Amendment to the Northeast, Upper Raritan, Sussex County and Upper Delaware Water Quality Management Plans

Phase I Passaic River Study Total Maximum Daily Load For Phosphorus in Wanaque Reservoir Northeast Water Region

Watershed Management Area 3
(Pequannock, Wanaque, Pompton and Ramapo Watersheds)
Watershed Management Area 4
(Lower Passaic and Saddle Rivers)
Watershed Management Area 6
(Upper & Middle Passaic, Whippany, and Rockaway Rivers)

Proposed: July 5, 2005
Established:
Approved:
Adopted:

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Division of Watershed Management
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1.0 Executive Summary

This Total Maximum Daily Load (TMDL) document constitutes the first phase of a two phase TMDL study. A phosphorus TMDL and a uniform allocation of this loading capacity is proposed for the Wanaque Reservoir. Additional water quality monitoring and modeling are currently underway throughout the entire non-tidal portion of the Passaic River watershed. This Phase 2 study will address the in-stream phosphorus impairments in the non-tidal Passaic River basin. The Phase 2 study will use a dynamic model that considers fate and transport and in-stream critical locations to determine if and where refinements to the allocation of load may be warranted. Subject to the constraints of achieving the specified load reduction and attaining Surface Water Quality Standards (SWQS) in all applicable locations, further modifications of wasteload allocations (WLAs) and load allocations (LAs) may also result from water quality trading.

In accordance with Section 305(b) and 303(d) of the Federal Clean Water Act (CWA), the State of New Jersey, Department of Environmental Protection (Department) developed the *2004 Integrated List of Waterbodies* , addressing the overall water quality of the State's waters and, in Sublist 5, identifying impaired waterbodies for which TMDLs may be necessary. A TMDL is developed to identify all the contributors of a pollutant of concern and the load reductions necessary to meet the Surface Water Quality Standards (SWQS) relative to that pollutant. The *2004 Integrated List of Waterbodies* was adopted by the Department on October 4, 2004 (36 NJR 4543(a)) as an amendment to the Statewide Water Quality Management Plan, as part of the Department's continuing planning process pursuant to the Water Quality Planning Act at N.J.S.A.58:11A-7 and the Statewide Water Quality Management Planning rules at N.J.A.C. 7:15-6.4(a).

The *2004 Integrated List of Waterbodies* identified the 17 impaired segments in the Passaic River basin identified in Table 1 as impaired for phosphorus based on in-stream concentrations of total phosphorus in excess of 0.1 mg/l. In addition, 9 stream segments, identified in Table 2, are identified on Sublist 3 as being in need of additional information in order to fully assess. Analysis of additional data compiled for this TMDL has determined that 2 of these segments are actually not impaired, 2 are confirmed impaired and 5 are still unconfirmed. The Wanaque Reservoir, although not listed as impaired, had been identified as a critical location that must be considered in the development of TMDLs for the impaired stream segments that are a source of phosphorus load to the reservoir. In the course of developing this TMDL, it has been determined that the reservoir is impaired, as indicated by phosphorus levels in excess of the standards. This report will establish one TMDL for the Wanaque Reservoir. TMDLs for the 19 in-stream impairments will be developed in the Phase 2 study.

Table 1: Phosphorus Impaired Stream Segments Located in the Passaic River Watershed

WMA	Site Id #	Station Name/Waterbody	2004 list status	Priority Ranking
03	01388910	Pompton River at Rt 202 in Wayne	Impaired	Medium
03	01388100	Ramapo River at Dawes Highway	Impaired	Medium
03	01387500	Ramapo River near Mahwah	Impaired	Medium
03	01387014	Wanaque River at Pompton Lakes	Impaired	Medium
03	01387000	Wanaque River at Wanaque	Impaired	High
04	01389880	Passaic River at Elmwood Park	Impaired	High
04	01389500	Passaic River at Little Falls (combined with Passaic River at Singac - 01389130)	Impaired	High
04	01389005	Passaic River Below Pompton River at Two Bridges	Impaired	High
06	01378855	Black Brook at Madison	Impaired	High
06	01379200	Dead River near Millington	Impaired	High
06	EWQ0231	Passaic River at Eagle Rock Ave in East Hanover	Impaired	High
06	01382000	Passaic River at Two Bridges	Impaired	High
06	01379500	Passaic River near Chatham	Impaired	High
06	1379000	Passaic River near Millington	Impaired	High
06	01381200	Rockaway River at Pine Brook	Impaired	High
06	1381500	Whippany River at Morristown	Impaired	High
06	01381800	Whippany River near Pine Brook	Impaired	Medium

Table 2: Stream Segments identified on Sublist 3 of the 2004 Integrated List of Waterbodies (not ranked)

WMA	Site Id #	Station Name/Waterbody	2004 list status	Recommended placement
03	01382800	Pequannock River at Riverdale*	Insufficient data (List 3)	Sublist 1
03	01388720	Pompton River Trib at Ryerson Rd**	Insufficient data (List 3)	Sublist 3 (No change)
04	01389138	Deepavaal Brook at Fairfield	Insufficient data (List 3)	Sublist 3 (No change)
04	01389860	Diamond Brook at Fair Lawn	Insufficient data (List 3)	Sublist 3 (No change)
04	01389600	Peckman River at West Paterson**	Insufficient data (List 3)	Sublist 5

04	01389080	Preakness Brook near Little Falls*	Insufficient data (List 3)	Sublist 1
06	01379530	Canoe Brook near Summit	Insufficient data (List 3)	Sublist 5
06	01379800	Green Pond Brook at Dover	Insufficient data (List 3)	Sublist 3 (No change)
06	01379853	Rockaway River at Blackwell St	Insufficient data (List 3)	Sublist 3 (No change)

* Additional water quality data has preliminarily indicated that these stream segments are not impaired for phosphorus, and therefore it is recommended that these segments be moved to Sublist 1.
** Additional water quality data has preliminarily indicated that these streams segments are impaired for phosphorus, and therefore it is recommended that these segments be moved to Sublist 5.

The LA-WATERS (Laterally Averaged - Wind and Temperature Enhanced Reservoir Simulation) model was used to link loading with concentration response in the development of the Wanaque Reservoir TMDL. This model includes a hydrothermal component and water quality modules, which were successfully calibrated to the Wanaque Reservoir using data collected as part of the Wanaque South water supply project (Najarian Associates, 1988), and then re-validated (Najarian Associates, 2000). This model was linked to an existing mass-balance model for the Passaic and Pompton Rivers, based on results of previous modeling studies of the Passaic River (NJDEP, 1987) and later water characterization studies (NJDWSC 2002a, 2002b, 2002c). The linked models were used to determine load reductions that would lead to attainment of the SWQS in the reservoir.

This TMDL Report is consistent with EPA's May 20, 2002 guidance document entitled, *Guidelines for Reviewing TMDLs under Existing Regulations Issued in 1992* (Sutfin, 2002), which describes the statutory and regulatory requirements for approvable TMDLs. This TMDL shall be proposed and, upon approval by EPA, adopted by the Department as an amendment to the Northeast Water Quality Management Plan (WQMP) in accordance with N.J.A.C. 7:15-3.4 (g).

2.0 Introduction

In accordance with Section 303(d) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of New Jersey is required biennially to prepare and submit to the USEPA a report that identifies waters that do not meet or are not expected to meet SWQS after implementation of technology-based effluent limitations or other required controls. This report is commonly referred to as the 303(d) List. In accordance with Section 305(b) of the CWA, the State of New Jersey is also required biennially to prepare and submit to the USEPA a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report. The *Integrated List of Waterbodies* combines these two assessments and assigns waterbodies to one of five sublists. Sublists 1 through 4 include waterbodies that are generally unimpaired (Sublist 1 and 2), have limited assessment or data

availability (Sublist 3), or are impaired due to pollution rather than pollutants or have had a TMDL or other enforceable management measure approved by EPA (Sublist 4). Sublist 5 constitutes the traditional 303(d) list for waters impaired or threatened by one or more pollutants, for which a TMDL may be required. For the non-tidal portion of the Passaic River basin, the *2004 Integrated List of Waterbodies* currently identifies 17 impaired segments and 9 segments that have limited assessment or data availability. Analysis of additional data used in this TMDL report has determined that 2 of these segments are actually not impaired, 2 are confirmed impaired and 5 remain as having insufficient data to determine the status. The Wanaque Reservoir, although not listed as impaired for phosphorus on the 2004 list, has been determined through this study to be impaired. Because the more stringent reservoir criterion for phosphorus could drive the load reductions required throughout the portion of the basin that contributes load to the reservoir, establishing the loading capacity for the reservoir was a necessary first step and is the subject of this TMDL study.

A TMDL represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint sources of pollutants of concern, natural background, and surface water withdrawals. A TMDL quantifies the amount of a pollutant a water body can assimilate without violating a state's water quality standards and allocates that load capacity to known point and nonpoint sources in the form of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, a margin of safety (MOS) and, as an option, a reserve capacity (RC).

Recent EPA guidance (Sutfin, 2002) describes the statutory and regulatory requirements for approvable TMDLs, as well as additional information generally needed for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations. The Department believes that the TMDLs in this report address the following items in the May 20, 2002 guideline document:

1. Identification of waterbody(ies), pollutant of concern, pollutant sources and priority ranking.
2. Description of applicable water quality standards and numeric water quality target(s).
3. Loading capacity – linking water quality and pollutant sources.
4. Load allocations.
5. Wasteload allocations.
6. Margin of safety.
7. Seasonal variation.
8. Reasonable assurances.
9. Monitoring plan to track TMDL effectiveness.
10. Implementation (USEPA is not required to and does not approve TMDL implementation plans).
11. Public Participation.

3.0 Pollutant of Concern and Area of Interest

Pollutant of Concern

The pollutant of concern for this TMDL is phosphorus. When present in excessive amounts, this nutrient can lead to excessive primary productivity, in the form of algal and/or macrophyte growth. The presence of excessive plant biomass can, in itself, interfere with designated uses, such as swimming or boating. In addition, the respiration cycle of excessive plant material can cause significant swings in pH and dissolved oxygen, which can result in violation of criteria for these parameters and can adversely affect the remainder of the aquatic community. Algal blooms can also affect taste and odor, an issue of importance with respect to drinking water, which is a significant use for the Wanaque Reservoir.

As stated in N.J.A.C. 7:9B-1.14(c) of the SWQS for Fresh Water 2 (FW2) waters:

> Phosphorus, Total (mg/l):
>
> i. Lakes: Phosphorus as total P shall not exceed 0.05 in any lake, pond, reservoir, or in a tributary at the point where it enters such bodies of water, except where site-specific criteria are developed pursuant to N.J.A.C. 7:9B-1.5(g)3.
>
> ii. Streams: Except as necessary to satisfy the more stringent criteria in paragraph i. above or where site-specific criteria are developed pursuant to N.J.A.C. 7:9B1.5(g)3, phosphorus as total P shall not exceed 0.1 in any stream, unless it can be demonstrated that total P is not a limiting nutrient and will not otherwise render the waters unsuitable for the designated uses.

Regarding site specific criteria, N.J.A.C. 7:9B-1.5(g)3 states:

> The Department may establish watershed or site-specific water quality criteria for nutrients in lakes, ponds, reservoirs or streams, in addition to or in place of the criteria in N.J.A.C. 7:9B-1.14, when necessary to protect existing or designated uses. Such criteria shall become part of these Water Quality Standards.

Elaborating on "…render waters unsuitable…" N.J.A.C. 7:9B-1.5(g)2 states:

> Except as due to natural conditions, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation, or otherwise render the waters unsuitable for the designated uses.

An alternative endpoint of meeting the criterion on a seasonal average basis was considered for the Wanaque Reservoir, because it is used as a water supply source and residence time in the reservoir can be short at times (less than a year). However, the Department has determined that the alternative endpoint could not be supported because it was not "… necessary to protect existing or designated uses." In fact, the alternative criterion was less protective than the existing criterion and would leave the reservoir in a near-eutrophic or eutrophic state, depending on the measure of eutrophic condition used as a reference point.

The waterbodies listed in Tables 1 and 2 have a FW2 classification. The designated uses, both existing and potential, that have been established by the Department for waters of the State classified as such are as stated below:

In all FW2 waters, the designated uses are (N.J.A.C. 7:9B-1.12):

1. Maintenance, migration and propagation of the natural and established aquatic biota;
2. Primary and secondary contact recreation;
3. Industrial and agricultural water supply;
4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and
5. Any other reasonable uses.

Area of Interest

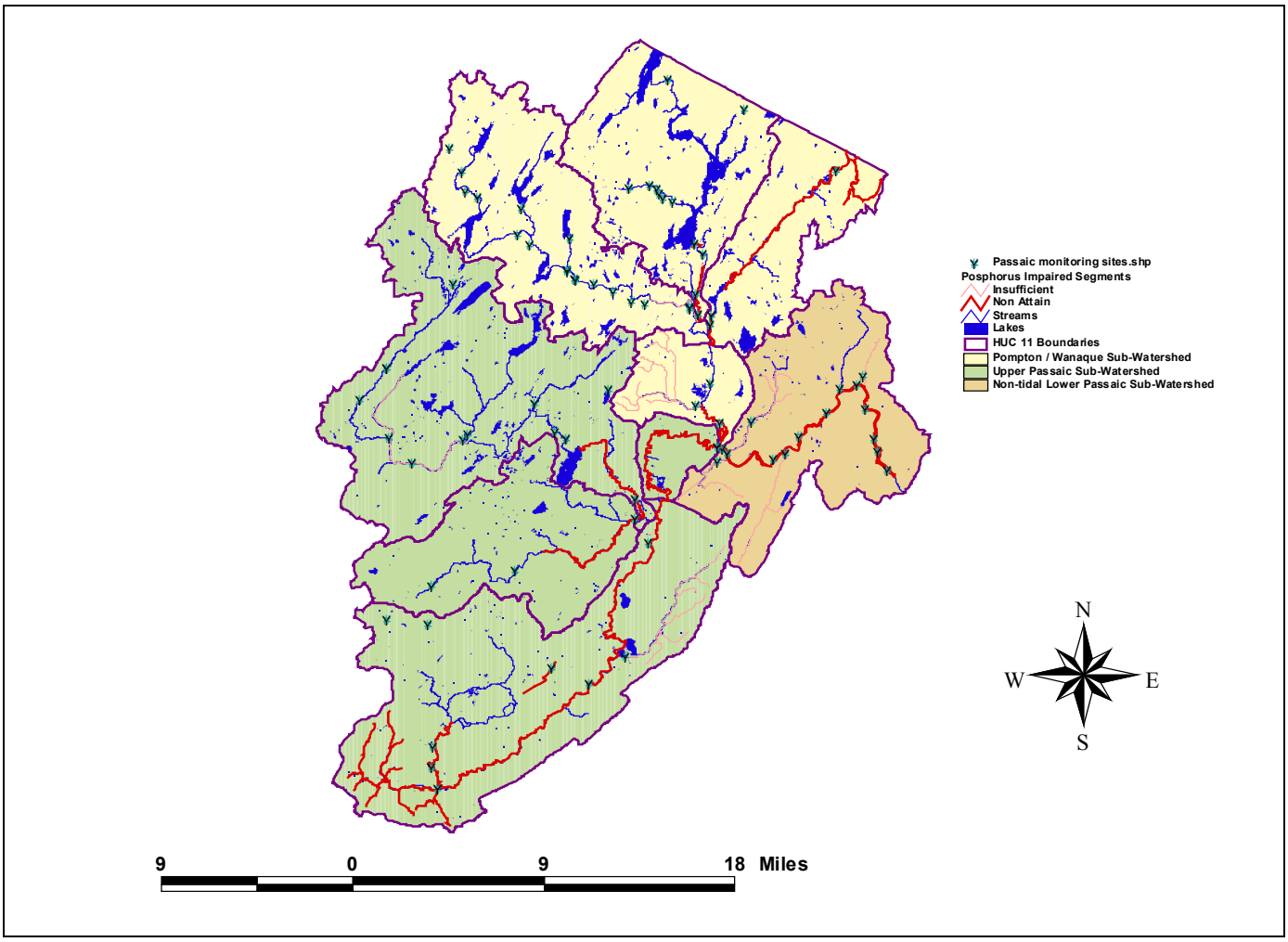
The spatial focus of the Phase 1 TMDL study is the Wanaque Reservoir and the watershed that contributes load to the reservoir, either via natural drainage or through diversion to the reservoir for water supply purposes. This spatial extent includes a number of impaired stream segments, for which the Wanaque Reservoir was determined to be a critical location. Therefore, the focus of the Phase 1 TMDL study is to determine the loading capacity of the reservoir and to allocate the loading capacity to the contributing sources, while reserving a portion for the MOS and RC. The impaired stream segments are within the spatial extent of this study, but the Phase 1 study will not determine compliance with the in-stream standard in the impaired stream segments. This will be accomplished in the Phase 2 TMDL study. It is possible that attaining the in-stream criterion, where it is determined to apply, may require an alternative allocation of loading capacity. It is also possible that, when considering fate and transport effects, a different distribution of the load allocation may be warranted. This will also be determined through the Phase 2 TMDL study. Upon completion of the Phase 2 TMDL study, the WLAs and LAs may be revised, subject to water quality trading, which is discussed further under allocation of loads.

Figure 1 depicts the spatial extent of the Sublist 5 and Sublist 3 stream segments, which are listed in Table 3. All of the Sublist 5 listed impairments have either a high or medium priority ranking, as described in the *2004 Integrated List of Waterbodies*. The Wanaque Reservoir and those stream segments that appear on Sublist 3 of the *2004 Integrated List of Waterbodies* were not assigned a priority ranking.

Table 3 Sublist 5 and Sublist 3 stream segments in non-tidal Passaic River basin

Site ID	Sub-list	Site Location and Waterbody/ General Description	Priority Ranking	Approx. River Miles
01388910	5	Pompton River at Rt 202 in Wayne	Medium	4.672
01388100	5	Ramapo River at Dawes Highway	Medium	1.883
01387500	5	Ramapo River near Mahwah	Medium	17.733
01387014	5	Wanaque River at Pompton Lakes	Medium	3.323
01387000	5	Wanaque River at Wanaque	Medium	0.553
01389880	5	Passaic River at Elmwood Park	High	13.725
01389500	5	Passaic River at Little Falls (combined with Passaic River at Singac - 01389130)	High	14.996
01389005	5	Passaic River Below Pompton River at Two Bridges	High	1.832
01378855	5	Black Brook at Madison	High	2.350
01379200	5	Dead River near Millington	High	21.855
EWQ0231	5	Passaic River at Eagle Rock Ave in East Hanover	High	10.330
01382000	5	Passaic River at Two Bridges	High	14.141
01379500	5	Passaic River near Chatham	High	14.900
01379000	5	Passaic River near Millington	High	5.165
01381200	5	Rockaway River at Pine Brook	High	6.773
01381500	5	Whippany River at Morristown	High	0.741
01381800	5	Whippany River near Pine Brook	Medium	6.606
01382800	3	Pequannock River at Riverdale	Not ranked	3.386
01388720	3	Pompton River Trib at Ryerson Rd	Not ranked	17.927
01389138	3	Deepavaal Brook at Fairfield	Not ranked	6.250
01389860	3	Diamond Brook at Fair Lawn	Not ranked	2.603
01389600	3	Peckman River at West Paterson	Not ranked	7.663
01389080	3	Preakness Brook near Little Falls	Not ranked	8.871
01379530	3	Canoe Brook near Summit	Not ranked	17.601
01379800	3	Green Pond Brook at Dover	Not ranked	4.484
01379853	3	Rockaway River at Blackwell St	Not ranked	6.083
			Total stream miles	216.446

Figure 1: Sublist 5 and Sublist 3 Phosphorus Impaired Stream Segments in the Non-Tidal Passaic River Basin



The non-tidal Passaic River Watershed contains approximately 1,308 total river miles, of which approximately 142 miles are impaired for phosphorus, and an additional 75 stream miles are listed on Sublist 3, for a total of 216.4 river miles. The Passaic River watershed includes all of Watershed Management Areas 3 and 6, and a portion of Watershed Management Area 4. The Watershed Management Area 4 component is below the confluence of the Pompton and Passaic Rivers and is outside the scope of the Phase 1 study, but will be addressed in the Phase 2 study. The Passaic River watershed is described below:

Watershed Management Area 3

Watershed Management Area 3 (WMA 3) includes watersheds that drain the Highlands portion of New Jersey. WMA 3 lies mostly in Passaic County but also includes parts of Bergen, Morris, and Sussex Counties and is comprised of 21 municipalities that lie entirely or partially within the watershed boundary. There are four sub-watersheds in WMA 3: Pompton, Ramapo, Pequannock and Wanaque River watersheds. The Pequannock, Wanaque and Ramapo Rivers all flow into the Pompton River. The

Pompton River is, in turn, a major tributary to the Upper Passaic River. WMA 3 contains some of the State's major water supply reservoir systems including the Wanaque Reservoir, the largest surface water reservoir in New Jersey.

The Pequannock River watershed is 30 miles long and has a drainage area of 90 square miles. The headwaters are in Sussex County and the Pequannock River flows east, delineating the Morris/Passaic County boundary line. The Pequannock River joins the Wanaque River and flows to the Pompton River in Wayne Township. Some of the major impoundments within this watershed are Kikeout Reservoir, Lake Kinnelon Reservoir, Clinton Reservoir, Canistear Reservoir, Oak Ridge Reservoir, and Echo Lake Reservoir. The great majority of the land within this watershed is forested and protected for water supply purposes and parklands.

The Ramapo River and Pompton River watersheds comprise a drainage area of about 160 square miles; 110 square miles of which are in New York State. The Ramapo River flows from New York into Bergen County and enters the Pequannock River to form the Pompton River in Wayne Township. The Ramapo River is 15 miles long on the New Jersey side. The Pompton River, a tributary to the Passaic River, is 7 miles long. Some of the major impoundments within this watershed include Point View Reservoir #1, Pompton Lakes, and Pines Lake. Over one-half of this watershed is undeveloped; however, new development is extensive in many areas.

The Wanaque River watershed has a total drainage area of 108 square miles. The headwaters of the river lie within New York State as a minor tributary to Greenwood Lake (located half in New Jersey and half in New York). The New Jersey portion lies in West Milford, Passaic County. The Wanaque River joins up with the Pequannock River in Riverdale Township. The Wanaque River is 27 miles in length. Some of the major impoundments and lakes with this watershed are the Wanaque Reservoir, Monksville Reservoir, Greenwood Lake, Arcadia Lake and Lake Inez. Most of the land in this watershed is undeveloped, consisting of vacant lands, reservoirs, parks and farms.

The supporting documentation for this TMDL, prepared by Najarian Associates, describes the Wanaque Reservoir system as follows:

> The Wanaque and Monksville Reservoirs are owned and operated by the North Jersey District Water Supply Commission (NJDWSC). These two "run-of-the-river" reservoirs comprise one of the largest water supply/storage systems in New Jersey. This system is the primary source of drinking water for much of Passaic, Essex, Bergen and Hudson Counties. Following the completion of the Wanaque South Project in the late 1980s, the long-term safe yield of this combined reservoir system was upgraded to 173 mgd. The system currently provides approximately 160 mgd of potable water supply to its customers (including other water companies).

Table 4: Description of Reservoirs

	Wanaque Reservoir	Monksville Reservoir
Water surface elevation	302.4 ft.	400.0 ft
Capacity of reservoir	29,630 mg	7,000 mg
Area of water surface	2,310 acres	505 acres
Width at widest point	1.2 mi	0.6
Length	6.6 mi	3.3 mi
Average width	0.5 mi	0.2 mi
Greatest depth	90 ft	100 ft
Average depth	37 ft	42 ft
Watershed area	90.1 mi^2	42.2 mi^2

To maintain this yield, the Wanaque Reservoir utilizes inflows from three separate sources: (1) its natural tributary system, which includes the Monksville Reservoir; (2) the Pompton Lakes intake, which is located on the Ramapo River; and (3) the Two Bridges intake, which is located on the Pompton River about 750 feet upstream from the confluence with the Passaic River. The NJDWSC has the capability of pumping up to 150 mgd from the Pompton Lakes intake, and up to 250 mgd from the Two Bridges intake. By design, when the diversion from the Two Bridges intake exceeds the available flow in the Pompton River, this intake has the ability to reverse flows in the lowermost reach of the Pompton River and tap the locally impounded waters of the Passaic River. Thus, the entire upper Passaic watershed (with a drainage area of 361 square miles) becomes a contributing source to the Reservoir. To maintain water quality in the downstream portions of the Passaic, Pompton and Ramapo Rivers, NJDEP has implemented several restrictions on intake usage, including: (a) no diversions during July and August unless there is a declared drought emergency; (b) no diversions from the Pompton Lakes intake when flows in the Ramapo River are below 40 mgd; and (c) no diversions when flows in the Passaic River at Little Falls are below 17.6 mgd. (modified from Najarian (2005)).

Watershed Management Area 4

Watershed Management Area 4 (WMA 4) includes the Lower Passaic River (from the Pompton River confluence downstream to the Newark Bay) and its tributaries, including the Saddle River. The Saddle River is located in the tidal portion of the Passaic River Watershed, and is outside of the scope of the non-tidal Passaic studies. The WMA 4 drainage area is approximately 180 square miles and lies within portions of Passaic, Essex, Hudson, Morris and Bergen Counties.

The Lower Passaic River watershed originates from the confluence of the Pompton River downstream to the Newark Bay. This 33-mile section meanders through Bergen, Hudson, Passaic, and Essex Counties and includes a number of falls, culminating with the Great Falls at Paterson.

Watershed Management Area 6

Watershed Management Area 6 (WMA 6) represents the area drained by waters from the upper reaches of the Passaic River Basin including the Passaic River from its headwaters in Morris County to the confluence of the Pompton River. Extensive suburban development and reliance upon ground water sources for water supply characterize WMA 6. WMA 6 lies in portions of Morris, Somerset, Sussex and Essex counties and includes the Upper & Middle Passaic River, Whippany River and Rockaway River watersheds.

The Upper Passaic River watershed is approximately 50 miles long and consists of a drainage area approximately 200 square miles in portions of Somerset, Morris, and Essex Counties. This section of the Passaic River is a significant source of drinking water for a much of northeastern New Jersey. Major tributaries to the Upper Passaic River include the Dead River, Rockaway River, Whippany River, and Black Brook. The Great Swamp National Wildlife Refuge is located within the Upper Passaic River watershed. Approximately one-half of this watershed is undeveloped or vacant, with the remainder primarily residential and commercial; however, this watershed is facing significant development in the vacant areas. This watershed is subject to frequent flooding.

The Middle Passaic River watershed includes Great Piece Meadows and Deepavaal Brook. The Great Piece Meadows is a freshwater wetland with a drainage area of approximately 12 square miles and is prone to flooding. Various owners privately own the Great Piece Meadows.

The Rockaway River watershed has a drainage area of approximately 133 square miles and is approximately 37 miles long. The Rockaway River flows east to its confluence with the Whippany River at Pine Brook. Major tributaries include Stone Brook, Mill Brook, Beaver Brook, and Den Brook. The land use patterns in this area are complex and include vacant areas, parklands, residential development and industrial/commercial uses.

The Whippany River watershed drains approximately 69 square miles and is located entirely within Morris County. The river is approximately 18 miles long and flows to the Passaic River. Two major tributaries are Black Brook and Troy Brook. The population is centered in Morristown, Parsippany-Troy Hills, Hanover Township and East Hanover Township.

Land Use

Land use in the Wanaque Reservoir contributory areas can be divided into the direct tributary area and the drainage areas of the Ramapo River, Pompton River and Passaic River upstream of the confluence with the Pompton River, which contribute flow to the reservoir through water supply diversions. The overall breakdown is provided in Tables 5 and 6 and Figure 2.

Table 5: Land Use Data for New Jersey Portion of Direct Drainage Area of Reservoir

Land Use Category	Total Acreage	Percent of Watershed*
Agriculture	104	0.2%
Barren	219	0.5%
Forest	28,749	68.1%
Urban	5,709	13.5%
Water	4,562	10.8%
Wetlands	2,850	6.8%

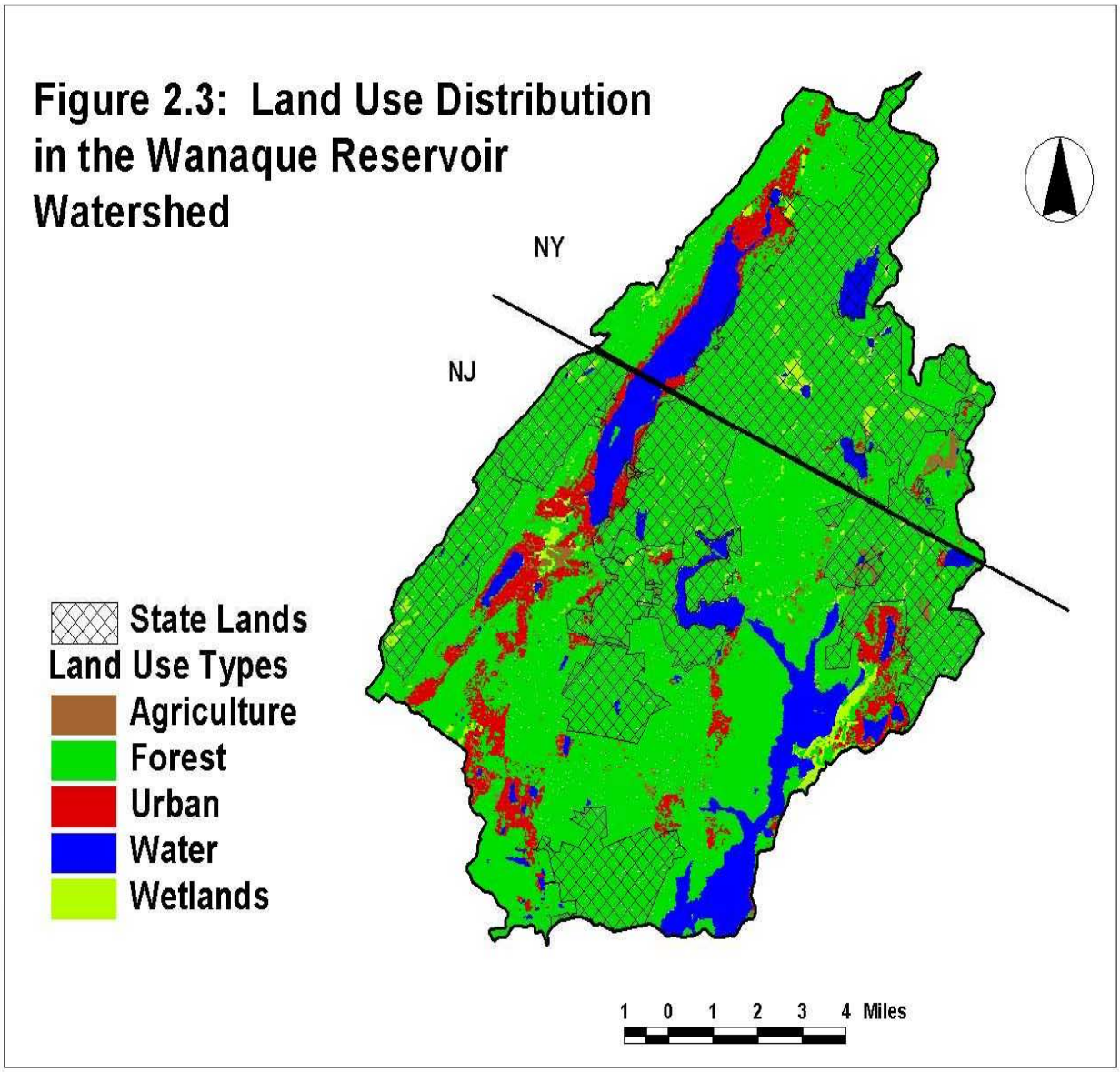
*based on NJDEP GIS data for 1995-1997 conditions (Najarian 2005)

Table 6: Land Use Data for Drainage Area of Reservoir Intake Sites

Characteristic	Ramapo River	Pompton River	Passaic River
Watershed Area	160 mi^2	372 mi^2	361 mi^2
Watershed in NJ	47 mi^2	238 mi^2	361 mi^2
Watershed in NY	113 mi^2	134 mi^2	-
Average Annual Flow	287 cfs	510 cfs	702 cfs
Percent Land use Coverage*			
Agriculture	0.6%	0.4%	2.1%
Barren	1.1%	0.6%	0.9%
Forest	47.9%	58.4%	33.6%
Urban	39.4%	24.3%	43.2%
Water	5.2%	6.7%	2.9%
Wetlands	5.9%	9.5%	17.3%
Impervious Cover	13%	7.7%	14.5%

* based on NJDEP GIS data for 1995-1997 conditions (Najarian 2005)

Figure 2: Land Use in Wanaque Reservoir Drainage Area (from Najarian 2005)



4.0 Source Assessment

Point Sources

For the purposes of TMDL development, point sources include domestic and industrial wastewater treatment plants that discharge to surface water, as well as stormwater discharges subject to regulation under the National Pollutant Discharge Elimination System (NPDES). This includes facilities with individual or general industrial stormwater permits and Tier A municipalities and state and county facilities regulated under the New Jersey Pollutant Discharge Elimination System (NJPDES) municipal

stormwater permitting program. Point sources contributing phosphorus loads within the affected drainage area are limited to stormwater point sources, including the Tier A municipalities listed in Appendix B. Stormwater point sources, like nonpoint sources, derive their pollutant load from runoff from land surfaces and load reduction is accomplished through BMPs. The distinction is that stormwater point sources are regulated under the Clean Water Act.

Table 7 identifies the point source dischargers, other than stormwater point sources, that are a significant source of phosphorus. These facilities will receive individual WLAs. The remaining point sources will be assigned a WLA that will be expressed as a percent reduction based on land use. Tier A municipalities in the spatial extent are identified in Appendix B.

Table 7: Significant Point Source Discharges of Phosphorus within the Spatial Extent of Phase 1 TMDL Study (from Najarian 2005)

Sub-Shed[1]	NJPDES #	Facility Name	Current Flow (mgd)[2]	Current Load (lbs/yr)[3]	Design Flow (mgd)
1	NJ0029858	OAKLAND CARE CENTER	0.0239	9.5	0.0300
1	NJ0053112	OAKLAND-CHAPEL HILL ESTATES STP	0.0069	0.5	0.0100
1	NJ0080811	RAMAPO RIVER CLUB STP	0.0696	14.2	0.1137
1	NJ0027774	OAKLAND-OAKWOOD KNOLLS WWTP	0.0177	2.4	0.0350
1	NJ0021253	RAMAPO-INDIAN HILLS H.S. WTP	0.0068	7.1	0.0336
1	NJ0021342	OAKLAND-SKYVIEW-HIGH BROOK STP	0.0130	2.3	0.0230
2	NJ0053759	WANAQUE VALLEY REG S.A.	0.9181	927.2	1.2500
2	NJ0029386	TWO BRIDGES SEWERAGE AUTHORITY	4.7503	51,868.8	10.0000
2	NJ0023698	POMPTON LAKES BOROUGH MUA	0.7377	655.3	1.2000
2	NJ0032395	RINGWOOD PLAZA STP	0.0066	7.4	0.0117
2	NJ0027006	RINGWOOD ACRES STP	0.0231	29.4	0.0360
2	NJ0026514	PLAINS PLAZA SHOPPING CENTER	0.0093	165.7	0.0200
3	NJ0022284	KINNELON TWP HIGH SCHOOL	0.0051	29.8	0.0300
3	NJ0024457	OUR LADY OF THE MAGNIFICAT	0.0009	0.7	0.0012
3	NJ0027685	WEST MILFORD MUA-HIGHVIEW ACRES STP	0.0534	84.5	0.2000
1	NJ0020281	CHATHAM HILL SEWAGE TREATMENT	0.0071	35.6	0.0300
1	NJ0020290	CHATHAM TWP MAIN STP	0.6596	1,203.1	1.0000
1	NJ0021083	VETERANS ADMIN MEDICAL CENTER-LYONS	0.0999	1,229.3	0.4000
1	NJ0021636	NEW PROVIDENCE WWTP	0.0275	167.4	1.5000
1	NJ0022489	WARREN TWP STAGE I-II STP	0.3344	3,009.9	0.4700
1	NJ0022497	WARREN TWP STAGE IV STP	0.3129	4,713.3	0.8000
1	NJ0022845	BERNARDS SA - HARRISON BROOK STP	1.7288	20,924.2	2.5000
1	NJ0024465	LONG HILL TWP-STIRLING HILLS STP	0.9091	8,551.6	0.9000
1	NJ0024929	MORRIS TWP - WOODLAND STP	1.2567	2,396.8	2.0000
1	NJ0027961	BERKELEY HTS WPCP	1.5494	18,522.0	3.1000
1	NJ0029912	NJDOT-HARDING REST AREA (Oct-April)	0.0014	5.7	0.0250
1	NJ0050369	WARREN TWP STAGE V STP	0.1377	1,542.2	0.3800
2	NJ0020427	CALDWELL BORO STP	3.3667	34,510.6	4.5000
2	NJ0024511	LIVINGSTON TWP STP	2.8492	29,565.1	4.6000
2	NJ0024937	MADISON-CHATHAM JT MTG - MOLITOR	2.2971	27,824.8	3.5000
2	NJ0025518	FLORHAM PARK S.A.	0.8793	6,088.5	1.4000
2	NJ0052256	CHATHAM TWP-CHATHAM GLEN STP	0.1214	1,280.0	0.1550
3	NJ0003476	EXXONMOBIL RESEARCH & ENGINEERING	0.0499	576.1	0.2900
3	NJ0024902	HANOVER SEWERAGE AUTHORITY	1.9508	22,570.1	4.6100
3	NJ0024911	MORRIS TWP - BUTTERWORTH STP	1.6506	8,668.8	3.3000
3	NJ0024970	PARSIPPANY TROY HILLS	12.5092	122,347.7	16.0000
3	NJ0025496	MORRISTOWN TOWN STP	2.9079	5,566.2	6.3000
3	NJ0026689	NJDHS-GREYSTONE PARK PSYCH HOSP	0.2153	156.7	0.4000
4	NJ0021091	JEFFERSON TWP HIGH-MIDDLE SCHOOL	0.0101	22.3	0.0275
4	NJ0022276	STONYBROOK SCHOOL	0.0011	3.6	0.0100
4	NJ0022349	ROCKAWAY VALLEY REG SA	9.3000	50,472.3	12.0000
4	NJ0026867	JEFFERSON TWP-WHITE ROCK STP	0.0978	39.2	0.1295

Nonpoint Sources

For the purposes of TMDL development, potential nonpoint sources include stormwater discharges that are not subject to regulation under NPDES, such as Tier B municipalities, which are regulated under the NJPDES municipal stormwater permitting program, and direct stormwater runoff from land surfaces, as well as malfunctioning sewage conveyance systems, failing or inappropriately located septic systems, and direct contributions from wildlife, livestock and pets. Tier B municipalities in the spatial extent are identified in Appendix B.

Nonpoint source contributions were quantified by separating stream flow into base flow and runoff. Baseflow was assigned a constant value of 0.01 mg/l TP, which was found to be representative of base flow from a relatively pristine location in the watershed. Runoff was assigned a concentration using the unit areal load (UAL) method. The areas of various land uses were calculated using GIS. A loading coefficient for each land use was then applied. A concentration was derived with the following equation using an iterative procedure:

$$\sum_{annual} L_{run} = \sum_{annual} C_{run} Q_{run} = C_{run} \sum_{annual} Q_{run} = \sum_{lulc} K_{ual} A_{lulc}$$

where L_{run} = stormwater runoff load; K_{ual} = land-use appropriate UAL coefficient (lbs/ac/yr); and A_{lulc} = total watershed area associated with a specific land use/land cover type (in acres). The middle term sums products of the runoff concentration (assumed constant) and the daily runoff flow over a one-year period. Results of this analysis are presented in Table 8.

Table 8: Watershed Land Use Areas (in acres) used in TMDL Calculations

Land Use Categories	UAL Coeff. (kg/hc/yr)	UAL Coeff. (lb/ac/yr)	Wanaque Reservoir[1]	Passaic above Canoe Bk.	Passaic above Rockaway	Rockaway River[2]	Whippany River	Passaic above Pompton[3]	Ramapo River[4]	Pompton River[5]
Low Intensity Residential	0.7	0.623	2,453	13,419	16,567	1,320	5,251	23,561	4,956	10,377
High Intensity Residential	1.6	1.424	2,341	8,101	16,267	2,420	9,637	29,446	3,328	13,476
Comm./Ind./Trans[6]	2/1.7/1	1.8/1.5/.9	1,072	5,741	6,407	739	5,449	13,282	1,789	5,100
Mixed Urban/Recreational	1.0	0.890	605	1,832	6,204	833	4,657	11,979	1,603	3,452
Crops/Pasture/Hay	1.5	1.335	587	4,218	4,375	134	565	5,150	143	732
Deciduous Forest	0.1	0.089	30,445	13,208	17,599	2,681	10,385	31,238	13,556	48,107
Evergreen Forest	0.1	0.089	3,067	161	254	33	52	339	70	2,940
Mixed Forest	0.1	0.089	7,477	253	355	22	130	644	492	3,400
Shrubland	0.1	0.089	440	2,433	2,752	165	1,240	4,310	404	1,214
Woody Wetlands	0.1	0.089	2,663	10,242	13,449	1,079	3,752	20,825	1,590	8,725
Herbaceous Wetlands	0.1	0.089	302	4,239	5,120	285	2,045	8,613	113	1,654
Open Water	0.1	0.089	6,059	539	1,199	245	803	2,561	1,551	5,346
Disturbed Areas	0.1	0.089	292	854	1,076	207	506	1,898	336	943
Total			57,805	65,240	91,624	10,163	44,472	153,846	29,931	105,466

(modified from Najarian 2005)

5.0 Analytical Approach and TMDL Calculation

The Wanaque Reservoir is not listed as an impaired waterbody on the *2004 Integrated List of Waterbodies* because data that would have established an impairment were not submitted for consideration in accordance with the *Integrated Water Quality Monitoring and Assessments Methods* document. However, in assessing the Passaic River watershed, which has 17 listed impaired stream segments, the Wanaque Reservoir was identified as a critical location, not just for the direct tributary watershed, but also for the Pompton River and Passaic River, above the confluence with the Pompton River, because of the diversions of these rivers to the reservoir for water supply purposes. Therefore, this Phase 1 TMDL was developed to establish the loading capacity of the reservoir and to allocate that loading capacity to the direct tributary watershed, as well as the watersheds that contribute phosphorus loads to the reservoir through water supply diversions. In the course of developing this TMDL, data evaluated indicate that the reservoir is impaired, as indicated by elevated concentrations of TP.

The following discussion of the modeling approach is a summary of more detailed discussion available in the supporting document for this TMDL prepared by Najarian Associates (Najarian 2005) under contract to the Department.

The LA-WATERS (Laterally Averaged - Wind and Temperature Enhanced Reservoir Simulation) model was used to link loading with concentration response in the development of the Wanaque Reservoir TMDL. LA-WATERS is a two-dimensional (longitudinal and vertical) hydrothermal/water quality model. It was successfully calibrated to the Wanaque Reservoir using data collected as part of the Wanaque South water supply project (Najarian Associates, 1988), and then re-validated (Najarian Associates, 2000). A detailed description of LA-WATERS is provided in Najarian (1988). A simulation of baseline (existing) conditions was conducted over the selected 10-year period (1993-2002) using water quality data obtained from NJDWSC, USGS and PVWC, flow data from USGS gaging stations, pumping data from NJDWSC and meteorological data from National Climatic Data Center's Newark International Airport weather station. In response to model inputs, LA-WATERS predicts laterally averaged velocities, water temperature and constituent concentrations at all grid locations for the period 1/1/1991-12/31/2002. Simulated constituents include organic phosphorus, dissolved inorganic phosphorus, particulate inorganic phosphorus, dissolved oxygen, carbonaceous biological oxygen demand, nitrogenous biological oxygen demand and temperature. The three phosphorus species were summed to yield corresponding TP concentrations. The model reasonably predicts TP and dissolved oxygen behavior, although TP simulations are generally slightly higher than observed concentrations. A summary of the hydrologic and loading budgets for the reservoir are provided in Table 8. The loading capacity associated with attainment of SWQS was determined to be 17,496 lbs/yr of TP.

Table 8: Reservoir Hydrologic and Phosphorus Loading Budget

Source	Percent of Hydrologic Budget	Percent of Phosphorus Loading Budget
Tributary Watershed	71%	28%
Ramapo River	7%	6%
Pompton River	16%	31%
Passaic River	6%	35%

LA-WATERS was linked to an existing mass-balance model for the Passaic and Pompton Rivers in order to assess the relationship of source loads to the loading capacity. This mass-balance model was based on results of previous modeling studies of the Passaic River (NJDEP, 1987) and later water characterization studies (NJDWSC 2003a, 2003b, 2003c). These studies support a modeling assumption that phosphorus is a conservative constituent and the dominant factor in determining in-stream concentrations of phosphorus in the Passaic system is the relative dilution, depending on available streamflow, of a significant and relatively constant wastewater discharge load. NPS loadings become noticeable only under high-flow conditions. Such a relationship would be an idealization since other processes (such as respiration, uptake, settling, etc.) do exist; however, these processes (and treatment plant variability) account for much less of the variation in observed concentrations.

An 11-year time series (from 1992 through 2002) of in-stream concentrations was generated using an input of observed USGS flow data, reported discharger monitoring data and GIS-based land-use statistics. As shown, the mass-balance model can simulate the overall magnitude, variability and trend of the observed data over the long-term (10-year) simulation period. This includes periods of relatively high streamflow – when PS loads may become less dominant over NPS loadings. The "fit" to the data is generally good despite the fact that that the model neglects many water quality processes. The result suggests that, within an effluent-dominated environment, in-stream processes can be of secondary (minor) importance for certain parameters. Deviations from the observed data are most marked during extreme low-flow periods – periods when discharge variability or in-stream processes would have the greatest impact on water quality. The fit of the model was checked statistically at several control points. Fit was best where larger data sets were available and where wastewater point sources were large relative to nonpoint sources. A summary of error statistics is provided in Table 9.

Table 9: Error Statistics for River Simulation Sites

Location	Absolute Mean Error Statistic (mg/l)	RMS Statistic (mg/l)	Relative Error Statistic (%)	Coefficient of Determination* r^2
Passaic River at Chatham	0.093	0.126	23	0.901
Rockaway River at Pine Brook	0.138	0.188	31	0.925
Whippany River at Pine Brook	0.093	0.113	34	0.631
Passaic River at Two Bridges	0.106	0.153	21	0.772
Ramapo River at Mahwah	0.050	0.070	27	0.876
Ramapo River at Pompton Lakes	0.032	0.042	43	0.244
Pompton River at Two Bridges	0.101	0.139	54	0.222
Passaic River at Little Falls	0.092	0.124	21	0.779

Certain premises were factored into this TMDL study, as follows. A TMDL has been established for Greenwood Lake (NJDEP 2004), which is within the drainage area for this TMDL study. Therefore, the loading output from the Greenwood Lake drainage area was based on attainment of the load reductions, including the WLAs and LAs, specified in that TMDL. The Ramapo River originates in New York and enters New Jersey with a significant phosphorus load; data indicate the concentration is in excess of the SWQS. As a boundary condition for this TMDL study, it was assumed that the water quality will attain New Jersey's SWQS at the border, assumed to be represented by the quality at the Ramapo at Mahwah monitoring station. As the Ramapo River currently enters New Jersey with phosphorus concentrations in excess of the standards, it will be necessary for New York to develop and implement a TMDL in order to realize this boundary condition.

Seasonal Variation, Critical Conditions, MOS and Reserve Capacity

A TMDL must account for critical conditions and seasonal variations. The summer season is the critical period for biological activity that uses phosphorus present and results in algal blooms or oxygen effects (excessive swings and/or dips below criterion). Yet winter and early spring are the times when, due to diversions from the Pompton and Passaic Rivers, phosphorus concentrations are usually highest. Critical conditions were addressed through inclusion of a 10 year modeling period that included an extreme period, 2002, during which diversions from the Pompton and Passaic were much greater than normal.

In the development of a TMDL, Section 303(d) of Clean Water Act requires specification of a Margin of Safety (MOS) – an unallocated portion of the assimilative capacity. MOS

is needed to account for a "lack of knowledge concerning the relationship between effluent limitations and water quality" (33 U.S.C. 1313(d)). In particular, a MOS accounts for uncertainties in the loading estimates, physical parameters and the linked models themselves – uncertainties that may influence simulated Reservoir TP concentrations. The MOS, as described in USEPA guidance (Sutfin, 2002), can be either explicit or implicit (i.e., addressed through conservative assumptions used in establishing the TMDL). An *explicit* MOS was used for this study. This explicit MOS was designed to account for potential errors in the simulated Reservoir TP concentrations due to uncertainties in the data and model algorithms.

Reserve capacity is an optional means of reserving a portion of the loading capacity to allow for future growth. Reserve capacity is addressed in this TMDL by calculating WLAs based on full permitted capacity for wastewater treatment facilities, assuming a pumping regime for the Wanaque Reservoir that assumes full utilization of the allocated capacity and by reserving an explicit portion of the loading capacity. As described in greater detail in the support document (Najarian, 2005), an explicit MOS of 6% and an explicit reserve capacity of 1% are included.

Allocation of Loading Capacity

WLAs are established for all point sources, while LAs are established for nonpoint sources, as these terms are defined in "Source Assessment."

For the Wanaque Reservoir, the total assimilative capacity for TP loading is 17,496 lbs/yr. This corresponds to a 68% overall loading reduction from the existing load of 57,574 lbs/yr. Load allocations for river diversions total 6,483 lbs/yr (622 lbs/yr from Ramapo River, 2,717 lbs/yr from Pompton River and 3,144 lbs/yr from Passaic River). Collectively, the load allocations for river diversions represent an average reduction of about 83% for significant point sources, other than stormwater point sources, based on a long term average effluent concentration of 0.20 mg/l. For stormwater point sources and nonpoint sources, an 80% load reduction was allocated, either as a WLA or LA, depending on land use in accordance with Table 10, as explained below. The MOS and explicit reserve capacity for the Wanaque Reservoir are specified as 1,049 lbs/yr (6%) and 171 lbs/yr (1%), respectively. A cumulative summary of loads for each intake site (that would be compatible with the Reservoir TMDL) is presented within Tables 11 to 18 (all modified from Najarian 2005), along with the reduction specified for land uses, either a WLA or LA per Table 10. The point source allocation for significant point source discharges, other than stormwater point sources, is distributed as WLAs in Tables 19 and 20.

Stormwater discharges can be a point source or a nonpoint source, depending on NPDES regulatory jurisdiction, yet the suite of measures to achieve reduction of loads from stormwater discharges is the same, regardless of this distinction. Stormwater

point sources receiving a WLA are distinguished from stormwater generating areas receiving a LA on the basis of land use. This distribution of loading capacity between WLAs and LAs is consistent with recent EPA guidance that clarifies existing regulatory requirements for establishing WLAs for stormwater discharges (Wayland, November 2002). Stormwater discharges are captured within the runoff sources quantified according to land use, as described previously. Distinguishing between regulated and unregulated stormwater is necessary in order to express WLAs and LAs numerically; however, "EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability within the system" (Wayland, November 2002, p.1). Therefore allocations are established according to source categories as shown in Table 10. This demarcation between WLAs and LAs based on land use source categories is not perfect, but it represents the best estimate defined as narrowly as data allow. The Department acknowledges that there may be stormwater sources in the residential, commercial, industrial and mixed urban runoff source categories that are not NJPDES-regulated. Nothing in these TMDLs shall be construed to require the Department to regulate a stormwater source under NJPDES that would not already be regulated as such, nor shall anything in these TMDLs be construed to prevent the Department from regulating a stormwater source under NJPDES.

Table 10 Distribution of WLAs and LAs among source categories

Source category	**TMDL allocation**
Nonpoint and Stormwater Sources	
medium / high density residential	WLA
low density / rural residential	WLA
commercial	WLA
industrial	WLA
Mixed urban / other urban	WLA
agricultural	LA
forest, wetland, water	LA
barren land	LA

Loads from some land uses, specifically forest, wetland, water and barren land are not adjustable. There are no measures that can reasonably be applied to runoff from these sources to reduce the loads generate. As a result, existing loads from these sources are equal to the future loads. Therefore, in order to achieve the overall load reduction required from land uses, the load reduction from land uses for which reduction measures can reasonably be applied must be increased proportionally.

Table 11: TMDL calculations for Wanaque Reservoir
(average annual loads based on 1993-2002 model simulation)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of LC	lbs TP/yr	% of LC	Reduction[2]
Loading Capacity (LC)	54,574	100%	17,496	100%	68%
Point Sources other than Stormwater					
NJPDES Dischargers[3,4]	257	0.5%	157	0.9%	39%
Loading from Intake Diversions					
Diversions from Ramapo River[5]	2,240	4.1%	622	3.6%	72%
Diversions from Pompton River[6]	13,449	24.6%	2,717	15.5%	80%
Diversions from Passaic River[7]	24,165	44.3%	3,144	18.0%	87%
Internal Loading					
Sediment/Base Flow	2,525	4.6%	2,525	14.4%	0%
Land Use Surface Runoff[8]					
Low Intensity Residential	1,529	2.8%	520	3.0%	66%[9]
High Intensity Residential	3,333	6.1%	1,133	6.5%	66%[9]
Commercial/Industrial/Transportation	1,465	2.7%	498	2.8%	66%[9]
Mixed Urban/Recreational	538	1.0%	183	1.0%	66%[9]
Crops/Pasture/Hay	447	0.8%	152	0.9%	66%[9]
Deciduous Forest	2,714	5.0%	2,714	15.5%	0%
Evergreen Forest	273	0.5%	273	1.6%	0%
Mixed Forest	665	1.2%	665	3.8%	0%
Shrubland	39	0.1%	39	0.2%	0%
Woody Wetlands	237	0.4%	237	1.4%	0%
Herbaceous Wetlands	27	0.0%	27	0.2%	0%
Open Water	539	1.0%	539	3.1%	0%
Disturbed Areas	130	0.2%	130	0.7%	0%
Other Allocations					
Margin of Safety	n/a	n/a	1,049	6.0%	n/a
Reserve Capacity	n/a	n/a	171	1.0%	n/a

1 average annual loads based on 1993-2002 model simulation
2 = 1 - (TMDL load /Existing load)*100
3 facilities within Reservoir tributary watershed -- existing condition based on 1997-2000 DMR data
4 WLA derived from NJDEP TMDL study for Greenwood Lake (2004)
5 diversion load typically equals about 3%-5% of the annual river load
6 diversion load typically equals about 7%-9% of the annual river load
7 diversion load typically equals about 3%-5% of the annual river load
8 see Table 8 for associated land use areas
9 percent reduction equals 43% for Greenwood Lake watershed and 80% for other tributary watersheds

Table 12: TMDL calculations for Ramapo River Watershed (at Pompton Lakes) (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	43,925	100%	13,780	100%	69%
Point Sources other than Stormwater NJPDES Dischargers[3]	37	0.1%	149	1.1%	0%
Internal Loading Sediment/Base Flow	1,634	3.7%	1,634	11.9%	0%
Boundary Inputs New York[4]	28,320	64.5%	6,851	49.7%	76%
Land Use Surface Runoff[5]					
Low Intensity Residential	3,087	7.0%	617	4.5%	80%
High Intensity Residential	4,739	10.8%	948	6.9%	80%
Commercial/Industrial/Transportation	2,758	6.3%	552	4.0%	80%
Mixed Urban/Recreational	1,426	3.2%	285	2.1%	80%
Crops/Pasture/Hay	191	0.4%	38	0.3%	80%
Deciduous Forest	1,206	2.7%	1,206	8.8%	0%
Evergreen Forest	6	0.0%	6	0.0%	0%
Mixed Forest	44	0.1%	44	0.3%	0%
Shrubland	36	0.1%	36	0.3%	0%
Woody Wetlands	138	0.3%	138	1.0%	0%
Herbaceous Wetlands	10	0.0%	10	0.1%	0%
Open Water	142	0.3%	142	1.0%	0%
Disturbed Areas	150	0.3%	150	1.1%	0%
Other Allocations					
Margin of Safety	n/a	n/a	832	6.0%	n/a
Reserve Capacity	n/a	n/a	141	1.0%	n/a

1 average annual loads based on 1993-2002 model simulation

2 = 1 - (TMDL load /Existing load)*100

3 detailed listing of individual discharge facilities is provided with Table 19-20

4 includes PS and NPS discharges to Ramapo River within New York State

Table 13: TMDL calculations for Pompton River Watershed (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	133,838	100%	36,894	100%	72%
Point Sources other than Stormwater					
NJPDES Dischargers[3]	53,348	39.9%	7,915	21.5%	85%
Internal Loading					
Sediment/Base Flow	3,929	2.9%	3,929	10.6%	0%
Boundary Inputs					
Wanaque Reservoir	4,143	3.1%	1,357	3.7%	55%
New York[4]	28,320	21.2%	6,851	18.6%	76%
Land Use Surface Runoff[5]					
Low Intensity Residential	6,465	4.8%	1,293	3.5%	80%
High Intensity Residential	19,190	14.3%	3,838	10.4%	80%
Commercial/Industrial/Transportation	7,625	5.7%	1,525	4.1%	80%
Mixed Urban/Recreational	3,072	2.3%	614	1.7%	80%
Crops/Pasture/Hay	976	0.7%	195	0.5%	80%
Deciduous Forest	4,308	3.2%	4,308	11.7%	0%
Evergreen Forest	261	0.2%	261	0.7%	0%
Mixed Forest	303	0.2%	303	0.8%	0%
Shrubland	78	0.1%	78	0.2%	0%
Woody Wetlands	777	0.6%	777	2.1%	0%
Herbaceous Wetlands	147	0.1%	147	0.4%	0%
Open Water	476	0.4%	476	1.3%	0%
Disturbed Areas	420	0.3%	420	1.1%	0%
Other Allocations					
Margin of Safety	n/a	n/a	2,229	6.0%	n/a
Reserve Capacity	n/a	n/a	377	1.0%	n/a

1 average annual loads based on 1993-2002 model simulation[2]
2 = 1 - (TMDL load /Existing load)*100
3 detailed listing of individual discharge facilities is provided with Table 19-20
4 includes PS and NPS discharges to Ramapo River within New York State
5 see Table 8 for associated land use areas

Table 14: TMDL calculations for Passaic River Watershed (above Pompton confluence) (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	479,918	100%	85,887	100%	82%
Point Sources other than Stormwater NJPDES Dischargers[3]	367,672	76.6%	42,838	49.9%	86%
Internal Loading Sediment/Base Flow	5,074	1.1%	5,074	5.9%	0%
Boundary Inputs Boonton Reservoir[4]	6,151	1.3%	6,151	7.2%	0%
Land Use Surface Runoff[5]					
Low Intensity Residential	14,682	3.1%	2,936	3.4%	80%
High Intensity Residential	41,931	8.7%	8,386	9.8%	80%
Commercial/Industrial/Transportation	19,930	4.2%	3,986	4.6%	80%
Mixed Urban/Recreational	10,661	2.2%	2,132	2.5%	80%
Crops/Pasture/Hay	6,875	1.4%	1,375	1.6%	80%
Deciduous Forest	2,780	0.6%	2,780	3.2%	0%
Evergreen Forest	30	0.0%	30	0.0%	0%
Mixed Forest	57	0.0%	57	0.1%	0%
Shrubland	384	0.1%	384	0.4%	0%
Woody Wetlands	1,853	0.4%	1,853	2.2%	0%
Herbaceous Wetlands	766	0.2%	766	0.9%	0%
Open Water	228	0.0%	228	0.3%	0%
Disturbed Areas	844	0.2%	844	1.0%	0%
Other Allocations					
Margin of Safety	n/a	n/a	5,188	6.0%	n/a
Reserve Capacity	n/a	n/a	878	1.0%	n/a

1 average annual loads based on 1993-2002 model
2 = 1 - (TMDL load /Existing load)*100
3 detailed listing of individual discharge facilities is provided with Table 19-20
4 = observed flow * mean reported concentration
5 see Table 8 for associated land use areas

Table 15: TMDL calculations for Whippany River Watershed (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	192,291	100%	30,469	100%	84%
Point Sources other than Stormwater NJPDES Dischargers[3]	158,597	82.5%	18,824	61.8%	88%
Internal Loading					
Sediment/Base Flow	1,579	0.8%	1,579	5.2%	0%
Land Use Surface Runoff[4]					
Low Intensity Residential	3,272	1.7%	654	2.1%	80%
High Intensity Residential	13,723	7.1%	2,745	9.0%	80%
Commercial/Industrial/Transportation	8,358	4.3%	1,672	5.5%	80%
Mixed Urban/Recreational	4,145	2.2%	829	2.7%	80%
Crops/Pasture/Hay	754	0.4%	151	0.5%	80%
Deciduous Forest	924	0.5%	924	3.0%	0%
Evergreen Forest	5	0.0%	5	0.0%	0%
Mixed Forest	12	0.0%	12	0.0%	0%
Shrubland	110	0.1%	110	0.4%	0%
Woody Wetlands	334	0.2%	334	1.1%	0%
Herbaceous Wetlands	182	0.1%	182	0.6%	0%
Open Water	71	0.0%	71	0.2%	0%
Disturbed Areas	225	0.1%	225	0.7%	0%
Other Allocations					
Margin of Safety	n/a	n/a	1,841	6.0%	n/a
Reserve Capacity	n/a	n/a	311	1.0%	n/a

1 average annual loads based on 1993-2002 model simulation
2 = 1 - (TMDL load /Existing load)*100
3 detailed listing of individual discharge facilities is provided with Table 19-20
4 see Table 8 for associated land use areas

Table 16: TMDL calculations for Rockaway River Watershed (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	63,695	100%	16,842	100%	74%
Point Sources other than Stormwater NJPDES Dischargers[3]	50,447	79.2%	7,413	44.0%	85%
Internal Loading					
Sediment/Base Flow	342	0.5%	342	2.0%	0%
Boundary Inputs					
Boonton Reservoir[4]	6,151	9.7%	6,151	36.5%	0%
Land Use Surface Runoff[5]					
Low Intensity Residential	822	1.3%	164	1.0%	80%
High Intensity Residential	3,446	5.4%	689	4.1%	80%
Commercial/Industrial/Transportation	1,073	1.7%	215	1.3%	80%
Mixed Urban/Recreational	741	1.2%	148	0.9%	80%
Crops/Pasture/Hay	179	0.3%	36	0.2%	80%
Deciduous Forest	239	0.4%	239	1.4%	0%
Evergreen Forest	3	0.0%	3	0.0%	0%
Mixed Forest	2	0.0%	2	0.0%	0%
Shrubland	15	0.0%	15	0.1%	0%
Woody Wetlands	96	0.2%	96	0.6%	0%
Herbaceous Wetlands	25	0.0%	25	0.1%	0%
Open Water	22	0.0%	22	0.1%	0%
Disturbed Areas	92	0.1%	92	0.5%	0%
Other Allocations					
Margin of Safety	n/a	n/a	1,017	6.0%	n/a
Reserve Capacity	n/a	n/a	172	1.0%	n/a

1 average annual loads based on 1993-2002 model simulation
2 = 1 - (TMDL load /Existing load)*100
3 detailed listing of individual discharge facilities is provided with Table 19-20
4 = observed flow * mean reported concentration
5 see Table 8 for associated land use areas

Table 17: TMDL calculations for Upper Passaic Watershed (above Rockaway confluence) (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	219,005	100%	36,737	100%	83%
Point Sources other than Stormwater					
NJPDES Dischargers[3]	157,981	72.1%	16,601	45.2%	83%
Internal Loading					
Sediment/Base Flow	2,566	1.2%	2,566	7.0%	0%
Land Use Surface Runoff[4]					
Low Intensity Residential	10,321	4.7%	2,064	5.6%	80%
High Intensity Residential	23,164	10.6%	4,633	12.6%	80%
Commercial/Industrial/Transportation	9,505	4.3%	1,901	5.2%	80%
Mixed Urban/Recreational	5,522	2.5%	1,104	3.0%	80%
Crops/Pasture/Hay	5,841	2.7%	1,168	3.2%	80%
Deciduous Forest	1,566	0.7%	1,566	4.3%	0%
Evergreen Forest	23	0.0%	23	0.1%	0%
Mixed Forest	32	0.0%	32	0.1%	0%
Shrubland	245	0.1%	245	0.7%	0%
Woody Wetlands	1,197	0.5%	1,197	3.3%	0%
Herbaceous Wetlands	456	0.2%	456	1.2%	0%
Open Water	107	0.0%	107	0.3%	0%
Disturbed Areas	479	0.2%	479	1.3%	0%
Other Allocations					
Margin of Safety	n/a	n/a	2,219	6.0%	n/a
Reserve Capacity	n/a	n/a	376	1.0%	n/a

1 average annual loads based on 1993-2002 model simulation
2 = 1 - (TMDL load /Existing load)*100
3 detailed listing of individual discharge facilities is provided with Table 19-20
4 see Table 8 for associated land use areas

Table 18: TMDL calculations for Upper Passaic Watershed (above Canoe Brook confluence) (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	99,845	100%	22,685	100%	77%
Point Sources other than Stormwater NJPDES Dischargers[3]	59,288	59.4%	7,981	35.2%	87%
Internal Loading					
Sediment/Base Flow	1,944	1.9%	1,944	8.6%	0%
Land Use Surface Runoff[4]					
Low Intensity Residential	8,360	8.4%	1,672	7.4%	80%
High Intensity Residential	11,536	11.6%	2,307	10.2%	80%
Commercial/Industrial/Transportation	7,162	7.2%	1,432	6.3%	80%
Mixed Urban/Recreational	1,630	1.6%	326	1.4%	80%
Crops/Pasture/Hay	5,631	5.6%	1,126	5.0%	80%
Deciduous Forest	2,323	2.3%	2,323	10.2%	0%
Evergreen Forest	14	0.0%	14	0.1%	0%
Mixed Forest	23	0.0%	23	0.1%	0%
Shrubland	217	0.2%	217	1.0%	0%
Woody Wetlands	912	0.9%	912	4.0%	0%
Herbaceous Wetlands	377	0.4%	377	1.7%	0%
Open Water	48	0.0%	48	0.2%	0%
Disturbed Areas	380	0.4%	380	1.7%	0%
Other Allocations					
Margin of Safety	n/a	n/a	1,370	6.0%	n/a
Reserve Capacity	n/a	n/a	232	1.0%	n/a

[1] average annual loads based on 1993-2002 model simulation

[2] = 1 - (TMDL load /Existing load)*100

[3] detailed listing of individual discharge facilities is provided with Table 19-20

[4] see Table 8 for associated land use areas

Table 19: Wasteload Allocations

Sub-Shed[1]	NJPDES #	Facility Name	Current Flow (mgd)[2]	Current Load (lbs/yr)[3]	Permitted Flow (mgd)	WLA (lbs/yr)[4]	Load % Reduction*
1	NJ0029858	OAKLAND CARE CENTER	0.0239	9.5	0.0300	18.3	*
1	NJ0053112	OAKLAND-CHAPEL HILL ESTATES STP	0.0069	0.5	0.0100	6.1	*
1	NJ0080811	RAMAPO RIVER CLUB STP	0.0696	14.2	0.1137	69.2	*
1	NJ0027774	OAKLAND-OAKWOOD KNOLLS WWTP	0.0177	2.4	0.0350	21.3	*
1	NJ0021253	RAMAPO-INDIAN HILLS H.S. WTP	0.0068	7.1	0.0336	20.5	*
1	NJ0021342	OAKLAND-SKYVIEW-HIGH BROOK STP	0.0130	2.3	0.0230	14.0	*
2	NJ0053759	WANAQUE VALLEY REG S.A.	0.9181	927.2	1.2500	761.0	18%
2	NJ0029386	TWO BRIDGES SEWERAGE AUTHORITY	4.7503	51,868.8	10.0000	6,088.2	88%
2	NJ0023698	POMPTON LAKES BOROUGH MUA	0.7377	655.3	1.2000	730.6	*
2	NJ0032395	RINGWOOD PLAZA STP	0.0066	7.4	0.0117	7.1	4%
2	NJ0027006	RINGWOOD ACRES STP	0.0231	29.4	0.0360	21.9	25%
2	NJ0026514	PLAINS PLAZA SHOPPING CENTER	0.0093	165.7	0.0200	12.2	93%
3	NJ0022284	KINNELON TWP HIGH SCHOOL	0.0051	29.8	0.0300	18.3	39%
3	NJ0024457	OUR LADY OF THE MAGNIFICAT	0.0009	0.7	0.0012	0.7	*
3	NJ0027685	WEST MILFORD MUA-HIGHVIEW ACRES STP	0.0534	84.5	0.2000	121.8	*
	TOTAL		6.6423	53,805	12.9942	7,911	85%

From Najarian 2005

Table 20: Wasteload Allocations

Sub-Shed[1]	NJPDES #	Facility Name	Current Flow (mgd)[2]	Current Load (lbs/yr)[3]	Permitted Flow (mgd)	WLA (lbs/yr)[4]	Load % Reduction*
1	NJ0020281	CHATHAM HILL SEWAGE TREATMENT	0.0071	35.6	0.0300	18	49%
1	NJ0020290	CHATHAM TWP MAIN STP	0.6596	1,203.1	1.0000	609	49%
1	NJ0021083	VETERANS ADMIN MEDICAL CENTER-LYONS	0.0999	1,229.3	0.4000	244	80%
1	NJ0021636	NEW PROVIDENCE WWTP	0.0275	167.4	1.5000	913	*
1	NJ0022489	WARREN TWP STAGE I-II STP	0.3344	3,009.9	0.4700	286	90%
1	NJ0022497	WARREN TWP STAGE IV STP	0.3129	4,713.3	0.8000	487	90%
1	NJ0022845	BERNARDS SA - HARRISON BROOK STP	1.7288	20,924.2	2.5000	1,522	93%
1	NJ0024465	LONG HILL TWP-STIRLING HILLS STP	0.9091	8,551.6	0.9000	548	94%
1	NJ0024929	MORRIS TWP - WOODLAND STP	1.2567	2,396.8	2.0000	1,218	49%
1	NJ0027961	BERKELEY HTS WPCP	1.5494	18,522.0	3.1000	1,887	90%
1	NJ0029912	NJDOT-HARDING REST AREA (Oct-April)	0.0014	5.7	0.0250	15	*
1	NJ0050369	WARREN TWP STAGE V STP	0.1377	1,542.2	0.3800	231	85%
2	NJ0020427	CALDWELL BORO STP	3.3667	34,510.6	4.5000	2,740	92%
2	NJ0024511	LIVINGSTON TWP STP	2.8492	29,565.1	4.6000	2,801	91%
2	NJ0024937	MADISON-CHATHAM JT MTG - MOLITOR	2.2971	27,824.8	3.5000	2,131	92%
2	NJ0025518	FLORHAM PARK S.A.	0.8793	6,088.5	1.4000	852	86%
2	NJ0052256	CHATHAM TWP-CHATHAM GLEN STP	0.1214	1,280.0	0.1550	94	93%
3	NJ0003476	EXXONMOBIL RESEARCH & ENGINEERING	0.0499	576.1	0.2900	177	69%
3	NJ0024902	HANOVER SEWERAGE AUTHORITY	1.9508	22,570.1	4.6100	2,807	88%
3	NJ0024911	MORRIS TWP - BUTTERWORTH STP	1.6506	8,668.8	3.3000	2,009	77%
3	NJ0024970	PARSIPPANY TROY HILLS	12.5092	122,347.7	16.0000	9,741	92%
3	NJ0025496	MORRISTOWN TOWN STP	2.9079	5,566.2	6.3000	3,836	31%
3	NJ0026689	NJDHS-GREYSTONE PARK PSYCH HOSP	0.2153	156.7	0.4000	244	*
4	NJ0021091	JEFFERSON TWP HIGH-MIDDLE SCHOOL	0.0101	22.3	0.0275	17	25%
4	NJ0022276	STONYBROOK SCHOOL	0.0011	3.6	0.0100	6	*
4	NJ0022349	ROCKAWAY VALLEY REG SA	9.3000	50,472.3	12.0000	7,306	86%
4	NJ0026867	JEFFERSON TWP-WHITE ROCK STP	0.0978	39.2	0.1295	79	*
	TOTAL		45.231	371,993.1	70.327	42,816	88%

From Najarian 2005

The assignment of WLAs to point sources, other than stormwater point sources, is based on each source discharging at the permitted capacity at the same long term average effluent concentration. On balance, reductions in point and nonpoint sources must achieve the overall load reduction needed to attain SWQS in the Wanaque Reservoir. Therefore, effluent limits in NJPDES permits would be expressed in terms of monthly average loads, not concentrations. As a result of the Phase 2 study, effluent limits may need to be expressed as load and/or concentration and may be redistributed in consideration of the dynamic processes at work in the river system. Dischargers will also be allowed to engage in water quality trading negotiations to effect a change in effluent limits, with Department approval. It should be noted that, in June 2005 EPA awarded a grant in the amount of $900,000 to Rutgers for the purpose of developing a water quality trading pilot with respect to the phosphorus impairment in the Passaic River watershed. This project will investigate the options for and overall viability of a trading approach in the Passaic River watershed. For example, it may be more cost effective for a few larger facilities to upgrade to a higher level than for all treatment facilities to upgrade to the same level. It may also be possible for wastewater treatment plant reductions to be traded for a greater reduction from regulated municipal stormwater sources. Another option in this watershed is to trade wastewater treatment plant upgrades for treatment of river water by NJDWSC prior to diversion to the reservoir. Any viable trading option would have to ensure that EPA and DEP requirements for trading be met, including ensuring that SWQS are maintained in all locations and there is full and enforceable accountability for required load reductions. A trading project must identify the fungible unit of trade and associated value to ensure a level playing field among potential traders. The relative in-stream effectiveness of load reductions with respect to attaining SWQS must also be established, as well as a means to ensure the goals of the project are being achieved.

6.0 Follow-up Monitoring

The Water Resources Division of the U.S. Geological Survey and the Department have cooperatively operated the Ambient Stream Monitoring Network (ASMN) in New Jersey since the 1970s. The ASMN currently includes approximately 115 stations that are routinely monitored on a quarterly basis. A second ambient monitoring network, DEP's Supplemental Ambient Surface Water Network (100 stations), has improved spatial coverage for water quality monitoring in New Jersey. The data from this these networks have been used to assess the quality of freshwater streams and percent load reductions. The ambient networks, as well as targeted studies, will be the means to determine the effectiveness of TMDL implementation and the need for additional management strategies.

7.0 Implementation Plan

Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint and stormwater sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint and stormwater source pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA, 1993).

The Department recognizes that TMDLs alone are not sufficient to restore impaired stream segments. The TMDL establishes the required pollutant reduction targets while the implementation plan identifies some of the regulatory and non-regulatory tools to achieve the reductions, matches management measures with sources, and suggests responsible entities for non-regulatory tools. This provides a basis for aligning available resources to assist with implementation activities. Projects proposed by the State, local government units and other stakeholders that would implement the measures identified within the impaired watershed are a priority for available State (for example, CBT) and federal (for example, 319(h)) funds. In addition, the Department's ongoing watershed management initiative will develop detailed watershed restoration plans for impaired stream segments in a priority order that will identify more specific measures to achieve the identified load reductions.

In these impaired watersheds wetlands and forest represent a significant portion of the land use. As discussed under source assessment, loads from these land uses are not adjustable. Urban and agricultural land use sources must be the focus for implementation. Urban land use will be addressed primarily by stormwater regulation. Agricultural land uses will be addressed by implementation of conservation management practices tailored to each farm. Other measures are discussed further below.

Stormwater measures

The stormwater facilities subject to regulation under NPDES in this watershed must be assigned WLAs. The WLAs for these point sources are expressed in terms of the required percent reduction for nonpoint sources and are applied to the land use categories that correspond to the areas regulated under industrial and municipal stormwater programs. The BMPs required through stormwater permits, including the additional measure discussed below, are generally expected to achieve the required load reductions. The success of these measures will be assessed through follow up monitoring. As needed through adaptive management, other additional measures may need to be identified and included in stormwater permits. Follow up monitoring or watershed restoration plans may determine that other additional measures are required, which would then be incorporated into municipal stormwater permits.

Additional measures that may be considered include, for example, more frequent street sweeping and inlet cleaning, or retrofit of stormwater management facilities to include nutrient removal. .A more detailed discussion of stormwater source control measures follows.

On February 2, 2004 the Department promulgated two sets of stormwater rules: The Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Rules, N.J.A.C. 7:14A and the Stormwater Management Rules, N.J.A.C. 7:8

The Phase II NJPDES rules for the Municipal Stormwater Regulation Program require municipalities, highway agencies, and regulated "public complexes" to develop stormwater management programs consistent with the NJPDES permit requirements. The stormwater discharged through "municipal separate storm sewer systems" (MS4s) is regulated under the Department's Phase II NJPDES Stormwater Rules. Under these rules and associated general permits, Tier A municipalities are required to implement various control measures that should substantially reduce phosphorus loadings in the impaired watersheds. These control measures include adoption and enforcement of a pet waste disposal ordinance, prohibiting the feeding of unconfined wildlife on public property, cleaning catch basins, performing good housekeeping at maintenance yards, and providing related public education and employee training. These basic requirements will provide for a measure of load reduction from existing development.

All municipalities within the contributory drainage area of the Wanaque Reservoir will be required to adopt an ordinance as an additional measure that prohibits the outdoor application of fertilizer other than low phosphorus fertilizer, consistent with a model ordinance provided by the Department. Fertilizer does not include animal or vegetable manure or compost. This model ordinance has been posted on www.njstormwater.org. The additional measure is as follows:

Low Phosphorus Fertilizer Ordinance

Minimum Standard – Municipalities listed in Appendix B shall adopt and enforce an ordinance, consistent with a model ordinance provided by the Department, to prohibit the outdoor application of fertilizer other than low phosphorus fertilizer, except:

Any application of fertilizer at a commercial farm that is exempted by the Right to Farm Act, N.J.S.A. 4:1C-1 et seq.

Any application of fertilizer needed for establishing new vegetation after land disturbance in accordance with the requirements established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq. and implementing rules.

Measurable Goal - Municipalities listed in Appendix B shall certify annually that they have met the Low Phosphorus Fertilizer Ordinance minimum standard.

Implementation - Within 6 months from adoption of the TMDL, municipalities listed in Appendix B shall have fully implemented the Low Phosphorus Fertilizer Ordinance minimum standard.

The Stormwater Management Rules have been updated for the first time since their original adoption in 1983. These rules establish statewide minimum standards for stormwater management in new development, and the ability to analyze and establish region-specific performance standards targeted to the impairments and other stormwater runoff related issues within a particular drainage basin through regional stormwater management plans. The Stormwater Management Rules are currently implemented through the Residential Site Improvement Standards (RSIS) and the Department's Land Use Regulation Program (LURP) in the review of permits such as freshwater wetlands, stream encroachment, CAFRA, and Waterfront Development.

The Stormwater Management Rules focus on the prevention and minimization of stormwater runoff and pollutants in the management of stormwater. The rules require every project to evaluate methods to prevent pollutants from becoming available to stormwater runoff and to design the project to minimize runoff impacts from new development through better site design, also known as low impact development. Some of the issues that are required to be assessed for the site are the maintenance of existing vegetation, minimizing and disconnecting impervious surfaces, and pollution prevention techniques. In addition, performance standards are established to address existing groundwater that contributes to baseflow and aquifers, to prevent increases to flooding and erosion, and to provide water quality treatment through stormwater management measures for TSS and nutrients.

As part of the requirements under the municipal stormwater permitting program, municipalities are required to adopt and implement municipal stormwater management plans and stormwater control ordinances consistent with the requirements of the stormwater management rules. As such, in addition to changes in the design of projects regulated through the RSIS and LURP, municipalities will also be updating their regulatory requirements to provide the additional protections in the Stormwater Management Rules within approximately two years of the issuance of the NJPDES General Permit Authorization.

Furthermore, the New Jersey Stormwater Management Rules establish a 300-foot special water resource protection area (SWRPA) around Category One (C1) waterbodies and their intermittent and perennial tributaries, within the HUC 14 subwatershed. In the SWRPA, new development is typically limited to existing disturbed areas to maintain the integrity of the C1 waterbody. C1 waters receive the highest form of water

quality protection in the state, which prohibits any measurable deterioration in the existing water quality. Definitions for surface water classifications, detailed segment description, and designated uses may be found in various amendments to the Surface Water Quality Standards at www.state.nj.us/dep/wmm/sgwqt/sgwqt.html.

C1 designations within the pertinent portion of the Passaic River watershed are depicted on Figure 3.

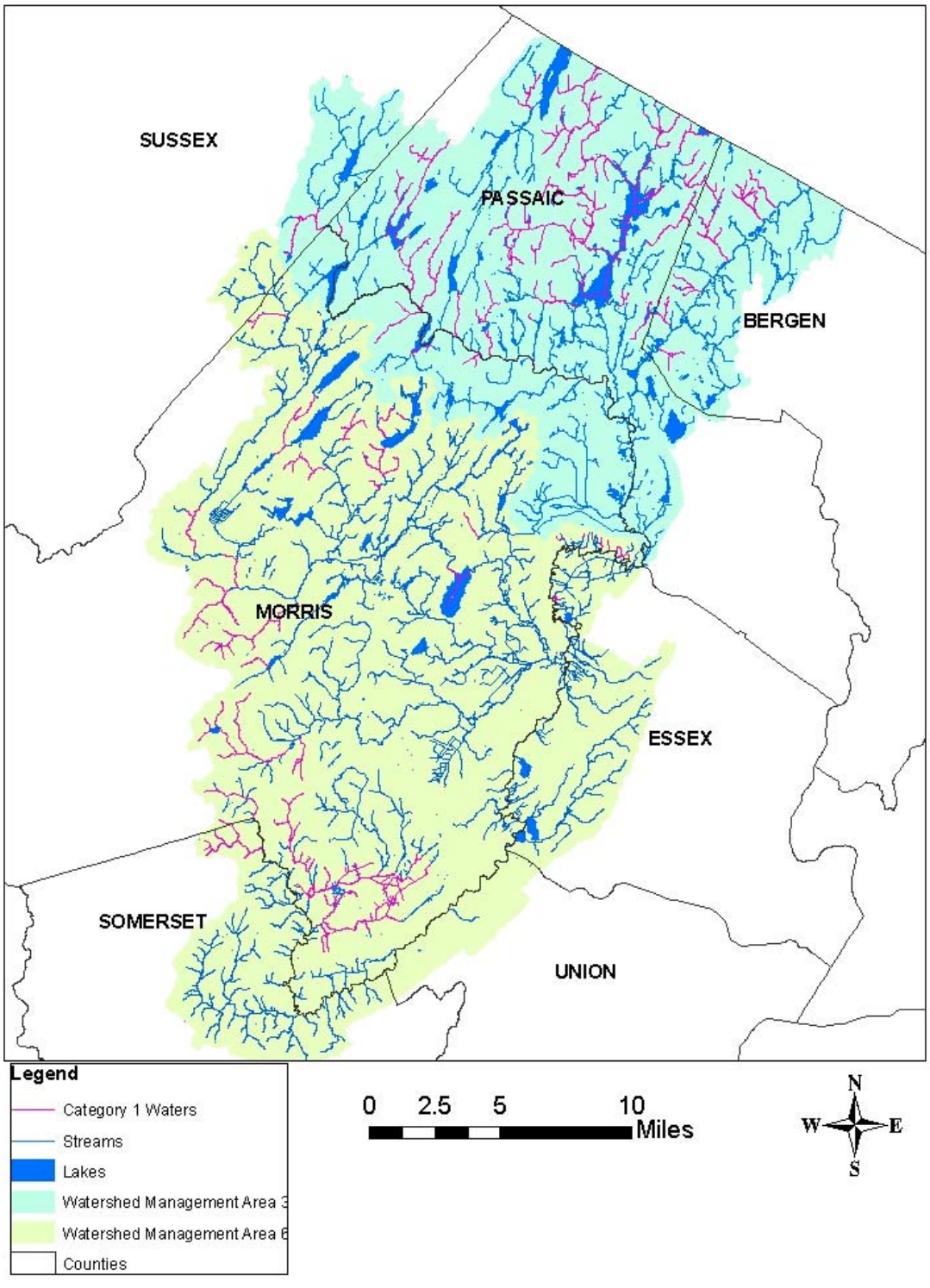


Figure 3: C1 waterways in WMAs 3 and 6

Agricultural and other measures

Generic management strategies for nonpoint source categories, beyond those that will be implemented under the Phase II stormwater management program, and responses are summarized below.

Table 21 Nonpoint source management measures

Source Category	Responses	Potential Responsible Entity	Possible Funding options
Human Sources	Septic system management programs	Municipalities, residents, watershed stewards, property owner	319(h), State sources
Non-Human Sources	Goose management programs, riparian buffer restoration	Municipalities, residents, watershed stewards, property owner	319(h), State sources
Agricultural practices	Develop and implement conservation plans or resource management plans	Property owner	EQIP, CRP, CREP

Human and Non-Human measures

Where septic system service areas are located in close proximity to impaired waterbodies, septic surveys should be undertaken to determine if there are improper effluent disposal practices that need to be corrected. Septic system management programs should be implemented in municipalities with septic system service areas to ensure proper design, installation and maintenance of septic systems. Where resident goose populations are excessive, community based goose management programs should be supported. Through stewardship programs, areas such as commercial/corporate lawns should be converted to alternative landscaping that minimizes goose habitat and areas requiring intensive landscape maintenance. Where existing developed areas have encroached on riparian buffers, riparian buffer restoration projects should be undertaken where feasible.

Agricultural measures

Several programs are available to assist farmers in the development and implementation of conservation management plans and resource management plans. The Natural Resource Conservation Service is the primary source of assistance for landowners in the development of resource management pertaining to soil

conservation, water quality improvement, wildlife habitat enhancement, and irrigation water management. The USDA Farm Services Agency performs most of the funding assistance. All agricultural technical assistance is coordinated through the locally led Soil Conservation Districts. The funding programs include:

The Environmental Quality Incentive Program (EQIP*)* is designed to provide technical, financial, and educational assistance to farmers/producers for conservation practices that address natural resource concerns, such as water quality. Practices under this program include integrated crop management, grazing land management, well sealing, erosion control systems, agri-chemical handling facilities, vegetative filter strips/riparian buffers, animal waste management facilities and irrigation systems.

The Conservation Reserve Program (CRP) is designed to provide technical and financial assistance to farmers/producers to address the agricultural impacts on water quality and to maintain and improve wildlife habitat. CRP practices include the establishment of filter strips, riparian buffers and permanent wildlife habitats. This program provides the basis for the Conservation Reserve Enhancement Program (CREP).

Conservation Reserve Enhancement Program (CREP) The New Jersey Departments of Environmental Protection and Agriculture, in partnership with the Farm Service Agency and Natural Resources Conservation Service, signed a $100 million CREP agreement earlier this year. This program matches $23 million of State money with $77 million from the Commodity Credit Corp. within USDA. Through CREP, financial incentives are offered for agricultural landowners to voluntarily implement conservation practices on agricultural lands. NJ CREP will be part of the USDA's Conservation Reserve Program (CRP). There will be a ten-year enrollment period, with CREP leases ranging between 10-15 years. The State intends to augment this program to make these leases permanent easements. The enrollment of farmland into CREP in New Jersey is expected to improve stream health through the installation of water quality conservation practices on New Jersey farmland.

Current Implementation Projects

The following projects are either ongoing or are anticipated to be implemented in the TMDL study area. These projects were funded using 319(h) grants and are expected to have an immediate and positive effect on water quality.

1. Rockaway River: Installation of constructed wetland to treat stormwater from 6-acre drainage area prior to discharge into the Rockaway River. (Work ongoing)

2. Whippany River: Development of ordinances and zoning policies to reduce NPS pollution in municipalities of the Whippany River watershed. (Work completed)
3. Posts Brook: Development of a regional stormwater management plan. (Work ongoing)
4. Visual Assessment of Streams in WMA 3 and ranking for stream restoration; Restoration of Sheffield Brook in Wayne nearing completion. (Work ongoing)
5. Ramapo Reservation Lake: Installation of 1000 feet of riparian buffer restoration. (Completed)
6. Greenwood Lake: Identify stormwater problem areas and implement retrofits to reduce NPS load, as funds permit. (Work ongoing)
7. Belchers Creek: Installation of cross-sectional catch basins to reduce NPS pollutants to Pinecliff Lake. (Work completed)
8. Goffle Brook: Riparian buffer restoration to address a large resident goose population in the Passaic County park system. (Work ongoing)
9. Verona Park Lake: Installation of 10-foot wide vegetated buffer on lake shoreline to address large resident goose population. (Work completed)
10. Bee Meadow Pond: Development of goose management plan with streambank restoration with pre and post monitoring. (Post monitoring is ongoing)
11. East Lake and Bryant's Stream: Riparian restoration on Whippany tributaries. (Work completed)
12. Troy Brook: Development of regional stormwater management plan. Characterization and assessment portion has been completed. (Work ongoing)
13. Speedwell Lake: Riparian restoration to address erosion, stormwater and geese. (Work completed)
14. Whippany River: Retrofit an existing stormwater detention basin to reduce NPS load, plant approximately 20,000 square feet of detention basin with native vegetation. (Work ongoing)

Priority Stream Segment Initiative

In addition to the generic and specific, current and future implementation measures identified above, the Department, through its watershed management program, is undertaking the development of watershed restoration plans for priority stream segments. These restoration plans will identify specific measures and the means to accomplish them, beyond those identified in this TMDL report, that will assist in attainment of the required load reductions. Due to the number of TMDLs recently generated, the Department must prioritize which stream segments will be the focus of initial consideration. The Department's nutrient policy states that, "Except as due to natural conditions, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation, abnormal diurnal fluctuations in dissolved oxygen or pH, changes to the composition of aquatic ecosystems, or otherwise render the water unsuitable for the designated uses (N.J.A.C. 7:9B-1.5(g)3)." With respect to nutrient TMDLs, the initial priority will be given to those streams where

use impairments exist in the impaired stream or downstream lakes, beyond simple exceedance of the water quality criterion. Other priority considerations include:

- Headwater area;
- Proximity to drinking water supply;
- Proximity to recreation area;
- Possibility of adverse human health conditions;
- Proximity to a lake intake;
- Existence of eutrophication;
- Phosphorus is identified as the limiting nutrient;
- Existence of use impairments;
- Ability to create a measurable change;
- Probability of human source;
- Stream Classifications;
- High success level.

8.0 Reasonable Assurance

Commitment to carry out the activities described in the implementation plan to reduce phosphorus loads provides reasonable assurance that the SWQS will be attained for phosphorus in the Wanaque Reservoir. Follow up monitoring will identify if the strategies implemented are completely, or only partially successful. It will then be determined if other management measures can be implemented to fully attain the SWQS or if it is necessary to consider other approaches, such as use attainability.

9.0 Public Participation

In accordance with the Water Quality Management Planning Rules each TMDL shall be proposed by the Department as an amendment to the appropriate areawide water quality management plan(s) in accordance with N.J.A.C. 7:15-3.4(g). N.J.A.C. 7:15-3.4(g)5 states that when the Department proposes to amend an areawide water quality plan on its own initiative, the Department shall give public notice by publication in a newspaper of general circulation in the planning area, shall send copies of the public notice to the applicable designated planning agency, if any, and may hold a public hearing or request written statements of consent as if the Department were an applicant.

The Department has maintained a long term commitment to the stakeholder process and public participation in the development of this Phase 1 TMDL for the Wanaque Reservoir. The Phase 1 TMDL was developed with assistance and direct input from stakeholders in Watershed Management Areas 3, 4 and 6.

The stakeholder process in the Passaic River Basin has been continuous for over eleven years. The resulting collaborative restoration process arose out of a 1993 pilot watershed initiative in the Whippany River Watershed (1993 – 2000) and litigation over permit requirements. The Department's early meetings with dischargers in 1996 in response to a settlement agreement over proposed phosphorus permit limits coupled with the Whippany River Watershed Pilot project evolved into a comprehensive watershed management process. This model for watershed management was later refined and replicated throughout the state in twenty watershed management areas (WMAs).

The Department initiated a pilot watershed project in 1993 in the Whippany River Watershed to aid the Department in developing a comprehensive watershed process that could be replicated throughout the state. The 70 square mile Whippany River Watershed lies in the heart of the larger Passaic River Basin and was instrumental in pulling stakeholders with varied interests and backgrounds together to discuss and address issues germane to the Watershed. Stakeholders include: active watershed groups, academics, business, industry, consultants, interested public, purveyors as well as dischargers. The watershed management process has afforded New Jersey a unique opportunity to openly discuss and vet projects that need to be undertaken to ensure New Jersey achieves its statewide "clean and plentiful" water goal.

The Public Advisory Group (PAG), Technical Advisory Committee (TAC) and several subcommittees met for 6 years in an effort to achieve the goal to restore and preserve the value of the Whippany River as a vital natural resource. A main reason that the Whippany River Watershed was selected as the state's pilot watershed project was because of the number of dischargers located in the watershed. The Department recognized the unique opportunity that presented itself by having dischargers, purveyors, environmental interest groups, local and state governments come together to vet and resolve issues unique to a specific geographic location. In addition to a replicable format for watershed management, one of several significant outcomes of the pilot watershed process included: the *Report on the Establishment of a Total Maximum Daily Load for Fecal Coliform for the Whippany River Watershed* adopted in the year 2000 and its companion document *A Cleaner Whippany River Watershed NPS Pollution Control Guidance Manual for Municipal Officials, Engineers and Department of Public Works, May 2000*. A workshop was held to acquaint municipalities with the best management practices recommended by the Technical Advisory Committee's NPS Workgroup.

During this time, the Department had also been meeting with the dischargers and purveyors in the Passaic River Basin on a regular basis through The Passaic River Task Group (1996 – 1998). The first priority of the Group was common concerns on phosphorus and eutrophication. Originally, the Whippany TMDL was proposed in 1999 to address both fecal coliform and phosphorus. Subsequently, only the fecal TMDL was adopted, since it was determined that the Whippany River was in compliance with

the Surface Water Quality Standards for total phosphorus. The Department did not wish to pursue delisting because the Whippany River is a tributary to the Passaic River Basin wherein total phosphorus was known to contribute to impairment of designated uses.

The Group met through 1998, at which time the Department decided to incrementally pursue the implementation of a statewide watershed process based on the foundation of dividing the state into 20 watershed management areas. Consequently, a Public Advisory Committee (PAC) and TAC were initiated for WMA 6. After the completion of the Whippany Fecal TMDL the NJDEP led Whippany River Watershed PAG and its TAC evolved into the WMA 6 PAC and TAC respectively which, met regularly from 1998-2003. The WMA 6 TAC assumed the mandate to discuss water quality related issues such as TMDL requirements.

In the Fall of 2000, the NJDEP awarded two years worth of grant funding to 16 lead entities to serve as an extension of the Department to facilitate the watershed process for all 20 watershed management areas throughout the state. Deliverables from this statewide process varied; but resulted in the creation of PACs and TACs for WMAs 3 and 4; development of an extensive watershed characterization and assessment for WMAs 3, 4, and 6; creation of water resource based open space plans; and the implementation of numerous streambank restoration projects. Also, in 2000 the Department recognized that in order to successfully develop and prepare a comprehensive Passaic River Basin TMDL document, a separate committee led by the Department should be created to focus only on nutrient impairments in the Basin. The result was the Passaic TMDL Workgroup, which continued to meet monthly through 2003.

In 2004, monitoring and initial modeling results from the TMDL work conducted by Quantitative Environmental Analysis, LLC (QEA); Najarian Associates and TRC Omni, acting under contract to the Department, were shared and made available to the Passaic River Basin stakeholders through several informal informational sessions. On March 23, 2004, QEA presented their findings from the Ramapo River and Pompton Lakes Study to the WMA 3 PAC. Data exchange meetings based on the information collected by TRC Omni were held on April 15, 2004, April 27, 2004, and September 28, 2004 and all stakeholders were invited to attend. Copies of presentations and data sets were posted on the consultant's web page at www.trcomni.com under Resources. On November 18, 2004, Najarian Associates presented preliminary findings on the Wanaque TMDL to the Passaic River Basin stakeholders. The Department held a meeting on June 23, 2005 with the affected dischargers in the Basin to present the findings from the work completed by Najarian Associates for the Wanaque Reservoir and that portion of the Basin above the confluence of the Pompton and Passaic Rivers.

Additional input was received through Rutgers New Jersey EcoComplex (NJEC). The Department contracted with the NJEC in August 2001. The NJEC consists of a ten member review panel of New Jersey university professors whose role is to provide comments on the Department's technical approaches for the development of TMDLs and other management strategies.

Notice proposing this TMDL was published July 5, 2005 in the New Jersey Register and in a newspaper of general circulation in the affected area in order to provide the public an opportunity to review the TMDL and submit comments. In addition, a public hearing will be held on August 4, 2005 at the Cultural Center at Lewis Morris County Park, 300 Mendham Road, Morristown, NJ 07962-1295. Notice of the proposal and hearing was provided to affected municipalities, dischargers, and purveyors in the watershed.

All comments received during the public notice period and at the public hearing will become part of the record for this TMDL and will be considered in the Department's decision to establish this TMDL through submittal to EPA Region 2. Once approved by EPA, this TMDL will be adopted as an amendment to the Northeast WQMP.

Appendix A References

Najarian Associates, Inc. (1988), Influence of Wanaque South Diversion on the Trophic Level of Wanaque Reservoir and its Water Quality Management Program by Poshu Huang, Tavit O. Najarian and Vajira Gunawardana, prepared for the North Jersey District Water Supply Commission and Hackensack Water Company.

Najarian Associates (2000), "Water Quality Assessment of the Upper Passaic River Watershed and the Wanaque Reservoir," prepared for New Jersey Department of Environmental Protection, Watershed Management – Northeast Bureau.

Najarian Associates, Inc. (2005) Development of a TMDL for the Wanaque Reservoir and Cumulative WLAs/LAs for the Passaic River Watershed

New Jersey Department of Environmental Protection, Integrated Water Quality Monitoring and Assessments Methods, November 2003

New Jersey Department of Environmental Protection, New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d)

NJDEP (1987) "Passaic River – Water Quality Management Study." New Jersey Department of Environmental Protection Special Report, by Jenq, T., Litwack, H. S., Hundal, H., and Hsueh, S.F. (1987). New Jersey Department of Environmental Protection, Trenton NJ.

NJDEP (2004). "Amendment to the Northeast Water Quality Management Plan - Total Maximum Daily Loads for Phosphorus To Address Greenwood Lake in the Northeast Water Region."

North Jersey District Water Supply Commission (NJDWSC), 2003a, "Watershed Characterization and Assessment – Passaic River Basin, WMA3."

North Jersey District Water Supply Commission (NJDWSC), 2003b, "Watershed Characterization and Assessment – Passaic River Basin, WMA4."

North Jersey District Water Supply Commission (NJDWSC), 2003c, "Watershed Characterization and Assessment – Passaic River Basin, WMA6."

Sutfin, C.H. May 2002. Memo: EPA Review of 2002 Section 303(d) Lists and Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992. Office of Wetlands, Oceans and Watersheds, U.S. EPA.

USEPA. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. EPA-840-B-92-002. Washington, DC.

Wayland, R.H. III. November 22, 2002. Memo: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs. Office of Wetlands, Oceans and Watersheds, U.S.E.P.A.

Appendix B Municipalities Located in The Passaic River Basin and their MS4 Designation

Municipality	County	WMA(s)	Tier A or B
Franklin Lakes Boro	Bergen	3,4	A
Mahwah Twp	Bergen	3,4	A
Ramsey Boro	Bergen	3,4	A
Oakland Boro	Bergen	3	A
Butler Boro	Morris	3	A
Jefferson Twp	Morris	3,6	A
Kinnelon Boro	Morris	3,6	A
Lincoln Park Boro	Morris	3	A
Montville Twp	Morris	3,6	A
Pequannock Twp	Morris	3	A
Riverdale Boro	Morris	3	A
Rockaway Twp	Morris	3,6	A
Bloomingdale Boro	Passaic	3	A
North Haledon Boro	Passaic	3, 4	A
Pompton Lakes Boro	Passaic	3	A
Ringwood Boro	Passaic	3	A
Wanaque Boro	Passaic	3	A

Wayne Twp	Passaic	3, 4	A
West Milford Twp	Passaic	3	A
Hardyston Twp	Sussex	3	B
Sparta	Sussex	3	A
Vernon Twp	Sussex	3	B
Caldwell Boro	Essex	4, 6	A
Cedar Grove Twp	Essex	4, 6	A
Essex Fells Boro	Essex	4,6	A
Fairfield Boro	Essex	4, 6	A
Livingston Twp	Essex	6	A
Millburn Twp	Essex	6	A
North Caldwell Boro	Essex	4, 6	A
Roseland Boro	Essex	6	A
Verona Boro	Essex	4, 6	A
West Caldwell Boro	Essex	4, 6	A
West Orange Town	Essex	4, 6	A
Boonton Town	Morris	6	A
Boonton Twp	Morris	6	A
Chatham Boro	Morris	6	A
Chatham Twp	Morris	6	A
Denville Twp	Morris	6	A
Dover Town	Morris	6	A
East Hanover Twp	Morris	6	A
Florham Park Boro	Morris	6	A
Hanover Twp	Morris	6	A
Harding Twp	Morris	6	B
Lincoln Park Boro	Morris	4, 6	A
Long Hill	Morris	6	A
Madison Boro	Morris	6	A
Mendham Boro	Morris	6	A
Mendham Twp	Morris	6	A
Mine Hill Twp	Morris	6	A
Morris Twp	Morris	6	A
Morris Plains Boro	Morris	6	A
Morristown Town	Morris	6	A
Mount Arlington Boro	Morris	6	A
Mountain Lakes Boro	Morris	6	A
Parsippany-Troy Hills Twp	Morris	6	A
Randolph Twp	Morris	6	A
Rockaway Boro	Morris	6	A
Roxbury Twp	Morris	6	A
Victory Gardens Boro	Morris	6	A
Wharton Boro	Morris	6	A
Bernards Twp	Somerset	6	A
Bernardsville Boro	Somerset	6	A
Bridgewater Twp	Somerset	6	A
Far Hills Boro	Somerset	6	B
Warren Twp	Somerset	6	A
Berkeley Heights Twp	Union	6	A
New Providence Boro	Union	6	A
Summit City	Union	6	A