (PA)
Turbidity										15 (NJ)
CaCO3 Alkalinity										Min 20 (PA)
Chloride										250 (all)
Nitrate NO3-N										10 (PA,NJ)
Ammonia NH3-N										Formula (PA,NJ)
Total Phosphorus										0.1 (NJ)
Total Dissolved Solids										120/256 (DRBC)
Total Suspended Solids										40 (NJ)
E. coli geometric mean										126 (EPA)
Fecal Coliform geometric mean										200,400 (all)
Enterococcus geometric mean										33,61 (NJ)
Biocriteria	**NO STANDARD**			**EWQ definition would create targets for parameters without standards**						None
CaCO3 Hardness	**NO STANDARD**									None
Chlorophyll A mg/m3	**NO STANDARD**									None
Dissolved Oxygen % Saturation	**NO STANDARD**									None
Orthophosphate PO4-P	**NO STANDARD**									None
Phytoplankton Biomass mg/m3	**NO STANDARD**									None
Specific Conductance umhos/cm	**NO STANDARD**									None
Total Nitrogen : Total Phosphorus ratio	**NO STANDARD**									None
Total Kjeldahl Nitrogen	**NO STANDARD**									None
Total Nitrogen	**NO STANDARD**									None

Table 2. Lower Delaware River Existing Water Quality (2000-2003) vs. Most Stringent Water Quality Criteria.

How much better is EWQ than criteria?

DRBC's Integrated Listing Methodology (2004) identified key water quality parameters associated with each designated use being assessed in the non-tidal Delaware River:

Recreation: Fecal coliform (col/100ml)
Water Supply: TDS; Turbidity; Chloride mg/l
Aquatic Life: DO; pH; Water Temp; TDS; Alkalinity; Turbidity

The assumption was made that if criteria are met for parameters associated with designated uses, then the designated use is met. Perception of water quality in the Delaware River and its tributaries is dependent on the perspective of the designated use being examined.

Key parameters for the uses designated for Delaware River Zones 1D (north of the Lehigh River) and 1E (south of the Lehigh River) are better than criteria. According to integrated listing methods, the Water Supply and Aquatic Life designated uses are met, and existing water quality is much better than criteria for all of the key parameters associated with these uses. Even fecal coliform bacteria concentrations (the only bacteria

parameter for which DRBC has standards) meet the primary contact Recreation use most of the time. In the Delaware River, seasonal geometric mean fecal coliform concentrations were well below the criterion of 200 colonies per 100 ml. Fecal coliform bacteria problems become evident only when results show that the single-sample maximum limit of 400 colonies per 100 ml is exceeded in more than 10% of samples. High-flow events explain almost all occurrences of criteria violations. This infers that it is safe to swim in the Delaware River at most times except for storm conditions. It is recommended for purposes of policy and program management that if existing water quality is better than standards, then water quality should be prevented from degrading below EWQ levels. SPW declaration would provide such water quality protection.

Some criteria could directly serve as EWQ targets, as natural EWQ is close to criteria levels: turbidity, alkalinity, pH, and water temperature. Other criteria are far higher than EWQ, as in the case of chloride, where the criterion level is 250 mg/l to protect human health but observed concentrations rarely exceed 30 mg/l. Special Protection Waters policy may be applied to create more stringent natural water quality targets. Similar parameters include TDS, maximum turbidity, fecal coliforms, dissolved oxygen, and nitrates. In some cases, as with nutrients, no DRBC criteria currently exist and effect levels of nutrient concentrations in the Delaware River are unknown at this time. Even if effect levels were known, we do not know what concentrations or loadings represent natural background conditions or human enrichment. Establishment of EWQ targets in these cases would ensure that nutrient pollution does not become worse – we need only to look at the Chesapeake experience as an extremely expensive example of nutrient enrichment consequences and large-scale abatement efforts that may or may not succeed.

Delaware River Biomonitoring Results

Biological integrity and habitat quality are two directly measurable aspects of ecological condition. Only the first season's results of the Delaware River Biomonitoring Program were available for this evaluation. There are not yet sufficient data to evaluate variability or trends. Sufficient data exist to compare Lower Delaware biological scores against known reference conditions. When DRBC Special Protection Waters rules were enacted in the early 1990's, three biological metric targets were included in the definition of EWQ: Shannon Wiener Diversity; Equitability; and EPT Richness. In the late 1990's, equitability was found to be an unresponsive indicator of changes to biological integrity. DRBC biologists are presently refining a list of macroinvertebrate community metrics that respond best to water quality changes in the Delaware River.

Lower Delaware biological diversity and taxonomic richness scores from 2001 were compared with exceptional quality Middle and Upper Delaware River biological targets from DRBC's water quality rules. Healthy macroinvertebrate assemblages score higher in diversity and EPT richness than stressed assemblages. Lower Delaware macroinvertebrate data were also compared with New Jersey's most stringent pollution tolerance criterion (Hilsenhoff Biotic Index score of 4.0). The lower the Hilsenhoff score, the better and less tolerant of pollution is the macroinvertebrate assemblage. Results are positive though not definitive due to small sample size. Delaware River biocriteria development is underway with assistance from the U.S. EPA.

Desirable and measurable traits of habitat quality were examined, including parameters listed in the U.S. EPA Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour et al., 1999). Not all of the Rapid Bioassessment Protocol's habitat parameters translate well to large rivers, but parameters that do so include substrate heterogeneity and stability; heterogeneous flow and depth regimes, sediment deposition indicators; channel flow status; bank stability and vegetative protection; and overall habitat complexity and cover. Even in low flow periods the Lower Delaware received optimal habitat scores at every site. Such evidence indicates that the Lower Delaware possesses exceptional habitat conditions for aquatic life.

Preliminary benthic macroinvertebrate results suggest that that the biological community of the non-tidal Lower Delaware River is exceptional and appears worthy of Special Protection Waters designation. Lower Delaware benthic community data collected during August-September 2001 compared favorably with existing targets for the Special Protection Waters of the Upper Delaware River. Because biocriteria do not currently exist for the Lower Delaware, the Upper Delaware's most conservative thresholds were used. Results indicate

that Special Protection Waters protection is appropriate, since the Lower Delaware River largely scored as well as or better than target values set for waters already so designated.

The Shannon-Wiener Index measures diversity of the macroinvertebrate assemblage. Limited results suggest that the Lower Delaware River possesses a highly diverse macroinvertebrate assemblage, meriting SPW status. The Hilsenhoff Biotic Index value was calculated for each sample and then compared against the strictest criterion. New Jersey's HBI of 4.0 is their threshold for intolerance. Results suggest that the Lower Delaware River's benthic macroinvertebrate assemblage is intolerant of pollution, indicates excellent water quality, and merits SPW status. At all but 2 sites, the Lower Delaware biological community met the Upper Delaware EWQ target of 15.5 for the presence of Ephemeroptera, Plecoptera, and Trichoptera taxa (EPT), a measure of richness of the most pollution sensitive taxa in aquatic systems. Results indicate that the Lower Delaware River benthic macroinvertebrate assemblage is very rich in pollution intolerant genera; to such a degree that EPT taxa often dominate macroinvertebrate samples taken from the Lower Delaware. This indicates excellent water quality, and supports SPW status.

Lower Delaware River Water Quality Changes from Portland to Trenton

In general, smaller tributaries (Pidcock, Paunnacussing, Tinicum, Lockatong, Wickecheoke, Nishisakawick) had no measurable effects upon Delaware River water quality. Even where small tributary concentrations of water quality constituents were significantly higher or lower than the Lower Delaware, no overall effect could be detected at neighboring Interstate Control Points. This is due to the tributaries' small flows relative to the Delaware River. Three small tributaries (Pidcock, Wickecheoke, and Lockatong) flow into the canal systems during all but very high flow events. Flow capture by canals reduced effects of these tributaries even more.

Statistically significant changes in constituent concentrations were examined at each Interstate Control Point from Portland downstream to Trenton. **Table 3** lists significant changes (p=.05, or 95% probability that water quality differed from one location to the next) in water quality within each Delaware River segment. Appendix C in the "Lower Delaware Monitoring Program: 2000-2003 Results and Water Quality Management Recommendations " (DRBC 2004) contains a table of all river-to-river segment site comparisons and tributary-to-river site comparisons of median water quality concentrations.

FROM	TO	+/-	PARAMETER
Portland	Belvidere	increase	TDS (+12 mg/l – limestone)
(major tributary between Portland and Belvidere is Paulins Kill)		increase	Alkalinity (+6 mg/l – limestone)
		increase	Enterococcus (+24 colonies/100ml)
		decrease	Dissolved Oxygen Saturation (-3.3%)
Belvidere	Easton	increase	TDS (+20 mg/l – limestone)
(major tributaries between Belvidere and Easton are Pequest River, Martins Creek, and Bushkill Creek)		increase	Hardness (+11 mg/l - limestone)
		increase	Alkalinity (+8 mg/l – limestone)
		increase	Nitrate-N (+0.16 mg/l)
		increase	Total Nitrogen (+0.315 mg/l)
		increase	Fecal Coliform (+65 colonies/100ml)
		increase	Enterococcus (+106 colonies/100ml)
Easton	Riegelsville	increase	TDS (+30 mg/l – limestone)
(major tributaries between Easton and Riegelsville are Lehigh River and Pohatcong Creek)		increase	Hardness (+20.5 mg/l – limestone)
		increase	Alkalinity (+10.5 mg/l – limestone)
		increase	Total Phosphorus (+0.06 mg/l)
		increase	Nitrate-N (+0.355 mg/l)
		increase	Total Nitrogen (+0.190 mg/l)
		decrease	Enterococcus (-83 colonies/100ml)
FROM	**TO**	**+/-**	**PARAMETER**
Riegelsville	Milford	increase	Total Nitrogen (+0.145 mg/l)
(major tributaries between Riegelsville and Milford are Musconetcong River and Cooks Creek)		decrease	Enterococcus (-19 colonies/100ml)
		decrease	Fecal Coliform (-26 colonies/100ml)
Milford	Bulls Island	increase	Dissolved Oxygen Saturation (+2.4%)
(major tributary between Milford and Bulls Island is Tohickon Creek)		decrease	Enterococcus (-16 colonies/100ml)
Bulls Island	Lambertville	decrease	Dissolved Oxygen Saturation (-4.97%)
(no major tributaries in reach except wastewater dischargers)		increase	Chloride (+3.7 mg/l)
		increase	TKN (+0.160 mg/l)
		increase	Total Nitrogen (+0.203 mg/l)
Lambertville	Washington Crossing	increase	Dissolved Oxygen Saturation (+4.11%)
(no major tributaries in reach except wastewater dischargers)		decrease	Chloride (-2.7 mg/l)
		decrease	TKN (-0.110 mg/l)
		decrease	Total Nitrogen (-0.070 mg/l)
Washington Crossing	Trenton	increase	TKN (+0.130 mg/l)
(no major tributaries in reach except wastewater dischargers)		increase	Fecal Coliform (+28 colonies/100ml)

Table 3. Significant Changes in Concentrations of Water Quality Constituents Between Interstate Control Points of the Lower Delaware River, 2000-2003. Red represents degradation and Blue represents improvement between river sites.

Water Quality Ranking of Sites by Designated Use

DRBC's Integrated Listing Methodology (2004) identified specific water quality parameters associated with each designated use being assessed. The assumption was made that if criteria are met for parameters associated with designated uses, then the designated use is met. Perception of water quality in the Delaware River and its tributaries is dependent on the perspective of the designated use being examined. The relationship of Delaware River quality to its major tributaries (**Table 4**) was examined in terms of general water quality, nutrient quality, water supply quality, aquatic life water quality, and recreation-related water quality.

General Water Quality:	Average of nutrient; recreation; water supply; aquatic life scores
Recreation Quality:	E. coli; Fecal coliform; Enterococcus geometric mean (col/100ml)
Water Supply Quality:	TDS mg/l; Turbidity NTU; Chloride mg/l; Specific Conductance umhos/cm
Aquatic Life Chem.Quality:	DO; pH; Water Temp; TDS load lbs/day; Alkalinity; Turbidity; Specific Cond.
Nutrient Quality:	Total Phosphorus concentration (mg/l), and load per sq.mi. (lbs/sq.mi.) Total Nitrogen concentration (mg/l), and load per sq. mi. (lbs/sq.mi).

Average Ranks of Designated Use Scores

Site	General Water Quality	General WQ Rank	Recr Quality	Recr Rank	Water Supply Quality	Water Supply Rank	Aquatic Life Chemistry	Aquatic Life Rank	Nutrient Quality	Nutrient Rank
207.40 Delaware @ Portland	**4.6**	1	**4.3**	3	**3.0**	1	**6.3**	1	**4.8**	2
197.84 Delaware @ Belvidere	**5.3**	2	**2.7**	2	**4.5**	2	**7.1**	2	**7.0**	3
183.82 Delaware @ Easton	**9.2**	3	**12.3**	7	**6.3**	3	**8.7**	3	**9.3**	5
157.00 Tohickon	**11.0**	4	**14.7**	11	**12.8**	10	**14.4**	10	**2.0**	1
134.34 Delaware @ Trenton	**11.1**	5	**4.3**	3	**11.0**	6	**12.4**	5	**16.5**	14
141.80 Delaware @ Washington Crossing	**11.2**	6	**2.3**	1	**13.3**	11	**12.9**	6	**16.3**	11
148.70 Delaware @ Lambertville	**12.1**	7	**9.3**	6	**11.3**	7	**10.9**	4	**17.0**	15
174.80 Delaware @ Riegelsville	**12.4**	8	**12.7**	8	**10.0**	4	**13.0**	8	**13.8**	8
207.00 Paulins Kill	**14.1**	9	**7.3**	5	**23.0**	18	**18.1**	14	**7.8**	4
167.70 Delaware @ Milford	**14.2**	10	**17.3**	14	**12.0**	8	**13.1**	9	**14.5**	9
155.40 Delaware @ Bulls Island	**14.6**	11	**16.7**	12	**12.3**	9	**12.9**	6	**16.3**	11
173.70 Cooks	**15.3**	12	**25.0**	17	**10.0**	4	**15.9**	12	**10.3**	6
197.80 Pequest	**16.6**	13	**13.3**	9	**21.0**	15	**20.4**	18	**11.8**	7
190.58 Martins	**17.7**	14	**16.7**	12	**16.8**	12	**14.9**	11	**22.3**	17
183.66 Lehigh	**17.7**	15	**14.0**	10	**18.0**	13	**16.6**	13	**22.3**	17
174.60 Musconetcong	**19.4**	16	**21.7**	15	**21.3**	16	**18.1**	14	**16.3**	11
177.40 Pohatcong	**20.1**	17	**25.3**	18	**20.3**	14	**18.7**	16	**16.0**	10
184.10 Bushkill	**20.5**	18	**23.0**	16	**21.3**	16	**20.1**	17	**17.5**	16

Table 4. Average Scores and Relative Ranks of Designated Use Indicators. Low scores are best water quality.

In **Table 4**, each parameter was ranked at each site. Scores represent average ranks of parameters listed above. Each site was then ranked by the average parametric ranks.

In terms of **general water quality**, all Delaware River sites scored better than tributaries, with only the Tohickon Creek and Paulins Kill among the best sites. The worst general water quality streams are Bushkill Creek, Pohatcong Creek, and the Musconetcong River. **Recreation quality** scores show that the highest overall bacteria concentrations were found in Pohatcong, Cooks, Bushkill, and Musconetcong. Scoring best in recreation quality scores were all of the Delaware River sites except for Milford and Bulls Island, and Paulins Kill, Pequest, Lehigh and Tohickon Creek. Only the Lehigh River, however, contained similar or lower bacteria concentrations than the Delaware River. **Water supply quality** results show that the upstream

Delaware River sites are best (Portland, Belvidere, and Easton). Tohickon Creek and Cooks Creek are the best tributaries, scoring among the Delaware River sites. The lowest scoring water supply quality sites are the Paulins Kill, Bushkill Creek, Musconetcong, and Pequest. Limestone effects upon TDS and specific conductance heavily influenced water supply scores. Scoring best in **aquatic life chemistry** are all of the Delaware River sites, followed by Tohickon, Martins Creek, and Cooks Creek. The worst aquatic life chemistry scores went to the Pequest River and Bushkill Creek. Note that this is only a water chemistry index, as no direct biomonitoring results are incorporated into the index. Most investigators would prefer a directly measured biological score to this inferential aquatic life chemistry score. For **nutrient quality**, the Lehigh River, Martins Creek, and Bushkill Creek are the worst. Tohickon Creek, Cooks Creek, and the Paulins Kill River impart the least nutrient impacts upon the Delaware River, though Cooks and Paulins Kill River median concentrations are still significantly higher than neighboring Delaware River sites. Only Tohickon Creek actually improves the Delaware River in terms of nutrient loading, possibly because of Lake Nockamixon acting as a nutrient sink. Delaware River results were mixed, with the upper sites (Portland, Belvidere, and Easton) scoring well and the rest toward the middle and lower ends of the ranking scale.

Prioritization of Watersheds for EWQ Maintenance or Restoration

There are no sites where water quality should be strictly maintained or restored for every parameter. **Table 2** shows where and for which parameters maintenance or restoration of water quality should occur. **Table 4** shows how Delaware River water quality relates to its tributaries. Delaware River water quality is as good or better than even state designated antidegradation waters for most uses. For this reason, it is recommended that the Delaware River should be declared Outstanding Basin Waters in Scenic and Recreational River designated segments, and Significant Resource Waters in undesignated segments. In the Delaware River, recreation quality must be improved at Milford and Bulls Island, and nutrient quality should be improved from Riegelsville to Trenton. Intrastate priority watersheds (**Table 5**) were determined according to designated uses to be protected, as well as relative effects upon the Delaware River.

Table 5. Priority watersheds tributary to the Lower Delaware River.

Water Quality Management	General Water Quality	Recreation Quality	Water Supply Quality	Aquatic Life	Nutrients
Protect	Tohickon	Lehigh	Tohickon	Tohickon	Tohickon
	Paulins Kill		Cooks	Martins	
				Cooks	
Restore	Bushkill	Pohatcong	Paulins Kill	Pequest	Lehigh
	Pohatcong	Cooks	Bushkill	Bushkill	Martins
	Musconetcong	Bushkill	Musconetcong		Bushkill
		Musconetcong	Pequest		

Maintenance of EWQ can be done using antidegradation policy, cooperative and adaptive management, long term monitoring, corrective or protective action, and periodic re-evaluation of site-specific targets. Restoration of water quality has historically been a high priority to DRBC and the states, conducted through numerous programs and TMDL activities. Improved coordination between DRBC, the states, and watershed organizations will be necessary to achieve protective or restorative goals.

Risks Associated With Water Quality Degradation

In water resources, the need to protect supply and quality is exceptionally important. This is especially true in urbanized or growing areas that are not as easily protected as forested headwaters. Wherever people live, even 'average' water quality may prove to be of exceptional value. Arguably it should not be necessary for water quality levels to exist above some extremely high threshold for designation of SPW to occur. In principle it is certain that all users demand and deserve the cleanest possible water.

What's so 'special' or 'exceptional' about the Lower Delaware? In measures of water quality and biological integrity, the Delaware River is better than the state designated HQ, EV, and C1 waters in most cases. The magnitude of importance of meeting designated uses is certainly of exceptional value in the Lower Delaware, since the resource is so intensively used. Even though more people live in the Lower Delaware, placing these waters more at risk than those of the Upper Basin, direct comparison of biological scores revealed that the Lower Delaware is every bit as healthy as the cleanest upper basin waters.

Degraded water quality in the Lower Delaware means worse quality water and more expensive supply for Central and Southern New Jersey; Bucks, Montgomery, and Philadelphia Counties in Pennsylvania, and points south. Even though water quality of the Lower Delaware shows bacteria problems, it may be 'exceptional' based on all the other parameters that are better than standards.

Concerning water quality that does not meet standards, what are the risks associated with degradation? We can assume the following statements are true as common knowledge. Clean water is safe and economically beneficial. It costs little to treat, and extends the life of treatment infrastructure. Corporations want to locate where water is clean and plentiful. Recreation is a positive experience. Tourism and environmental education benefits are provided in riverside towns like Lambertville and Easton that hold festivals featuring the river. Quality of life is tied closely to quality of water. Waterfront homes are highly valuable where the water quality is good. Clean water is taken for granted. If water quality got worse, negative effects would be felt in terms of rising treatment costs, expenses related to delivery of alternative water supply sources, increased incidence of waterborne illness, increased trash, nuisance vegetation and decaying organic matter, stresses to aquatic life, loss of riverside home value, and loss of recreation and tourism economic benefits. Even water that meets minimally acceptable criteria may be associated with some of these negative results if existing water quality is not protected.

Expected Effects of Waste Water Dischargers and Stormwater Upon EWQ

Appendix E of the "Lower Delaware Monitoring Program: 2000-2003 Results and Water Quality Management Recommendations " (DRBC 2004) technical report contains an inventory of municipal, institutional, and industrial wastewater dischargers of over 100,000 gallons per day to streams in the Lower Delaware watershed. The wastewater from these facilities is included in the definition of existing water quality, and these facilities as permitted would not be subject to additional treatment requirements set forth in DRBC's water quality rules for Special Protection Waters. Only new and expanded discharge facilities would be subject to such rules. **Figure 1** displays the locations of selected dischargers of over 1 million gallons per day and/or direct dischargers to the Delaware River. These are shown relative to the location of DRBC monitoring locations and designated Scenic Rivers segments. In terms of average monthly wastewater effluent flow during the 2000-2003 study period, Pennsylvania dischargers operated at 71% of their overall permitted flow, and New Jersey dischargers operated at 66% of their overall capacity.

Existing water quality might or might not measurably change if all of the permitted dischargers increase their effluent rate to 100% of their capacity. As defined during the 2000-2003 study period, existing water quality reflects a very broad range of discharge situations from extreme low flow conditions to relatively high flow conditions, when most dischargers operated at effluent flow rates far beyond normal flow rates. Thus, the statistical definition of existing water quality includes such cases of high flow events. Under such conditions

the dischargers achieved their permitted water quality limits without permit violations or severe increases in the rate of pollutant loading to the Delaware River. A few treatment facilities continue to experience infiltration and inflow (I and I) problems related to storm events, which forces the facility to treat stormwater in addition to sanitary sewage flow. Maintenance of I and I is an excellent step toward ensuring that existing water quality is maintained or improved.

Of much more concern is non-point source water pollution, or that caused by stormwater runoff. The increase in non-point source pollution associated with future growth and development is very likely to measurably change existing water quality if it increases unmanaged. It is expected, however, that existing water quality will continue to improve even as the wastewater treatment facilities grow toward their full capacity. New stormwater rules and policies are taking effect in New Jersey and Pennsylvania, efforts to improve riparian buffer zones continue to grow and evolve, residential and business stormwater management practices are improving, and education of municipal officials and the general public on stormwater issues is becoming more widespread. These powerful tools improve water quality and allow for growth and development.

To ensure that existing water quality is maintained or improved, the control point monitoring approach should be used to document cumulative effects of combined point source and non-point source water management. The water quality targets at Boundary Control Points (final targets will be defined using the 2000-2004 data set) must not be exceeded, or the water quality of the Delaware River will degrade. Conversely, the targets may also be used as a reference to quantify trends and improvements in water quality resulting from combined efforts to manage dischargers and non-point source pollution in each watershed.

Lessons From Upper and Middle Delaware SPW

Three unanticipated flaws became apparent with attempts to implement Special Protection Waters rules in the Middle and Upper Delaware in the 1990's. The first, as previously mentioned, was the technical difficulty with detecting measurable change using reachwide targets. It required years of baseline monitoring to gather sufficient data for assessment of 'measurable change.' Once enough data were collected, the resolution and statistical power of the data were poor (Evans et al., 2000). Water quality changes may have occurred with no mechanism for timely reaction by DRBC or the states. The LDMP solved this assessment issue by creating site specific EWQ targets instead of reach wide EWQ targets. No two spots on the river are exactly alike, so why should the targets be averaged?

Lack of cooperation between partners was a second failure. Chief among the many reasons was a lack of clear commitment and delineation of financial, management, monitoring, and assessment responsibilities between partner agencies. In the Middle and Upper Delaware, the National Park Service has monitored the Delaware River and its tributaries since 1992 without direct DRBC support. The NPS recently contracted with the U.S. Geological Survey to collect water quality data for DRBC Boundary Control Points. In support of DRBC mandates, the National Park Service units continue to commit significant portions of their resource management budgets to monitor and protect water quality. DRBC should support these efforts.

A third and smaller problem internal to DRBC has been the programmatic and budgetary separation of the Upper, Middle, Lower and Estuary monitoring programs for the Delaware River. When DRBC shifted interest from the Upper/Middle to the Lower Delaware, its staff began participating with the planning committee, monitoring water quality, and envisioning SPW protection of yet another reach of river (before the Upper and Middle Delaware SPW implementation was completed and fully tested). The LDMP became a monitoring program separate from the existing Scenic Rivers Monitoring Program (SRMP) and essentially a competitor for limited monitoring funds and staff resources. This contributed to diminution of DRBC efforts in the Upper and Middle Delaware, and delayed implementation of important pieces of SPW rules such as development of Boundary Control Point EWQ targets. At least a decade past the expected date, the states have not received EWQ targets useful for prevention of measurable change in the Delaware River. In the same period, evidence suggests that measurable change may have occurred at locations including the Tri-State region between the

Upper and Middle Delaware; Callicoon Creek; Bushkill Creek, and Brodhead Creek.

Due to the three problems mentioned above, SPW antidegradation policy has not been as effective as it might have been. On a positive note, the project review responsibilities of DRBC were functional during the first ten years of Special Protection Waters. If SPW rules are to be successfully implemented in the Lower Delaware, several steps must be taken. First, all partners must commit to responsible action via formal interagency agreements and sufficiently funded programs. Second, Upper Delaware, Middle Delaware, and Lower Delaware water quality monitoring programs must be consolidated and managed more holistically to reduce competition and increase efficiency by combining the shared efforts of DRBC, NPS, and state agency staff. Additionally, EWQ assessment should be conducted in parallel with the 305B assessment**,** so staff resources may be further shared to reduce assessment redundancy and create consistency in reporting of results. Third, all watershed partners must be made aware of and versed in the use of Boundary Control Point water quality targets to report measurable results of their efforts to improve water quality. DRBC and partner organizations should contribute significant resources to education, capacity building of watershed organizations, and creation of guidance on implementation of SPW rules and targets.

Thus far, the Lower Delaware Monitoring Program has been cooperatively managed by dedicated and talented local residents and agency staffers. Federal, state, local, and regional partners are represented on the management committee. Early in the process of creating the monitoring program, DRBC was assisted and directed by a technical committee of scientists and managers from all concerned agencies. Successful implementation of Lower Delaware Special Protection Waters will depend on DRBC's ability to direct and/or monitor efforts of many partners within tributary watersheds in order to meet EWQ targets. Reallocation of DRBC staff resources may be necessary to market the effort to maintain or improve water quality of the Lower Delaware, coordinate and monitor progress of local restoration projects and watershed plans, and to widen involvement between agencies, local governments, and watershed organizations. On the technical side, DRBC should create a water quality model to determine causes and effects of water quality changes, develop scenarios for accomodation of future growth while maintaining EWQ, and identifying the most effective means of protecting and improving water quality in the Lower Delaware region. Monitoring should be conducted at a frequency sufficient to determine measurable changes in water quality at ICP and BCP locations. Additional technical actions are noted below.

Recommendations to Commissioners

Recommendation 1. Designate & Implement Special Protection Waters

Where the Scenic Rivers legislation designated segments of the Delaware River, Outstanding Basin Waters should be applied where feasible. The segments in-between and those pending Wild and Scenic Rivers Act designation should be declared Significant Resource Waters. Final SPW targets should be adopted using the 2000-2004 data set. A sample of site specific targets (based on the 2000-2003 data set) is shown in **Appendix D**. Interim targets are not recommended because final targets will be available by the end of 2004.

Recommendation 2. Protect or Restore Priority Watersheds (Table 5, page 17)

Recommendation 3. Build Watershed Partnerships

- Memoranda of understanding with states and NPS
- Capacity building with non-governmental organizations
- Monitor and coordinate water quality actions and plans in the Lower Delaware region
- Create and market guidance for maintenance and improvement of EWQ
- Strategies to maintain and protect water quality for water suppliers

Recommendation 4. Fill Critical Information Needs

- Understand canal-river relationships
- Perform cause and effect surveys within river reaches
- Quantify effects of nutrients and primary production on water quality
- Manage nuisance vegetation and invasive species

Recommendation 5. Consider Changes to Water Quality Rules

- Introduce nutrient and/or eutrophication criteria
- Create numeric aquatic life biocriteria for macroinvertebrates
- Revise Middle and Upper Delaware reach wide EWQ targets to site-specific targets.
- Introduce bacteria standards for non-tidal river
- Adopt Pennsylvania warm water temperature standards for protection of aquatic life
- Consider raising pH upper limit to 9 instead of current 8.5
- Consider raising TDS limit above Easton to reflect natural limestone influences
- Raise minimum Dissolved Oxygen to 5.5 mg/l in Zones 1D and 1E.

Recommendation 6. Support Monitoring to Meet Recommendations

- Add ICP sites between major tributaries for improved cause-effect resolution.
- Continuous monitors at Belvidere, Riegelsville, Paulins Kill. Maintain existing monitors.
- Reduce frequency of DRBC monitoring of minor tributaries
- Maintain frequency of monitoring for ICP and major BCP sites.
- Streamline and make concurrent EWQ assessment and 305B assessments
- Rotate synoptic surveys of minor tributaries for compliance monitoring
- Combine Upper, Middle, Lower Delaware monitoring programs into Scenic Rivers Program.
- Support EWQ monitoring of major tributaries and ICP locations from Hancock to Trenton.
- Create water quality model to serve planning for protection or restoration of water quality.

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Appendix A. Lower Delaware Scenic Rivers Legislation

Public Law 106-418
106th Congress

An Act

To designate portions of the lower Delaware River and associated tributaries as a component of the National Wild and Scenic Rivers System.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the ``Lower Delaware Wild and Scenic Rivers Act".

SEC. 2. FINDINGS.

Congress finds that--

(1) Public Law 102-460 directed the Secretary of the Interior, in cooperation and consultation with appropriate Federal, State, regional, and local agencies, to conduct a study of the eligibility and suitability of the lower Delaware River for inclusion in the Wild and Scenic Rivers System;

(2) during the study, the Lower Delaware Wild and Scenic River Study Task Force and the National Park Service prepared a river management plan for the study area entitled ``Lower Delaware River Management Plan" and dated August 1997, which establishes goals and actions that will ensure long-term protection of the river's outstanding values and compatible management of land and water resources associated with the river; and

(3) after completion of the study, 24 municipalities along segments of the Delaware River eligible for designation passed resolutions supporting the Lower Delaware River Management Plan, agreeing to take action to implement the goals of the plan, and endorsing designation of the river.

SEC. 3 DESIGNATION.

Section 3(a) of the Wild and Scenic Rivers Act (16 U.S.C. 1274(a)) is amended--

(1) by designating the first undesignated paragraph following paragraph 156, pertaining to Elkhorn Creek and enacted by Public Law 104-208, as paragraph 157;

(2) by designating the second undesignated paragraph following paragraph 156, pertaining to the Clarion River, Pennsylvania, and enacted by Public Law 104-314, as paragraph 158;

(3) by designating the third undesignated paragraph following paragraph 156, pertaining to the Lamprey River, New Hampshire, and enacted by Public Law 104-333, as paragraph 159;

(4) by striking the fourth undesignated paragraph following paragraph 156, pertaining to Elkhorn Creek and enacted by Public Law 104-333; and

(5) by adding at the end the following: (161) Lower Delaware River and associated tributaries, New Jersey and Pennsylvania.--

(A) The 65.6 miles of river segments in New Jersey and Pennsylvania, consisting of--

(i) the segment from river mile 193.8 to the northern border of the city of Easton, Pennsylvania (approximately 10.5 miles), as a recreational river;

(ii) the segment from a point just south of the Gilbert Generating Station to a point just north of the Point Pleasant Pumping Station (approximately 14.2 miles), as a recreational river;

(iii) the segment from the point just south of the Point Pleasant Pumping Station to a point 1,000 feet north of the Route 202 bridge (approximately 6.3 miles), as a recreational river;

(iv) the segment from a point 1,750 feet south of the Route 202 bridge to the southern border of the town of New Hope, Pennsylvania (approximately 1.9 miles), as a recreational river;

(v) the segment from the southern boundary of the town of New Hope, Pennsylvania, to the town of Washington Crossing, Pennsylvania (approximately 6 miles), as a recreational river;

(vi) Tinicum Creek (approximately 14.7 miles), as a scenic river;

(vii) Tohickon Creek from the Lake Nockamixon Dam to the Delaware River (approximately 10.7 miles), as a scenic river; and

(viii) Paunacussing Creek in Solebury Township (approximately 3 miles), as a recreational river.

(B) Administration.--The river segments referred to in subparagraph (A) shall be administered by the Secretary of the Interior. Notwithstanding section 10(c), the river segments shall not be administered as part of the National Park System.

4. MANAGEMENT OF RIVER SEGMENTS.

(a) Management of Segments.--The river segments designated in section 3 shall be managed--

(1) in accordance with the river management plan entitled “Lower Delaware River Management Plan” and dated August 1997 (referred to as the “management plan”), prepared by the Lower Delaware Wild and Scenic River Study Task Force and the National Park Service, which establishes goals and actions that will ensure long-term protection of the river's outstanding values and compatible management of land and water resources associated with the river; and

(2) in cooperation with appropriate Federal, State, regional, and local agencies, including--

(A) the New Jersey Department of Environmental Protection;
(B) the Pennsylvania Department of Conservation and Natural Resources;
(C) the Delaware and Lehigh Navigation Canal Heritage Corridor Commission;
(D) the Delaware and Raritan Canal Commission; and
(E) the Delaware River Greenway Partnership.

(b) Satisfaction of Requirements for Plan.--The management plan shall be considered to satisfy the requirements for a comprehensive management plan under subsection 3(d) of the Wild and Scenic Rivers Act (16 U.S.C. 1274(d)).

(c) Federal Role.--

(1) Restrictions on water resource projects.--In determining under section 7(a) of the Wild and Scenic Rivers Act (16 U.S.C. 1278(a)) whether a proposed water resources project would have a direct and adverse effect on the value for which a segment is designated as part of the Wild and Scenic Rivers System, the Secretary of the Interior (hereinafter referred to as the “Secretary”) shall consider the extent to which the project is consistent with the management plan.

(2) Cooperative agreements.--Any cooperative agreements entered into under section 10(e) of the Wild and Scenic Rivers Act (16 U.S.C. 1281(e)) relating to any of the segments designated by this Act shall--

(A) be consistent with the management plan; and
(B) may include provisions for financial or other assistance from the United States to facilitate the long-term protection, conservation, and enhancement of the segments.

(3) Support for implementation.--The Secretary may provide technical assistance, staff support, and funding to assist in the implementation of the management plan.

(d) Land Management.--

(1) In general.--The Secretary may provide planning, financial, and technical assistance to local municipalities to assist in the implementation of actions to protect the natural, economic, and historic resources of the river segments designated by this Act.

(2) Plan requirements.--After adoption of recommendations made in section III of the management plan, the zoning ordinances of the municipalities bordering the segments shall be considered to satisfy the standards and requirements under section 6(c) of the Wild and Scenic Rivers Act (16 U.S.C. 1277(c)).

(e) Additional Segments.--

(1) In general.--In this paragraph, the term “additional segment” means--

(A) the segment from the Delaware Water Gap to the Toll Bridge connecting Columbia, New Jersey, and Portland, Pennsylvania (approximately 9.2 miles), which, if made part of the Wild and Scenic Rivers System in accordance with this paragraph, shall be administered by the Secretary as a recreational river;
(B) the segment from the Erie Lackawanna railroad bridge to the southern tip of Dildine Island (approximately 3.6 miles), which, if made part of the Wild and Scenic Rivers System in accordance with this paragraph, shall be administered by the Secretary as a recreational river;
(C) the segment from the southern tip of Mack Island to the northern border of the town of Belvidere, New Jersey (approximately 2 miles), which, if made part of the Wild and Scenic Rivers System in accordance with this paragraph, shall be administered by the Secretary as a recreational river;
(D) the segment from the southern border of the town of Phillipsburg, New Jersey, to a point just north of Gilbert Generating Station (approximately 9.5 miles), which, if made part of the Wild and Scenic Rivers System in accordance with this paragraph, shall be administered by the Secretary as a recreational river;
(E) Paulinskill River in Knowlton Township (approximately 2.4 miles), which, if made part of the Wild and Scenic Rivers System in accordance with this paragraph, shall be administered by the Secretary as a recreational river; and
(F) Cook's Creek (approximately 3.5 miles), which, if made part of the Wild and Scenic Rivers System in accordance with this paragraph, shall be administered by the Secretary as a scenic river.
(2) Finding.--Congress finds that each of the additional segments is suitable for designation as a recreational river or scenic river under this paragraph, if there is adequate local support for the designation.

(3) Designation.--If the Secretary finds that there is adequate local support for designating any of the additional segments as a recreational river or scenic river--

(A) the Secretary shall publish in the Federal Register a notice of the designation of the segment; and
(B) the segment shall thereby be designated as a recreational river or scenic river, as the case may be, in accordance with the Wild and Scenic Rivers Act (16 U.S.C. 1271 et seq.).

(4) Criteria for local support.--In determining whether there is adequate local support for the designation of an additional segment, the Secretary shall consider, among other things, the preferences of local governments expressed in resolutions concerning designation of the segment.

SEC. 5. AUTHORIZATION OF APPROPRIATIONS.

There is authorized to be appropriated such sums as are necessary to carry out this Act.

Approved November 1, 2000.

LEGISLATIVE HISTORY--S. 1296:

SENATE REPORTS: No. 106-207 (Comm. on Energy and Natural Resources).
CONGRESSIONAL RECORD: Vol. 145 (1999): Nov. 19, considered and passed Senate.
Vol. 146 (2000): Oct. 17, considered and passed House.

Appendix B: Staff Replies to Delaware Riverkeeper Petition

The petitioner specifically asked:

1. *That the entire reach of Delaware River main stem from River Mile 209.5 (downstream boundary of the Delaware Water Gap National Recreation Area) to River Mile 133.4 (Head of Tide) be designated as a Special Protection Water;*

DRBC Staff Reply: Agree.

2. *That those sections of the proposed Special Protection Waters that are now components of the National Wild and Scenic Rivers System due to the enactment of Public Law 106-418 cited as the "Lower Delaware Wild and Scenic Rivers Act", be classified by the Commission as Outstanding Basin Waters;*

DRBC Staff Reply: Lower Delaware waters possess exceptionally high scenic, recreational, ecological, and water supply values that require special protection. Outstanding Basin Waters should be adopted for segments of the river that are components of the National Wild and Scenic Rivers system. However, it may not be safe, logical, feasible or economically practical to manage water quality strictly according to segmentation of the river as identified in the legislation. DRBC staff are presently evaluating feasibility of three management alternatives favored by various members of the Water Quality Advisory Committee:

   a. Significant Resource Waters for whole Lower Delaware, raise protection to Outstanding Basin Waters in eligible segments once the process of Scenic Rivers inclusion is completed by NPS in 2005.

   b. Declare all segments of the Delaware River from Gilbert Generating Station to Trenton as Outstanding Basin Waters, and all segments from the Delaware Water Gap to the Gilbert Generating Station as Significant Resource Waters.

   c. Strictly adhere to declaration of Outstanding Basin Waters where segments are included in the Scenic Rivers system, and Significant Resource Waters in all other segments.

3. *That those sections of the proposed Special Protection Waters that are not components of the National Wild and Scenic Rivers System be classified by the Commission as Significant Resource Waters;*

DRBC Staff Reply: Significant Resource Waters would be the most appropriate form of protection for the Lower Delaware River in segments <u>not</u> designated in the legislation.

4. *That the Commission adopt the Lower Delaware River Management Plan, as cited in Public Law 106-418 and dated August 1997, into its Comprehensive Plan as provided for in Compact Section 3.1;*

DRBC Staff Reply: The Commission endorsed the Lower Delaware Management Plan in 1998. The Management Plan should be reviewed for consistency with DRBC's Basin Plan before adoption into its CP.

5. *That the Commission, in cooperation with the States of New Jersey and Pennsylvania, initiate the development of the bi-state water quality management plan called for in the Lower Delaware River Management Plan, said plan to be focused on preserving and/or improving existing water quality;*

DRBC Staff Reply: Agree. DRBC and States should enter into formal cooperative agreements for this purpose. Site specific water quality targets will only be as strong as state and local recognition of such targets.

6. *That the Commission make the development of the bi-state water quality management plan for the Lower Delaware River a specific and high priority task of its pending Comprehensive Planning activity; and*

DRBC Staff Reply: Lower, Middle and Upper Delaware SPW should be part of such planning within the context of a single Scenic Rivers Program. The entire non-tidal river should be holistically managed and monitored.

7. *That the Commission adopts interim measures during the third quarter of 2001 that protect existing water quality from changing in the Lower Delaware while all necessary planning is being conducted. These measures should include interim definitions of existing water quality derived from all currently available data and effluent requirements based upon Best Demonstrable Treatment technology or facsimile as defined in the Special Protection Waters regulations.*

DRBC Staff Reply: Interim Special Protection Waters measures are appropriate using the site-specific targets in Appendix B from the Technical Water Quality Report's 2000-2003 data set. These may be used along with SPW effluent requirements to protect EWQ until final targets are created using the 2000-2004 data set. However, it may be wise to avoid confusion between interim and final targets, and issue only final targets when all 2000-2004 data become available by the end of 2004.

Furthermore, the petitioner requested:

8. *That the Commission comply with Section 3.10.3A.2e.3) of its regulations. This section of the Commission's water quality standards required the Commission to prioritize watersheds in the currently designated Special Protection Waters drainage area (Middle and Upper Delaware) by February 1996. The petitioner noted that this deadline was not met. Priority watersheds are watersheds where non-point source control plans were to be developed by the Commission no later than 2001. This deadline was not met either. The petitioner suggested that the February 1996 deadline be extended by Commission action to a date in 2003 that corresponds to the release of a draft new or updated Comprehensive Plan and that said plan contain the information and recommendations required by Section 3.10.3A.2e.3).*

DRBC Staff Reply: The Basin Plan has not yet been incorporated into DRBC's upcoming new Comprehensive Plan. The Basin Plan does not list priority watersheds. Based upon water quality findings in the Middle and Upper Delaware, the following watersheds should be considered "priority watersheds:"

- Upper Delaware: Callicoon Creek, Lackawaxen River
- Significant Resource Waters: All tributaries and direct drainage areas to the Tri-State segment of the Upper/Middle Delaware, including the Neversink River in New York.
- Middle Delaware: Bushkill Creek; Brodhead Creek

9. *That the Commission prioritizes the watersheds draining to the Lower Delaware River simultaneously with its prioritization of upper basin watersheds. This prioritization is necessary for the development of the bi-state water quality management plan as described above. Moreover, performing the prioritization activity as part of an overall Comprehensive Planning process insures that all future activities are directed at the highest priorities.*

DRBC Staff Reply: Table 5 on Page 19 shows priority tributaries based upon water quality ranks for designated uses. Prioritization was completed entirely based upon water quality results and significant tributary effects upon Delaware River EWQ. The lists may be revised as additional information becomes available.

Lastly, the petitioner suggested:

10. *That the Commission's Comprehensive Planning program consider using the Special Protection Waters boundary and interstate control point approach as its basic framework for developing policies and managing all water resource issues in the Basin – to the extent applicable. The control point approach establishes specific goals, objectives, and measures of success on an individual watershed and location basis as well as at Basin level. This allows specific goals and objectives to be established, distinct priorities and activities to be developed, and explicit actions to be assigned to specific organizations and agencies rationally within an overall Delaware River Basin planning context.*

DRBC Staff Reply: The control point approach serves water quality management very well. The National Park Service also requested that DRBC use the control point approach for the Upper and Middle Delaware Special Protection Waters regions. Using this approach, DRBC will be able to relate management activities directly to their measurable effects upon the Delaware River. This should allow the agency to better focus efforts upon what really matters – measurable results that benefit the river. For these reasons, DRBC staff members have already begun to integrate the control point method into all non-tidal water quality management activities. Closer cooperation between partners can strengthen results dramatically by focusing all agencies on specific measurable targets.

Appendix C. Selections from the Lower Delaware National Wild and Scenic Study Report (National Park Service, 1999).

Excerpts from the NPS report are reproduced here.
The NPS report is available for download at
http://www.nps.gov/chal/sp/p07new1.htm#contents

Requirements for Designation

Before a river can be added to the National Wild and Scenic Rivers System, it must be found both eligible and suitable. To be eligible, the river must be i) free-flowing; and, ii) possess at least one "outstandingly remarkable" resource value, such as exceptional scenery, recreational opportunities, fisheries and wildlife, historic sites, or cultural resources. The resource values must be directly related to, or dependent upon, the river. The determination of a resource's significance, i.e. the degree to which it fulfills the "outstandingly remarkable" requirement, is based on the professional judgment of the study team.

The suitability determination is based upon several findings. First, there must be evidence of lasting protection for the river's free-flowing character and outstanding resources, either through existing mechanisms (including patterns of conservation land ownership, state and local land use regulations, physical barriers to inappropriate development, etc.), or through a combination of existing and new conservation measures resulting from the wild and scenic study. Second, there must be strong support for designation from the entities — local municipalities, state agencies, riverfront landowners, conservation organizations — that will be partners in the longterm protection of the river. Third, a practical management framework must be devised that will allow these interests to work together as effective stewards of the river and its resources. Finally, wild and scenic designation must make sense for the river in question: it must be an appropriate and efficient river conservation tool.

In proposing a river for designation, a recommendation is also made regarding the river's proposed classification . The classification — wild, scenic, or recreational — is based solely on the intensity of human presence along the river corridor, in the form of railroads, highways, utility lines, buildings, etc., at the time of classification. A river's classification is principally used to guide future actions by federal agencies on projects affecting federally-owned lands (e.g., whether the construction of a new boat ramp is appropriate).

The Act defines the three classifications as follow:

Wild river areas — Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds and shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic river areas — Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational river areas — Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Description of the Study Area Resources

The lower Delaware River is unique in its diversity of significant resources. A high density of population and recreational opportunities combine here with a wealth of natural, cultural and historic features of unparalleled national significance. The river valley contains habitats that do not occur elsewhere in the region. For example, there are sheer cliffs that rise 400 feet above the river. Southern facing cliffs are dry and desert-like, and are home to prickly pear cactus. North-facing cliffs exhibit flora usually found only in arcticalpine climates. The river itself provides habitat for American shad, striped bass, and river herring, providing a high quality recreational and economic resource. The river is an important component of the Atlantic Flyway, one of four major waterfowl routes in North America. From an historic viewpoint, the river is one of the most significant corridors in the nation, with crucial infrastructure still intact. The corridor contains buildings used

during Washington's famous crossing, historic navigation canals, Native American and colonial era archaeological sites, mills, etc. Just as important is the magnificent scenery. The view from the river for most of its length is of an undisturbed natural area, despite development taking place in the corridor.

The Lower Delaware Wild and Scenic Task Force identified five major categories of resources that require proper management in order to protect the river corridor:

Water Quality
Natural Resources
Historic Resources
Recreation
Open Space

Natural Resources

The lower Delaware River includes a diversity of ecosystems that support unique vegetation and wildlife. It flows through rolling hills and broad valleys; cliffs and palisades have emerged where the river has cut deeply into the rock. Rare plants cling to rock outcrops. On shelves of north-facing cliffs in Pennsylvania grow Arctic-Alpine plants such as Rosey sedum, while cacti dot the cliff shelves on the south-facing New Jersey side. Woodlands cover many of the river islands and the sloping hills, cliffs, and palisades along its banks providing habitat for an abundance of wildlife including the endangered *Bald Eagle* and *Peregrine Falcon*. The water itself supports a diversity of fish populations. The river's valuable natural resources provide a sense of timeless beauty and peacefulness to all who take the opportunity to experience it. Following is a description of the natural resources in greater detail:

Geology

The character of the lower Delaware River corridor's geology changes dramatically over the corridor's length. Geologists have classified geologic differences by assigning them to geologic provinces. The lower Delaware corridor encompasses four such provinces, beginning at the northern end of the corridor with the Valley and Ridge Province. Like all of the geologic provinces, the Valley and Ridge is a band which crosses the river in a more-or-less east-west direction. The topography of the lower Delaware River is quite dramatic in the Valley and Ridge Province and gradually flattens as one proceeds southward through the New England and Piedmont Provinces, until reaching the Coastal Plain Province near Trenton, where the landscape becomes quite flat. The Coastal Plan Province, in fact, is a fairly recently elevated sea bottom.

Mineral resource extraction has a long history in the corridor. Fluxistone and iron ore mining and dimention stone quarrying flourished intermittently during the eighteen and nineteenth centuries. Presently basalt used for manufacture of asphalt, concrete and other construction purposes, sand, gravel, and dimention stone are mined in the corridor.

Vegetation/Critical Habitat

There is a variety of vegetation in the plan area resulting from differences in elevation, aspect, climate, physiography, geology and land use. Within the Piedmont uplands of red shale, red cedar grow on abandoned farms. They are eventually shaded by taller maples and oaks. North of the Piedmont in the New Jersey Highlands Province, the plant species in the early successional stages are dominated by gray birch and largetoothed aspen. Major tree species identified in the study corridor include: black, grey, river and yellow birch; red maple; red oak; white ash; large-toothed and trembling aspen; black locust, walnut, and black cherry; sycamore; and hemlock. Shrubs include willow, spirea, silk dogwood, and alder. Woody species above the floodplain include blueberry, huckleberry, rhododendron, mountain maple, staghorn sumac, sweet fern, and witch hazel. Vegetation along the river corridor provides valuable habitat for birds and other animals and shade for fish in the river.

Some areas contain special vegetation features including rare plant species, unique or unusual floral habitats, or outstanding individual specimens. For example, in some areas sheer cliffs, rising to 400 feet above the valley floor, support special flora found at no other sites in the area. Rapid drainage and exposure to winds and sun makes southern facing cliff habitats dry and desert-like. *Eastern red cedar* is the dominant tree. *Mountain spleenwort* and *Goat's rue* are commonly found on crests and ledges or in rock crevices. Flora on cliffs such as Milford Bluffs in Hunterdon County and Nockamixon Cliffs in Bucks County is rare for the northeastern U.S. *Roseroot,* an arctic-alpine herb that grows on

shelves and crevices near the top of these cliffs, is in its southern-most habitat here. Prickly Pear is abundant on Milford Bluffs which also provide habitat to *Green Violet* and *Smooth Veiny Peavine,* both on the NJ endangered plant list.

Bull's Island, about 3.5 miles north of Stockton, NJ has an exemplary forested floodplain habitat with mature sycamore, silver maple, locust and box elder. The southern portion of the island is a Natural Area, designated by New Jersey for its northern floodplain habitat and rare species habitat.

Continued development in the region is altering the composition of the forests because as these forests are fragmented, more forest edge is created causing a great increase in plant species that thrive in edge habitats.

The Nature Conservancy, in cooperation with the states of New Jersey and Pennsylvania, have identified "critical habitats" in the corridor. Meeting the outstandingly remarkable resource criteria are:

New Jersey
Alpha (Pohatcong) Grasslands
Bull's Island
Burlington Island
Byram Hillside
Delaware River Bridge at Stockton
Delaware River Floodplain, Delaware Township
Delaware River Floodplain, Harmony Township
Delaware River Floodplain, Knowlton Township
Garrison Road Site
Goat Hill
Hawk Island
Holcombe Island
Javes Road site (wetland at Hakihokake Creek)
Kingswood Township Bluffs
Manunka Chunk Bluffs
Milford Bluffs
Mine Hill
Mount Tammany
Newbold Island
Phillipsburg Bluffs
Pohatcong Mountain
Riegelsville Bluffs
Scudders Falls Islands
Strawberry Hill
Treasure Island

Pennsylvania
Biles Island
Delhaas Woods County Preserve
Durham Mines
Frya Run Creek
Hendricks Island
Jacoby Creek
Maple Beach
Mariton Wildlife Sanctuary
Marshall Island
Mine Hill
Morrisville river shore
Mud Island
Nockamixon Cliffs
Paunacussing Creek
Scudders Falls Islands
Sol and Rose Conservation Area
Van Sciver Lake

Fisheries

The lower Delaware River supports a wide diversity of anadromous and resident fish populations that are important commercially, recreationally and ecologically. Migratory species such as American shad, striped bass and river herring are increasing in the river in response to improved water quality and fish management. Their continued survival is dependent on the water quality of the river's lower reaches. Resident species such as smallmouth bass, channel catfish, walleye pike, hybrid muskellunge, white catfish, bullhead, white perch, sunfish, suckers, and eels add to this important recreational fishery.

One of the most recreationally and economically important fish species in the river basin is the *American Shad*, a New Jersey state threatened species. Populations of American Shad have increased tremendously in response to improved water quality. Today, approximately 900,000 adult American Shad ascend the Delaware River each spring. Fish ladders have been installed at Easton to allow shad to migrate up the Lehigh River. Annual shad festivals held in Lambertville, NJ and Easton, PA, and the Delaware River Shad Fisherman Tournament illustrate the successful relationship between tourism and fisheries.

The federally listed endangered *Shortnose Sturgeon* is concentrated in the estuary between Philadelphia and Trenton and is known to spawn in the Yardley and Lambertville areas. The globally rare *Atlantic Sturgeon* travels upriver as far as Trenton.

Coldwater fisheries are supported in numerous creeks entering the river in the plan area. Many creeks are stocked with trout and are accessible to the public.

River management practices could impact the diversity or the balance of fish and other aquatic life in the corridor. Diversion and release of the water, as well as dredging in the estuary, might create conditions that favor some species over others. The use of high speed boats and personal water craft, particularly in the shallower sections of the river, could also be altering the habitat for many species.

Wildlife

Many species of wildlife exist in the plan area, some of which are rare, threatened, or endangered.

Important reptile and amphibian species known to occur in or near the river corridor area include bog turtles, New Jersey chorus frogs, coastal plain leopard frogs, eastern mud turtles, and red-bellied turtles. The bog and/or red-bellied turtles occur at sites within the Cooks Creek watershed in upper Bucks County, Frya Run Creek, on the Delaware near Washington Crossing, and in Trenton-Hamilton Marsh in the southern portion of the plan area.

Among mammal species, white-tailed deer populations have increased notably since the early 1900's in New Jersey and Pennsylvania. Many naturalists are concerned that deer have increased in such numbers that they threaten the existence of many of the plant species they eat. Deer may also threaten other animal species that rely upon the same food for survival. Beaver and river otter are active along the Delaware. Four endangered, threatened or rare bat species inhabit parts of Upper Bucks (PA) and Hunterdon (NJ) counties in the river corridor vicinity: *Keen's bat, Small-footed bat, Northern Longeared bat, and Indiana bat.*

The plan area is recognized on a national and state level for many characteristics related to bird breeding and migration:

- It is located along the Atlantic Flyway, one of four major waterfowl migratory routes in the U.S.
- The Nockamixon Cliffs historically provided nesting sites for the federal and state-endangered Peregrine Falcon. They last nested here in the 1940's and reintroduction efforts have brought them back from the edge of extinction.
- Bald Eagles, federal (until 1994) and state endangered, use the river's shoreline and islands for winter habitat.
- State endangered osprey are also making a comeback along the Delaware River through a reintroduction program.
- The Least Bittern, a PA threatened species, breeds in Upper Bucks County and the Trenton-Hamilton Marsh.
- The Alpha (Pohatcong) Grasslands are noted for nesting grassland species that are declining and for over-winter populations of Northern Harriers and Short Eared Owls.
- Mature hardwood forests of the river's floodplain and islands are important breeding areas for declining neotropical bird species.

Potentially important areas for migrating birds include the many small ravines and stream valleys along the river and its tributaries, floodplains, and other wetland areas, river islands, and wooded corridors. A critical concern for species in the plan area is preservation of remaining habitat. The following is a list of birds in the plan area that are endangered or threatened:

Endangered:	Bald Eagle	
	Osprey	
	Peregrine Falcon	
Threatened:	American Bittern	Least Bittern
	Bobolink	Northern Harrier
	Common Snipe	Red-headed Woodpecker
	Cliff Swallow	Red Shouldered Hawk
	Cooper's Hawk	Savanna Sparrow
	Grasshopper Sparrow	Upland Sandpiper
	Great Blue Heron	Yellow-bellied Flycatcher

Delaware River Islands

There are about 50 islands in the plan area, varying in size from a few gravel mounds in summer to forested habitats of more than 300 acres. Ownership of the islands is divided nearly equally between private and public interests. Because of limited access and seasonal flooding, the islands remain relatively natural, a condition that is considered by many to be of very great importance to the continued natural charm of the corridor. Permanent preservation of the islands has been a high priority for many environmental groups.

The islands provide critical stopovers for migratory birds, and the shallow water areas around them are important nurseries and feeding grounds for a variety of fish. The forested islands provide a rich environment for nesting waterfowl, herons and songbirds.

Islands that contain habitat recognized as "critical" for endangered native plant species are included in the list on pages 29-30.

Wetlands

Wetlands, once thought to have little or no value, are now recognized as a vital link in our ecological system. Wetlands nurture some of the most uncommon plants in the region, including wild rice on which migrating waterfowl feed. The following is a list of critical wetlands in the Plan area:

New Jersey
Trenton/Hamilton Marsh, 1,200 acres; most northerly tidal marsh on the Delaware River.

Pennsylvania
Bristol Marsh, one of three remaining freshwater tidal areas on the river.
Kauffman Hill Swamp, 400 acres, Bridgeton and Nockamixon townships
Quakertown Swamp, headwaters of the Tohickon Creek

Historic Resources

The lower Delaware River contains historic resources of great national significance; it is a microcosm of American history. Colonial development, the American Revolution, transportation evolution, the Industrial Revolution, urbanization, suburbanization, art and theater are all represented within the corridor.

The river provided access to the region for both Native Americans and European settlers and defined development patterns. Virtually every major town on both sides of the river in the plan area began as a ferry crossing.

The first public reading of the Declaration of Independence took place in Easton on July 8, 1776. George Washington's crossing of the Delaware on Christmas Eve is an event known by most school age children in the United States. The development of canals and railroads along the river in the nineteenth century allowed mineral wealth and farm products to reach growing urban markets.

Before European settlement, the Lenni Lenape hunted and fished along the Delaware and its tributaries. Many Native American archaeological sites have been documented along the corridor. The names of numerous towns, roadways and creeks are taken from the Native American language, such as Tohickon, Tinicum, Lopatcong, Pohatcong, Paunacussing, Wichecheoke, Aquetong, and Pequest.

European settlement began in the seventeenth century and by the end of the eighteenth century had significantly changed the environment. Forests were cut, sawmills built, land cleared for farming, and roads opened.

The 1800's brought major technological changes, and the Industrial revolution was underway. The Delaware River corridor had all the natural assets needed to spur vibrant industrial growth. It was rich in the essential resources— water, coal, wood, and iron—and occupied a prime location.

In the nineteenth century canals were established to aid in the transportation of anthracite coal from the Lehigh River region to rapidly growing industrial markets in Trenton, Philadelphia, New York, and elsewhere. The Delaware Division of the Pennsylvania Canal, the Delaware and Raritan Canal, and the Morris Canal were built for that purpose. The canals were largely hand-dug by local farmers and Irish immigrants using picks, shovels, and wheelbarrows. Towns developed at the terminus of the canals. Smaller towns emerged along the canals, and parallel railroads were built soon after the canals. The Delaware Canal, which operated between 1827 and 1932, is now a State Park used for recreational purposes by thousands each year and is a National Historic Landmark. The Delaware Canal is also an important component of the Delaware & Lehigh Canal National Heritage Corridor. The Delaware and Raritan Canal, which serves today as a water supply system, is also a State Park and a National Historic Landmark. Interest is growing in protecting and interpreting the remains of the Morris Canal.

The river shaped the emerging economic/physical landscape in ways that are enduring. Above the fall line at Trenton, development of towns was limited, and tributary streams fall sharply from the highlands down into the river valley. Gristmills and sawmills were built near the Delaware River along many of these tributaries to exploit the water power. Though many mills have been destroyed, several remain. Limekilns were built on the river's edge, the ruins of which are still found near Uhlerstown and Phillipsburg.

The significance of the scenic river, historic canals and towns, and remnants of early industries has already been recognized by: Congressional designation in 1988 of the Delaware and Lehigh Navigational Canal National Heritage Corridor, a key component of which is the Delaware Canal; designation of twenty-nine National Historic Districts as well as eight National Historic Landmarks. In addition, thousands of other archaeological and historic sites along the river corridor have been identified and mapped.

Funding to encourage historic preservation through documentation, acquisition, restoration, development and interpretation is limited. The problem is compounded by lack of coordination between municipalities, non-profits, states, and other programs. Regional programs like the D&L Heritage Corridor are a strong advance toward better coordination. However, given the significance of the area's historic resources and their potential for economic development, the regional commitment to their preservation and interpretation is weak.

Historic and cultural sites and districts which are listed on the National Register of Historic Places:

New Jersey

Belvidere Historic District
Berkeley Square Historic District
Bordentown Historic District
Borough of Frenchtown Historic District
Burlington Historic District
Calhoun Street Bridge over the Delaware River
Delaware and Raritan Canal National Historic Landmark
Early Trenton Historic District
General Dickinson House
Jacob's Creek Somerset Mills
Lambertville Historic District
McCall Mansion, Cadwalader Park
Morris Canal National Historic Landmark and Morris Canal Arch
Old Barracks National Historic Landmark
Pennsylvania Railroad Bridge over the Delaware River
Pleasant Valley Rural Historic District
Point Breeze Historic District
Prallsville Mills Historic District
Pursley's Ferry Historic District
Ralph Kuser Mansion
Roebling Historic District
State House Historic District
Titusville Historic District
Washington Crossing National Historic Landmark
William Trent House National Historic Landmark

Pennsylvania

Andulusia – estate of Nicolaus Biddle, head of first Bank of the U.S.
Upper Aquetong Valley Historic District

Bristol Historic District
Bristol Industrial Historic District
Brownsburg Historic District
Carversville Historic District
Centre Bridge Historic District
Coffeetown Grist Mill
Delaware and Lehigh Canal National Heritage Corridor and State Heritage Park
Delaware Canal National Historic Landmark
Easton National Register Historic District
Frya Run Bridge
Grundy Mill Complex
Historic Fallsington District
Harriman Historic District
Honey Hollow Watershed National Historic Landmark
Jacoby Creek Bridge
Jefferson Land Association Historic District
Lumberville Historic District
New Hope Historic District
Pennsbury Manor – home of William Penn
Phillips Mill Historic District
Point Pleasant Historic District
Ridge Road Rural Historic District
Slate Hill Cemetery
Summerseat – home of Robert Morris, financier of the Revolution
Three Arches – home of John and Mary Sotcher, steward and housekeeper to William Penn.
Uhlerstown Historic District
Washington Crossing National Historic Landmark

Recreational Resources

Because of its great beauty and many natural and cultural resources, and because the Delaware River is within a day's drive of 40% of the U. S. population, it is an extraordinarily important recreational resource for millions of people. One can expect to see almost any kind of recreational boat on the river — canoes and kayaks, speed boats and jet skis, fishing boats, shells, excursion boats with pontoons and fringe-lined roofs —and in many places the river is dotted in summer with people floating with the current on innertubes. Hikers, joggers, and bicyclists crowd the canal paths on either side of the river. Fishermen, bird watchers, and people seeking a natural landscape are drawn in great numbers to the corridor. Campgrounds are scarce in the corridor, but those that do exist are popular.

There are large number of state and local parks in the corridor. The Delaware and Raritan Canal State Park (NJ) and the Delaware Canal State Park (PA) are popular recreational corridors. Both have trail systems designated as National Recreational Trails. While these parklands provide a wealth of recreational opportunities, they are primarily disconnected "areas" of recreation and do not represent a cohesive recreational system. A lack of sufficient public facilities and boating access is also a limiting factor to these areas, a situation that has its benefits as well as its problems.

The use of the corridor for recreation brings with it many difficulties. While the great majority of people drawn to the corridor for recreation are respectful of the region's fragile resources and of the rights of others, enough people lack this respect that conflicts arise. The privacy and security of property owners are often violated by boaters, tubers, and others. Trash is often discarded without consideration.

No recreational issue in the lower Delaware River corridor raises more comment than the use of personal water craft, commonly called Jet Skis. These vehicles are frequently modified in ways that maximize the amount of noise they can make — a level of noise that intrudes on any other activity in the corridor. Furthermore, the drivers often create a situation that frightens other boaters and river users by riding at high speeds in circumstances that are often unsafe. These water craft also disrupt wildlife both by their loud, intrusive noise and by disturbing the ecosystem of the river's shallow areas.

Citizen protest has prompted legislative review of ways to control personal water craft use. New Jersey passed new safety regulations effective July 1, 1997, which require operators of personal watercraft to be at least 16 years of age and to obtain a boating safety certificate. However, no satisfactory solution is yet in view. Action must be taken jointly by New Jersey and Pennsylvania, and enforcement must be provided on a far higher level than presently exists on either side of

the river. This enforcement can only be created by the allocation of more money for the enforcing bodies, a difficulty given the present budget restrictions in both states.

Protected open space and public parks in the plan area:

New Jersey
Blaugard Island
Bulls Island Recreation Area
Cadwalader Park
Columbia Lake Wildlife Management Area
Delaware & Raritan Canal State Park
Delaware Watergap National Recreation Area
Dildine Island, Macks Bar
Eagle Island
Frenchtown Municipal Park
Lockatong Creek Preserve
Milford Bluffs Preserve
Musconetcong Gorge County Preserve
Kittatinny Valley Trail State Park
Phillipsburg Riverfront Park
Roebling Memorial Park, Trenton Marsh
Rotary Island
Rush Island
Shandor Island
Trenton Riverfront Park
Washington Crossing State Park

Pennsylvania
Bowman's Hill Wildflower Preserve
Bristol Borough Riverfront Park
Delaware Canal State Park
Delaware Watergap National Recreation Area
Easton Riverfront Park
Falls of Delaware Park
Frost Hollow County Park
Frya Run County Park
Hal Clark Park
Lehigh Canal-Hugh Moore Park Heritage Corridor
Macclesfield Municipal Park
Martins Creek Recreation Area
Morgan Hill Island
Mount Jack County Park
Mud Run County Preserve
Neshaminy State Park
Nockamixon Cliffs
Nockamixon State Park
Old Sow Island
Pen Ryn County Park
Pennsbury Manor State Park
Prahls Island group
Ralph Stover State Park
Raubs Island
Ringing Rocks County Park
Silver Lake County Park
State Gamelands #56 (Rapp and Beaver creeks)
Tinicum County Park
Tohickon Valley Park
Washington Crossing State Park
Waterfront Park, Falls Township
Whippoorwill Island
Williamson Municipal Park
Wy-Hit-Tuk County Park

Scenic Resources

The lower Delaware River corridor provides year-round scenic opportunities. During the summer, lush vegetation along the river's floodplain and wooded slopes provides surprisingly "natural" landscapes. Fabulous fall colors combined with the pleasant autumn climate make the corridor an excellent site for color tours and outdoor opportunities. Winter provides dramatic natural ice sculptures on bluffs and cliffs. Spring heralds nature's migration and the songbirds reappear.

The traveler can choose to take to the water at various public access points to view the waterway. The view from the river provides a sense of being in pristine surroundings. Public riverfront parks have been established in some municipalities, but access to the river is still limited in many areas.

On the other hand, travel by roadway not only provides beautiful views of the river and canals, but passes through historic riverside towns. In Pennsylvania, River Road (Routes 32 & 611) from Kintnersville to Morrisville is a Pennsylvania Scenic Road. New Jersey's River Road (Route 29) between Frenchtown and Trenton has been designated a New Jersey Scenic Byway.

The Delaware River offers tranquil and often dramatic rural scenery that has become increasingly rare in the highly urbanized Northeast corridor.

Economic Resources

Land use between the Delaware Water Gap and Washington Crossing is a complex mix including agricultural, small towns, light commercial uses, growing suburban-style residential development, second-home and vacation residential development, tourist facilities such as restaurants, bed and breakfasts and river-related recreational facilities, and public lands. Despite the intensive use, the lower Delaware River corridor has retained much of its natural shoreline and highly scenic quality.

The river corridor between south of Washington Crossing and the southernmost border of the plan area at the Bucks County/Philadelphia line is the most densely populated with cities, suburban residential areas and light industrial uses. Trenton is the largest urban center in the lower Delaware River corridor. Major residential development occurred in lower Bucks County from 1950 to 1965 when Levittown and Fairless Hills were constructed to house employees of the USX Corporation Fairless Works, still the largest industrial complex in the plan area. The opening of Interstate Route 95, which crosses the river above Yardley, PA, led to increased residential subdivisions. Industrial sites are primarily located in the Easton, PA area and in the tidal estuary portion of the plan area beginning at Trenton, NJ and Morrisville, PA and extending down river to the southern plan area boundary. An expanding land use in the lower reaches in recent years is trash disposal landfills and processing plants.

Urban areas in the corridor are important as focal points for access to and celebration of the river and are valuable economic generators. Economic development is a significant component in the provision of jobs and in maintaining a balanced and prosperous economic base that not only helps attract visitors, but provides the tax base to support the preservation efforts of local governments.

The lands in and around the plan area are in great demand for new residential and commercial development, creating pressures that can threaten the fragile environment and scenic beauty of the river corridor. Economic prosperity depends upon both continued growth and preservation of the corridor's natural and cultural resources. Achieving these two often-conflicting goals will require a more region-wide approach to development than presently exists.

The historic treasures and scenic beauty of the Delaware River corridor offer numerous economic opportunities pertaining to "Eco-tourism." Many travelers are seeking destinations that provide historical and cultural stimulus as well as a chance to commune with nature through hiking, boating, bird watching, camping, etc.

More than three centuries of growth has left the Delaware River corridor a unique legacy. It is reflected in the area's prominent position in the nation's history, in the commerce and industry that grew up there and still characterize the region, in the ethnic and cultural diversity of the area, and in the wealth that its commerce and productivity have generated. The challenge now is to preserve that legacy while providing for managed economic growth.

Open Space

Preservation of open space is the basis for preserving all of the outstandingly remarkable resources in the lower Delaware River corridor. It is critical to water quality because it is from developed areas — not from natural lands — that pollution flows into the ground and surface waters. Natural areas have more stable soils than places where development has occurred, thus reducing the turbidity of storm water that runs off a site after a rainfall. Finally, natural lands in this region will eventually support a deciduous forest. Trees shade the water in smaller streams, cooling it and increasing the water's ability to contain oxygen, one of the most important elements in countering water pollution.

The preservation of open space is also the surest way of preserving habitat for rare and endangered plant and animal species. Some of these species scan survive in developed areas, but habitat loss is the primary reason that these species become rare or endangered.

Historic sites in the corridor are also dependent upon the preservation of open space. If a historic structure is preserved but the land around it experiences modern development, the structure often looses its context and much of its historic value.

The importance of open space to the preservation of scenic values and to recreation sites is obvious. Any loss of open space in the corridor would significantly reduce the scenic character and recreational opportunities that made the river corridor eligible for National Wild and Scenic designation. Recreational opportunities in the corridor are almost entirely dependent upon preserving open space. Boaters, bird watchers, campers, hikers, cross-country skiers, tubers — virtually all who come to the corridor for recreation — need open space for their activities and depend upon it to assure that the corridor is attractive enough to make it a suitable place for such activities.

Agricultural land is an important component of open space. Compared to most types of land uses, properly managed agriculture preserves many natural and cultural values such as retention of critical aquifer recharge areas, protection of critical wildlife areas, maintenance of natural stream flow, conservation of prime soils, preservation of rural or historic character, and preservation of scenic landscapes. Farmlands reduce some of the extensive costs associated with scattered development. Farmlands also reduce the negative environmental impacts that diminish the attractiveness of the Delaware Watershed. Farmlands consistently generate more tax revenue than it requires in service expenditures. In contrast, residential areas require services that cost more than the tax revenue they generate. Equally important, farmers often possess valuable knowledge of their community's natural and cultural environment. The lower Delaware River and its tributaries include extensive agricultural lands along their shores, contributing to their outstanding scenic value.

The Northeast corridor is the most densely populated area in the country. The Delaware River corridor presents a rare opportunity for solitude and oneness with nature. Preserving this quality is important to the social and cultural health of the public and the economic health of the region.

Eligibility and Classification

The purpose of this chapter is to document National Park Service findings relative to the eligibility of the study river segments for designation and the proposed classification under which the eligible segments could be included in the National Wild and Scenic River System.

Eligibility Requirements

The Wild and Scenic Rivers Act requires that for river segments to be eligible for inclusion into the national system they be free-flowing and adjacent to or within related land areas that possess one or more outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values.

Free-flowing Condition

The Wild and Scenic Rivers Act is intended to protect only "free-flowing" rivers, and such flows must be adequate to support all flow-dependent outstanding resource values. Section 16(b) of the Act defines "free-flowing" as:

"…existing or flowing in natural condition without impoundment, diversion, straightening, riprapping, or other modification of the waterway. The existence, however, of low dams, diversion works, and other minor structures…shall

not automatically bar…consideration for…inclusion: Provided, that this shall not be construed to authorize, intend, or encourage future construction of such structures within components of the national wild and scenic rivers system."

Federal guidelines provide the following additional clarification:

"The fact that a river segment may flow between large impoundments will not necessarily preclude its designation. Such segments may qualify if conditions within the segment ….Existing dams, diversion works, riprap and other minor structures, will not bar recreational classification provided that the waterway remains generally natural and riverine in its appearance."

Outstandingly Remarkable Resources

The criteria for deciding what qualifies as an outstandingly remarkable resource were adapted from two primary sources: *The Natural and Recreational Resource Evaluation* prepared for the Delaware and Lehigh Canal National Heritage Corridor Commission and *A Systematic Approach to Determining the Eligibility of Wild and Scenic River Candidates* produced for the Columbia Gorge National Scenic Area. These documents incorporated established criteria for National Park Service and United States Forest Service efforts. Further information was derived from professional planning publications. The criteria for outstandingly remarkable resources are as follows:

1. Officially Recognized

National

The resource's significance has been established through designation or recognition in federal programs such as endangered, threatened and/or rare species of fish, wildlife and vegetation; historical and cultural sites and parks; and exceptional waters.

State

The resource has been designated or recognized by the State of New Jersey and/or the Commonwealth of Pennsylvania in their programs such as scenic rivers or by-ways; historical and recreational parks; endangered, threatened or rare fish, wildlife or vegetation; and stream/water quality classifications.

Regional Importance

Regional significance has been recognized and documented in programs such as critical natural areas studies and university/ foundation research.

2. Relationship to the River

Existence

The resource's existence is/was owed to its location along the river or tributary corridor. For example, a rare bird depends on a specific habitat in the corridor for survival, or an historic mill was placed on a stream segment because of the water flow.

Role

The resource's contribution or influence on the functioning of the river or tributary, such as groundwater aquifers. If the resource meets one criteria from each of the two sections, it is considered outstandingly remarkable.

Outstandingly Remarkable River Values and Resources

The lower Delaware River corridor contains the following outstandingly remarkable resource values as exemplified by the corresponding resources. The listed resources meet the criteria for determination of outstandingly remarkable resources described above. The existence of these outstandingly remarkable resource values and the determination that a river segment is free flowing result in the river segment being eligible for inclusion into the National Wild and Scenic Rivers System.

Physiography and Geology

NEW JERSEY

Milford Bluffs, Holland Twp. **(Study Segment F)**
Devils' Teatable, Kingwood Twp. **(Study Segment F)**

PENNSYLVANIA

Nockamixon Cliffs, Nockamixon Twp. **(Study Segment E)**
Ringing Rock, Bridgeton Twp. **(Study Segment E)**
Monroe Triassic Border Fault, Durham Twp. - a National Natural Landmark **(Study Segment E)**
Tohickon Creek: Triassic Lockaton and Brunswick Formations, Tinicum Twp. **(Study Segment M)**
Tohickon High Rocks, Tinicum Twp. **(Study Segment M)**
Durham Caves and Durham Mines, Durham Twp. **(Study Segment E)**

Water Quality

The following streams have been designated by their respective state as having high water quality. Each stream listed flows into the Delaware River, a study tributary, or is a study tributary. The water quality of these tributaries sustains the water quality of the Delaware River itself.

PENNSYLVANIA

To implement federal antidegradation requirements, the Pennsylvania Department of Environmental Resources designates certain streams High Quality or Exceptional Value waters as defined in Chapter 93 of its rules and regulations. The definitions are as follows:

High Quality Waters — A stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection.

Exceptional Value Waters — A stream or watershed which constitutes an outstanding national, state, regional, or local resource, such as: waters on national, state, or county parks or forests; waters which are used as a source of unfiltered potable water supply; waters of wildlife refuges or state game lands; waters which have been characterized by the Fish Commission as 'Wilderness Trout Streams;' and other waters of substantial recreational or ecological significance.

Exceptional Value Streams:

Cooks Creek, Durham Twp. etc., Bucks Co. **(Study Segment K)**

High Quality - Cold Water Fisheries Streams:

Slateford Creek, Northampton Co. **(Study Segment A)**
Jacoby Creek, Northampton Co. **(Study Segment A)**
Bushkill Creek, Forks Twp., Northampton Co. **(Study Segment D)**
Frya Run, Northampton Co. **(Study Segment E)**
Pannucussing Creek, Bucks Co. **(Study Segment N)**
Cuttalossa Creek, Bucks Co. **(Study Segment G)**
Aquetong Creek, Bucks Co. **(Study Segment G)**
Rapp and Beaver Creeks, Bucks Co. (3rd Order) — headwaters of Tinicum Creek **(Study Segment L)**

NEW JERSEY

New Jersey's waters, as related to their ability to support trout, are defined in the NJ Department of Environmental Protection's Surface Water Quality Standards (N.J.A.C. 7:9-4) as follows:

Trout Production Waters — Waters designated for use by trout for spawning or nursery purposes during their first summer.

Trout Maintenance Waters — Waters designated for their support of trout throughout the year.

Trout Production Streams:
Buckhorn Creek, Warren Co. **(Study Segment D)**
Merrill Creek, Warren Co. **(Study Segment D)**
Lopatcong Creek, Warren Co. **(Study Segment E)**
Pohatcong Creek, Warren Co. **(Study Segment F)**

Trout Maintenance Streams:
Paulinskill River, Warren Co. **(Study Segment J)**
Pequest River, Warren, Co. **(Study Segment B)**
Delawanna Creek, Warren Co. **(Study Segment B)**
Musconetcong River, Warren & Hunterdon counties **(Study Segment O)**
Hakihokake Creek, Hunterdon Co. **(Study Segment F)**

Species of Concern

The species of concern below are identified and ranked by the Federal and State governments and the Nature Conservancy as endangered, threatened, or rare, thus, qualifying as outstandingly remarkable resources in need of protection. Below is a brief description of the rankings:

G = Global Element Ranks
- G1 = Critically imperiled globally.
- G2 = Imperiled globally.
- G3 = Very rare and local throughout its range or found locally in a restricted range.
- G4 = Apparently secure globally, quite rare in parts of its range.
- G5 = Demonstrably secure globally, quite rare in parts of its range.

S = State Element Ranks
- S1 = Critically imperiled in state.
- S2 = Imperiled in state.
- S3 = Rare in state.

E = Endangered, T = Threatened, R = Rare
(NJ = New Jersey, P = Pennsylvania)

B = Biodiversity Significance

H = Historical Significance

Vegetation

Segment vA: Delaware Water Gap to Columbia/Portland Toll Bridge

Pennsylvania
Hoary Willo/Sage-leaved Willow (Salix candida) PT, G5/S2
Grass of Parnassus (Parnassa glauca) PT, G5/2
Prostrate Sand Cherry (Prunus pumil var. depressa) PT, G5/S3
Brook Lobelia (Lobelia kalmii) PE, G5/S1
White Heath Aster (Aster ericodes) PR, G5/S3
Bicknell's Sedge (Carex bicknelli) PR, G5/S1
Atlantic Sedge (Carex sterilis) PT, G4/S2
Wood's Sedge (Carex tetanica) PT, G4/S2
Whorled Nut-rush (Scleria verticillata) PE

Segment B: Erie Lackawanna Railroad Bridge to Dildine Island

New Jersey
Nebraska Sedge (Carex jamesii) NJE, G5/S1
Broadleafed Waterleaf (Hydropphllum canadense) NJE, G5/SH
Foxtail Sedge (Carex alopecoidea) NJE, G5/SH
Blackberry Species (Rubus orarius) S2
Hairy Lipfern (Cheilanthes lanosa), G5/S2
American Purple Vetch (Vicia americana), G5/SH

Pennsylvania
Northern Pondweed (Potamogeton alpinus) PE, G5/S1

Segment C: Macks Island to Belvidere, NJ

Pennsylvania
White Heath Aster (Aster ericodes) PR, G5/S3

Segment D: Belvidere, NJ to Easton, PA

New Jersey
Round-leaved Serviceberry (Amelachier sanquinea), NJE, G5
Broad-leaved Waterleaf (Hydrophyllum canadense), NJE, G5/S2

Segment E: Phillipsburg, NJ to the Gilbert Generating Station

New Jersey
Side Oats Gramma Grass (Bouteloua curtipendula), NJE, G5/S1
False Pennroyal (Isanthus brachiatus) NJE, G4/S1
Carolina Wood Vetch (Vicia caroliniana) NJE, G5/S1
Plantain-leaved Sedge (Carex plantaginea) NJE, G5/S1 — only known state occurrence

Pennsylvania
Sand Cherry (Prunus pumila) PT, G5/S3
Bicknell's Sedge (Carex bicknelli) PE, G5/S1

Segment F: Gilbert Generating Station to Pleasant Pumping Station

New Jersey
Bush's Sedge (Carex bushii) NJE, G4/S1
Small-fruited Groovebur (Agrmonia microcarpa) NJE, G5/S2
Hairy Lipfern (Cheilanthes lanosa) G5/S2
Green Violet (Hybanthus concolor) NJE, G5/S1
Carolina Wood Vetch (Vicia caroliniana) NJE, G5/S1
Smooth Veiny Peavine (Lathyrus venosus) NJE, G5/S1
Basil Mountain Mint (Pycnanthemum clinopodiodes) G2/S1
Torrey's Mountain Mint (Pycnanthemum torrei) NJE, G2/SH
Pawpaw (Asimina triloba) NJE, G5/S1
Nebraska Sedge (Carex jamesii) NJE, G5/S1
Lowland Brittle Fern (Cystopteris protusa) G5/S2
Veined Skullcap (Scutellaria nervosa) G5/S2
Wafer Ash (Ptelea trifoliata) NJE, G5/S2
Missouri Goosefoot (Ribes missouriense) NJE, G5/S1
Ledge Spike-Moss (Selaginella rupestris) G5/S2
Wild Comfrey (Cynoglossum virginianum) G5/S2

Pennsylvania
Roseroot Stonecrop (sedum rosea) PR, G5/S1

White Heath Aster (Aster ericoides) PR, G5/S3
Prickley-Pear Cactus (Opuntia humifia) PR, G5, S3
Small-Flowered Crowfoot (Ranunculus mictanthus) PR, G5/S3
Eastern White Water-Crow (Ranunculus longirostis) PT, G5/S3

Segment G: Pt. Pleasant Pumping Station to Route 202 Bridge

New Jersey
ProstrateSand Cherry (Prunus pumila var. depressa) G5/S2
Broad-leaved Waterleaf (Hydrophyllum canadense), NJE, G5/S2
White Heath Aster (Aster ericodes) G5/S3
Willow-leaved Aster (Aster praeltus) NJE, G5/S1
Great St. John's-wort (Hyoericum pyramidatum) G4/S2
Basil Bee-balm (Monarda clinnopodia) NJE, G3-5/S1
Few-flowered Panic Grass (Panicum oligosanthes) G5/S2
Smooth Hedge-nettle (Stachys tenfolia) G5/SU

Pennsylvania
Common Hop-Tree (Ptelea Trifoliata) PR, G5/S3

Segment H & I: New Hope, PA to Washington Crossing, PA

New Jersey
Squirrel-corn (Dicentra canadensis) NJE, G5/S2
Green Violet (Hybanthus concolor) NJE, G5/S1
Twinleaf (Jeffersonia diphylla) NJE, G5/S1
Veined Skullcap (Scutellaria nervosa) G5/S2
Pale Indian Plantain (Cacalia atriplcifolia) NJE, G5/SH
Nebraska Sedge (Carex jamesii) NJE, G5/S1
Small-fruited Groovebur (Agrmonia microcarpa) NJE, G5/S2
Redbud (Cercis canadensis) NJE, G5/S1
Wild Comfrey (Cynoglossum virginianum) G5/S2
Ohio Spiderwort (Tradescantia ohiensis) G5/SU
Ellisia/Aunt Lucy (Ellisia nyctelea) NJE, G5/S1

Pennsylvania
Ellisia/Aunt Lucy (Ellisia nyctelea) PT, G5/S2
Spring Coral Root (Corallorrhiza) PT, G5/S3

Critical Habitat

Segment B: Erie Lackawanna Railroad Bridge to Dildine Island

New Jersey
Delaware River Floodplain, Knowlton Township, Warren County — high biodiversity, B3
Manunka Chunk Bluffs, Knowlton and White Townships, Warren County — biodiversity

Segment D: Belvidere, NJ to Easton, PA

New Jersey
Garrison Road Site, Harmony Township, Warren County — agricultural grasslands
Delaware River Floodplain, Harmony Township, Warren County — high biodiversity, B3

Segment E: Phillipsburg, NJ to the Gilbert Generating Station

New Jersey
Phillipsburg Bluffs, Pohatcong, Warren County limestone plant community — biodiversity, B3
Alpha Grasslands, Pohatcong Township, Warren County — biodiversity
Pohatcong Mountain, Pohatcong Township, Warren County — biodiversity

Pennsylvania
Durham Mines, Durham Township, Bucks County second most significant bat hibernaculum in state

Segment F: Gilbert Generating Station to Pt. Pleasant Pumping Station

New Jersey
Wetland at Hakihokake Creek (Javes Road Site), Holland Township, Hunterdon County — high biodiversity, B3
Milford Bluffs, Holland Township, Hunterdon County best red shale cliff community in the state, G3/S2 — high biodiversity, B3
Treasure Island, Kingwood Township, Hunterdon County — high biodiversity, B3
Byram Hillside, Kingwood Township, Hunterdon County — biodiversity

Pennsylvania
Nockamixon Cliffs, Nockamixon and Bridgeton Townships, Bucks County — state designated outstanding scenic geological feature and shale cliff plant community, including arctic-alpine species
Marshall Island, Tinicum Township, Bucks County — biodiversity

Segment G: Pt. Pleasant Pumping Station to Route 202 Bridge

New Jersey
Delaware River Floodplain, Delaware Township, Hunterdon County — biodiversity
Bull's Island, Kingwood Township, Hunterdon County — biodiversity
Delaware River Bridge at Stockton, Borough of Stockton, Hunterdon County — Cliff Swallow community

Segment H & I: New Hope, PA to Washington Crossing, PA

New Jersey
Goat Hill, West Amwell Township, Hunterdon County — biodiversity
Strawberry Hill, Hopewell Township, Mercer County — biodiversity

Fisheries

American Shad (Alosa sapidissima) - considered one of the most important fish species in the Delaware River Basin (Angler Study) —NJT
Shortnose Sturgeon (Acipenser brevirostrum) — Federal E, PE, G3/S1
Striped Bass — NJT

Reptiles and Amphibians

Bog Turtle (Clemmys muhlenbergii) — Federal T, G4, NJE, PE
New Jersey Chorus Frog (Pseudacris feriarum kalmi) — PR, G4/S2,
Coastal Plain Leopard Frog (Rana utricularia) — PE, G5/S2
Red-bellied Turtle (Pseudemys rubriventris) — PT, G5/S2
Longtail Salamander (Eurycea logicauda) — NJT, G5/S2
Wood Turtle (Clemmys insculpta) — NJT, G5/S3

Mammals

Keen's Bat (Myotis keenii) — PR, inhabits parts of upper Bucks County in the river corridor vicinity
Small-footed Bat (Myotis leibeii) — PT, G3/S1 - inhabits the same locations as Keen's Bat
Northern Long-eared Bat (Myotis septentrionalis) — G4/S2

Birds

Vesper Sparrow (Pooecetes gramineus) — NJE, G5/S2
Cliff Swallow (Hirundo pyrrhonota) — NJT, G5/S2
Grasshopper Sparrow (Ammodramus savannarum) — NJT, G4/S2
Savanna Sparrow (Passerculus sandwichensis) — NJT, G5/S2
Bobolink (Dolichonyx oryzivorus) — NJT, G5/S2
Osprey (Pandion haliaetus) — NJT
Least Bittern (Ixobrychus exilis) — PT, G5/S2
Red-headed Woodpecker (Helanerpes erythrocephalus) — NJT, G5/S2
Peregrine Falcon (Falco peregrinus) — Federal E, PE, G3/S1
Bald Eagle (Haliaetus leucocephalus) — Federal E, NJE, G3/S1
Upland Sandpiper (Scolopacidae) — NJE

Characteristics Related to Bird Breeding and Migration

The Delaware River, located along the Atlantic Flyway, is one of four major waterfowl migratory routes in the U.S.

The Nockamixon Cliffs in upper Bucks County are a historic nesting site for the federally and state-endangered peregrine falcon (Falco peregrinus). They last nested there in the 1950's, but are again nesting along the Delaware River because of reintroduction efforts.

Bald eagles (Haliaeetus leucocephalus) use the river's shoreline and islands for roosting sites.

The state-endangered osprey (Pandion haliaetus) also appears to be making a comeback along the Delaware River as a result of a reintroduction program several years ago.

The least bittern (Ixobrychus exilis), a PA threatened species, breeds in upper Bucks County.

Recreation

The lower Delaware River is clearly a major recreational resource; however, to meet the criteria for an outstandingly remarkable resource, a recreational resource is defined as a state park or having a national designation.

New Jersey
Paulinskill Valley Trail - part of Kittatinny State Park **(Study Segments A & J)**
Delaware and Raritan Canal National Recreational Trail **(Study Segments G, H & I)**
Delaware and Raritan Canal State Park **(Study Segments G, H & I)**
Bull's Island State Park **(Study Segment G)**
Washington Crossing State Park **(Study Segment I)**

Pennsylvania
Delaware Canal National Recreational Trail **(Study Segments E, F, G, H & I)**
Delaware Canal State Park **(Study Segments E, F, G, H & I)**
Washington Crossing State Park **(Study Segment I)**
Ralph Stover State Park **(Study Segment M)**
Nockamixon State Park **(Study Segment M)**

Scenic

Many members of the Lower Delaware National Wild and Scenic River Study Task Force strenuously stress the scenic values of the lower Delaware River. However, scenic values are difficult to objectively define. Thus, to meet the criteria for an outstandingly remarkable resource, scenic value is defined by a state scenic by-way designation.

Scenic By-ways

New Jersey
Route 29 (NJ Scenic Byway — designation pending)

Pennsylvania
Route 32 (PA Scenic Road- designated 12/89) – from US Rt. 1 to Rt. 611 **(Study Segments E, F, G, H & I)**
Route 611 (PA Scenic Road- designated 12/89) – from Kintnersville to
Rt. 209 **(Study Segment A. B, C, D)**

Cultural/Historic

Outstandingly remarkable cultural and historic resources for this study are defined as National Historic Districts and National Historic Landmarks.

Pennsylvania

Northampton County, Bucks County
Delaware and Lehigh Canal National Heritage Corridor and State Heritage Park **(Study Segment E, F, G, H & I)**

Bucks County
Tinicum Twp.
Uhlerstown Historic District **(Study Segment F)**
Point Pleasant Historic District **(Study Segment F)**
Ridge Valley Rural Historic District **(Study Segment L)**

Solebury Twp.
Lumberville Historic District **(Study Segment G & N)**
Centre Bridge Historic District **(Study Segment G)**
Phillips Mill Historic District **(Study Segment G)**
New Hope Historic District **(Study Segment H)**

Upper Makefield Twp.
Washington Crossing National Historic Landmark (upper tract) **(Study Segment I)**
Washington Crossing N.H.L. (Taylorsville) **(Study Segment I)**
Brownsburg Historic District **(Study Segment I)**

New Jersey

Warren County
Town of Belvidere
Belvidere Historic District **(Non-Study Segment)**

Hunterdon County, Mercer County
Delaware and Raritan Canal National Historic Landmark **(Study Segments G, H & I)**

Hunterdon County
Holland Township
Pursley's Ferry Historic District **(Study Segment E)**

Borough of Frenchtown
Frenchtown Historic District **(Study Segment F)**

Delaware Township
Prallsville Mills Historic District **(Study Segment G)**

City of Lambertville
Lambertville Historic District **(Study Segment H)**

Mercer County

Delaware and Raritan Canal National Historic Landmark **(Study Segment H & I)**

Hopewell Twp.
Titusville Historic District **(Study Segment I)**
Washington Crossing National Historic Landmark **(Study Segment I)**
Pleasant Valley Rural Historic District **(Study Segment I)**

Classification

Section 2(b) of the act requires that eligible river segments be classified as wild, scenic or recreational. For classification purposes, a study river may be segmented. Below is a brief description of each classification:

1) **Wild river areas** — Those that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

2) **Scenic river areas** — Those that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

3) **Recreational river areas** — Those areas that are readily accessible by road or railroad, that may have some development along their shorelines and that may have undergone some impoundment or diversion in the past.

Eligibility Findings

The entire study area, including all tributaries except the Tohickon Creek above Lake Nockamixon and the Smithtown Creek, meets the eligibility criteria. The lower Delaware River corridor exhibits exceptional natural, historic, scenic, and recreational values. The entire study corridor includes many outstandingly remarkable resources and is thus eligible for inclusion into the National Wild and Scenic Rivers System with classifications as outlined below.

The Mainstem of the Lower Delaware River

Each of the segments of the mainstem of the lower Delaware River, study segments A through I, are classified as recreational because each segment is readily accessible by road and/or contains some development along the shoreline.

Segment A: The segment from the Delaware Water Gap to the Toll Bridge connecting Columbia, NJ and Portland, PA
Classification: Recreational

Segment B: The segment from Erie Lackawanna Railroad Bridge to the southern tip of Dildine Island (approximately 3.6 miles, 5.8 km)
Classification: Recreational

Segment C: The segment from the southern tip of Mack Island to the northern border of the town of Belvidere, NJ (approx. 2 mi., 3.2 km)
Classification: Recreational

Segment D: The segment from the southern border of the town of Belvidere, NJ to the northern border of the city of Easton, PA, excluding river mile 196.0 to 193.8 (approx. 12.5 mi., 20.1 km)
Classification: Recreational

Segment E: The segment from the southern border of the town of Phillipsburg, NJ, to a point just north of Gilbert Generating Station (approx. 9.5 mi., 15.2 km)
Classification: Recreational

Segment F: The segment from a point just south of the Gilbert Generating Station to a point just north of the Point Pleasant Pumping Station (approx. 14.2 mi., 22.8 km)
Classification: Recreational

Segment G: The segment from the point just south of the Point Pleasant Pumping Station to a point 1000 feet north of the Route 202 bridge (approx. 6.3 mi., 10.1 km)
Classification: Recreational

Segment H: The segment from a point 1750 feet south of the Route 202 Bridge to the southern border of the town of New Hope, PA (approx. 1.9 mi., 3.0 km)
Classification: Recreational

Segment I: The segment from the southern boundary of the town of New Hope, PA to the town of Washington Crossing, PA (approx. 6 mi., 9.7 km)
Classification: Recreational

The Tributaries

Segment J: Paulinskill River in Knowlton Township — from the municipal border downstream to Brugler Rd. (approx. 2.4 mil., 3.8 km)
Classification: Recreational

Segment K: Cook's Creek (approx. 3.5 mi., 5.6 km) — Eligible
Classification: Scenic

Segment L: Tinicum Creek (approx. 14.7 mi., 23.7 km) — Eligible
Classification: Scenic

Segment M: Tohickon Creek (approx. 25.6 mi., 41.2 km)

Sub-Segment (1): Mainstem of the Delaware River to the Lake Nockamixon Dam - Eligible
Classification: Scenic

Sub-Segment (2): above the Lake Nockamixon Dam – Ineligible
The existence of the Lake Nockamixon Dam and the lake behind it makes this section of Tohickon Creek ineligible for inclusion into the National System. However, the lake and surrounding land is a state park and is thus protected as a recreational resource.

Segment N: Paunacussing Creek in Solebury Township (approx. 3 mi., 4.8 km)
Classification: Recreational

Segment O: Musconetcong
Nineteen of twenty municipalities along the Musconetcong River requested that it be added to Lower Delaware Wild and Scenic River Study. Therefore, the Musconetcong is being studied in a second phase and a separate recommendation will be issued at a later date.

Segment P: Lockatong and Wickecheoke Creeks
Delaware, Kingwood, Franklin, and Raritan townships recently passed resolutions requesting that these creeks be considered for Wild and Scenic River designation. To provide an adequate review of their eligibility and suitability, a separate recommendation will be presented at later date.

Segment Q: Smithtown Creek
Ineligible because no "outstandingly remarkable resource values" were identified.

Suitability

This chapter describes the study's findings relative to Section 4(a) of the Act, which requires the study report to detail the river's suitability for designation into the National Wild and Scenic Rivers System.

Suitability Criteria

A river's suitability for wild and scenic designation is a matter of whether it is free-flowing and contains outstandingly remarkable resources, whether designation makes sense, and whether designation provides lasting protection. For rivers such as the lower Delaware that flow through predominately private lands, federal land acquisition may not be an appropriate protective measure. Thus, protection must rely on a combination of federal, state, local, and private resource protection actions. If designation is to be effective, the non-federal entities must support and be committed to the implementation of any necessary resource protection measures.

For the lower Delaware River, the criteria used to assess suitability is:

1. Is there local support for designation of the river and implementation of the River Management Plan?

This support was determined primarily by municipal agreement to adopt the goals of the Management Plan and support for national designation of the river. To date 24 of the 37 municipalities in the area under consideration for designation (not counting the Musconetcong River communities) have passed resolutions of support. In addition, twenty-seven municipalities passed resolutions asking that the Musconetcong and Paulinskill rivers, Frya Run, and Smithtown, Paunacussing, Lockatong, and Wickecheoke creeks, be added to the study area.

Public workshops and the Landowner Survey Report document strong support for preserving the river's natural, historic, and recreational resources. Survey respondents listed scenic beauty, wildlife habitat, and overall atmosphere of the region as the three most important qualities of the area (see Appendix A). In fact, 89.9 percent of those who returned surveys said they would support land use regulations and programs to conserve and protect the river. Eighty-eight percent of the respondents said they support an overall conservation plan for the river.

2. How adequate are existing protection measures (including state and local resource protection laws, zoning, and land ownership) in conserving the river's outstanding resources and free-flowing character?

Two reports document the significant resource protection provided by the existing municipal land use control, the states of New Jersey and Pennsylvania, and the Delaware River Basin Commission. The Municipality Surveys provide a town-bytown description of land use and zoning regulations. The River Management Plan describes the regulatory and non-regulatory programs by the states, the Delaware River Basin Commission, federal agencies, and non-profit organizations. Further, the plan documents the publicly held land that protects important river-related resources, such as the two canal state parks that parallel the river.

3. Can a resource protection and management framework be developed that closes any resource protection gaps without relying on federal land acquisition and that facilitates communication and cooperation among governmental entities and private citizens who bear responsibility for implementing all river protection measures?

The River Management Plan that is summarized in Section IV provides the framework for enhanced resource protection and greater cooperation between resource management entities. This is accomplished in part through voluntary adoption of the six river management goals and through creation of a River Management Committee under direction of the existing Delaware River Greenway Partnership. By establishing the River Management Committee that will include representatives of all entities responsible for ongoing resource protection, the Plan ensures that future management decisions will be based on resource protection objectives that satisfy the Wild and Scenic Rivers Act mandate to protect and enhance the river's outstanding values. Federal designation will encourage enhanced coordination between two states, six counties, and fiftyseven municipalities. Further, most of the river corridor above the study area is already part of the National Wild and Scenic Rivers System.

Suitability Finding

All study segments under consideration for designation, except for Tohickon Creek above Nockamixon Dam, are eligible for designation into the National Wild and Scenic Rivers System. The following segments are suitable and recommended for national designation:

Segment D: The portion of this segment starting at river mile 193.8 to the northern border of the city of Easton, PA (approx. 10.5 mi., 16.9km)

Segment F: The segment from a point just south of the Gilbert Generating Station to a point just north of the Point Pleasant Pumping Station (approx. 14.2 mi., 22.8 km)

Segment G: The segment from the point just south of the Point Pleasant Pumping Station to a point 1000 feet north of the Route 202 bridge (approx. 6.3 mi., 10.1 km)

Segment H: The segment from a point 1750 feet south of the Route 202 Bridge to the southern border of the town of New Hope, PA (approx. 1.9 mi., 3.0 km)

Segment I: The segment from the southern boundary of the town of New Hope, PA to the town of Washington Crossing, PA (approx. 6 mi., 9.7 km)

Segment L: Tinicum Creek (approx. 14.7 mi., 23.7 km)

Segment M: Tohickon Creek from the Lake Nockamixon Dam to the Delaware River (approx. 10.7 mi., 17.2 km)

Segment N: Paunacussing Creek in Solebury Township (approx. 3 mi., 4.8 km)

The following segments are not suitable because not each municipality on both sides of the river has yet passed a resolution supporting designation. It is recommended that designation be granted if municipal resolutions from the communities on both sides of the river segment are passed in the future.

Segment A: The Segment from the Delaware Water Gap to the Toll Bridge connecting Columbia, NJ and Portland, PA

Segment B: The segment from Erie Lackawanna Railroad Bridge to the southern tip of Dildine Island

Segment C: The segment from the southern tip of Mack Island to the northern border of the town of Belvidere, NJ

Segment D: The portion of this segment from the southern border of the town of Belvidere, NJ to river mile 196.0

Segment E: The segment from the southern border of the town of Phillipsburg, NJ, to a point just north of Gilbert Generating Station (approx. 9.5 mi., 15.2 km)

Segment J: Paulinskill River in Knowlton Township

Segment K: Cook's Creek from Springfield/Durham townships' border to the Delaware River

Segment O: Musconetcong
Nineteen of twenty municipalities along the Musconetcong River requested that it be added to the Lower Delaware Wild and Scenic River Study. Given that the Musconetcong is the largest tributary to the Delaware River in New Jersey and the number of communities affected, it is being studied in a second phase and a separate recommendation will be issued at a later date.

Segment P: Lockatong and Wicecheoke Creeks
Delaware, Kingwood, Franklin, and Raritan townships recently passed resolutions requesting that these creeks be considered for Wild and Scenic River designation. To provide an adequate review of their eligibility and suitability a separate recommendation will be presented at a later date.

Recommended Boundary

Section 7(a) of the Wild and Scenic Rivers Act prohibits federal authorization of any water resources project that would have an adverse impact on the values for which the river is designated. For the purposes of administering Section 7 of the Act regarding actions of the federal government, the Study Task Force recommends that a formal boundary be established within one-quarter mile from the ordinary high water mark on each side of the suitable river segments.

Appendix D. Sample of Site-Specific EWQ Targets.

The following table represents site specific existing water quality targets for Lower Delaware Special Protection Waters rules. Targets shown are not final, not yet part of the rule, and shown only as an example. The median, 95% confidence interval about the median, and 10^{th} or 90^{th} percentile is presented for each parameter. These are based on the 2000-2003 data set collected by the DRBC Lower Delaware Monitoring Program. Final targets will become available once the 2004 data is included in the data set.

Ambient Water Quality Assessments:
The applicable confidence interval about the median and the percentile are used for assessing "measurable changes" to ambient existing water quality. Confidence limits about the median and data percentiles that are not applied to either discharge allocations or ambient water quality assessments have been excluded from the tables (e.g., upper 95 percent confidence limit and 90^{th} percentile for dissolved oxygen; and lower 95 percent confidence limit and 10^{th} percentile for fecal coliform, nutrients, etc. have been excluded).

Discharge Allocations:
The median and upper or lower 95 percent confidence interval about the median are targets for discharge allocations. Percentiles are not necessary for discharge allocation targets.

Unless additional water quality target sites are used within a watershed, all portions of the confidence interval that are used for allocations at a Control Point must be incrementally reduced for future allocations. This will ensure that no change to existing water quality occurs on a watershed basis in the situation where a watershed includes multiple discharges.

Dissolved Oxygen Targets:
Dissolved oxygen concentration shall be applied to discharge allocations, and percent dissolved oxygen saturation with the appropriate water temperature shall be used to assess changes to ambient water quality.

Note on Interpretation of Tables
In yellow highlighted cells, the proposed target is the most stringent criterion or guideline level used among the states, DRBC, or the U.S. EPA. The adjacent number (in parentheses) is the actual measured value from DRBC's 2000-2003 data set for the site. These represent cases where water quality must be improved to criteria levels from existing conditions.

Sample Existing Water Quality Targets for the Delaware River at Calhoun Street Bridge, Pennsylvania/New Jersey, River Mile 134.34 (Interstate Control Point)

PARAMETER	MEDIAN	UPPER (U) or LOWER (L) 95% CONFIDENCE LIMIT OF MEDIAN	10^{th} and/or 90^{th} PERCENTILE	TEMPORAL REPRESENTATION
Ammonia NH3-N (mg/l)	0.028	U = 0.050	90^{th} = 0.098	May-September
Chlorophyll A (mg/m^3)	2.70	U = 4.81	U = 7.48	May-September
Chloride (mg/l)	17.0	U = 21.0	90^{th} = 23.0	May-September
% Dissolved Oxygen Saturation	96.9%	L = 94.3%	10^{th} = 86.4%	May-September
Dissolved Oxygen (mg/l)	8.79	L = 8.40	10^{th} = 7.40	May-September
E. coli (colonies/100 ml)	42	U = 65	90^{th} = 125 (274)	May-September
Enterococcus (colonies/100 ml)	33 (44)	U = 33 (88)	90^{th} = 61 (352)	May-September
Fecal coliform (colonies/100 ml)	88	U = 140	90^{th} = 400 (720)	May-September
Nitrate NO3-N (mg/l)	1.20	U = 1.32	90^{th} = 1.70	May-September
Orthophosphate (mg/l)	0.050	U = .070	90^{th} = 0.096	May-September
PH	7.80	7.60 to 8.00	7.00 to 8.50	May-September
Specific Conductance (umhos/cm)	191.5	U = 211.0	90^{th} = 238.9	May-September
Total Dissolved Solids (mg/l)	140	U = 160	90^{th} = 169	May-September
Total Kjeldahl Nitrogen (mg/l)	0.495	U = 0.640	90^{th} = 0.879	May-September
Total Nitrogen (mg/l)	1.675	U = 1.830	90^{th} = 2.348	May-September
Total Phosphorus (mg/l)	0.10 (.11)	U = 0.1 (0.12)	90^{th} = 0.1 (0.14)	May-September
Total Suspended Solids (mg/l)	6.0	U = 9.0	90^{th} = 25.9	May-September
Turbidity (NTU)	2.8	U = 4.7	90^{th} = 10.9	May-September
Biological Criteria (RESERVED)				August-September
Alkalinity (mg/l) DESCRIPTIVE	45.0	36.0 to 50.7	25.2 to 61.9	May-September
Discharge (cfs) DESCRIPTIVE	10,131	4,793 to 13,499	3,256 to 22,133	May-September
Hardness (mg/l) DESCRIPTIVE	70.5	60.0 to 74.0	40.1 to 79.0	May-September
Water Temperature ^{o}F	MAXIMUM	Water Temperature \F	MAXIMUM	
January 1-31	40	August 1-15	87	Ambient Targets Only. Targets equivalent to PADEP Warm Water Fisheries criteria from Chapter 93. See additional DRBC criteria for heated waste sources in water quality rules.
February 1-29	40	August 16-31	87	
March 1-31	46	September 1-15	84	
April 1-15	52	September 16-30	78	
April 16-30	58	October 1-15	72	
May 1-15	64	October 16-31	66	
May 16-31	72	November 1-15	58	
June 1-15	80	November 16-30	50	
June 16-30	84	December 1-31	42	
July 1-31	87			

Note: These values represent daytime samples taken within the range of discharge from 2,918 cfs to 38,824 cfs. Compliance monitoring at this location should be conducted between the hours of 8:00 AM and 3:00 pm, twice per month from May through September, within the range of discharge presented above.