Amendment to the Atlantic Water Quality Management Plan, Cape May County Water Quality Management Plan, Monmouth County Water Quality Management Plan, Ocean County Water Quality Management Plan, and Tri-County Water Quality Management Plan

Total Maximum Daily Loads for Fecal Coliform to Address 31 Streams in the Atlantic Water Region

Watershed Management Area 12
(Manasquan, Shark, Shrewsbury, Navesink Rivers)
Watershed Management Area 13
(Cedar Creek, Metedeconk, Toms, and Forked Rivers, and Barnegat Bay)
Watershed Management Area 14
(Atsion Creek, the Mullica, Wading, Bass, Oswego, and Batsto Rivers, Nochescatauxin Brook, and Nescochaque, Landing, and Hammonton Creeks)
Watershed Management Area 15
(Great Egg Harbor River, Tuckahoe River, and Absecon and Patcong Creeks)
Watershed Management Area 16
(Dennis Creek, Delaware Bay Coastal Drainage, Cape May Atlantic Coastal Drainage)

Proposed:	April 21, 2003
Established:	June 27, 2003
Approved (by EPA Region 2):	September 29, 2003
Adopted:	

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1.0 Executive Summary

In accordance with Section 305(b) of the Federal Clean Water Act (CWA), the State of New Jersey developed the *2002 Integrated List of Waterbodies*, addressing the overall water quality of the State's waters and identifying impaired waterbodies for which Total Maximum Daily Loads (TMDLs) may be necessary. The *2002 Integrated List of Waterbodies* identified several waterbodies in the Atlantic Water Region as being impaired by pathogens, as indicated by the presence of fecal coliform concentrations in excess of standards. This report, developed by the New Jersey Department of Environmental Protection (NJDEP), establishes thirty-one TMDLs addressing fecal coliform loads to the waterbodies identified in Table 1.

Table 1 Fecal coliform-impaired stream segments in the Atlantic Water Region, identified in Sublist 5 of the 2002 Integrated List of Waterbodies, for which fecal coliform TMDLs are being established.

TMDL Number	WMA	Station Name/Waterbody	Site ID	County(s)	River Miles
1	12	Hollow Brook at Rt 35 in Neptune Twp	10	Monmouth	1.7
2	12	Wreck Pond Brook at Allenwood Rd in Wall	14	Monmouth	5.1
3	12	Squankum Brook at Easy St in Howell	16	Monmouth	3.0
4	12	Big Brook at Maywood Drive in Marlboro	21	Monmouth	2.4
5	12	Whale Pond Brook at Route 35 in Eatontown	31	Monmouth	3.7
6	12	Lafetras Brook at Hope Rd in Tinton Falls	32	Monmouth	1.8
7	12	Husky Brook at South St in Eatontown	33	Monmouth	1.7
8	12	Pine Brook at Hockhockson Rd in Tinton Falls	34	Monmouth	2.9
9	12	Willow Brook at Willow Brook Rd in Holmdel	52	Monmouth	0.9
10	12	Ramanessin Brook at Willow Rd in Holmdel	53	Monmouth	9.7
11	12	Bordens Brook at Route 520 in Holmdel	54	Monmouth	2.3
12	12	Barren Neck Bk at Long Bridge Rd in Colts Neck	56	Monmouth	2.4
13	12	Big Brook at Laurelwood Dr in Colts Neck	57	Monmouth	3.5
14	12	Town Brook at Middletown	01407090	Monmouth	3.7
15	12	Yellow Brook near Malboro	01407360	Monmouth	4.0
16	12	Poplar Brook at Deal	01407630	Monmouth	3.5
17	12	Long Brook at Wyckoff Mills	01407868	Monmouth	4.2
18	12	Marsh Bog Brook at Squankum	01407997	Monmouth	6.4
19	12	Manasquan River at Squankum	01408000	Monmouth	9.3
20	12	Mingamahone Brook near Earle	01408009	Monmouth	5.8
21	13	Toms River at Route 537 in Millstone	7	Ocean and Monmouth	6.4
22	13	Muddy Ford Brook at Lakewood-Allenwood Rd in Howell	17	Monmouth	4.4
23	13	Haystack Brook at Maxim-Southard Rd in Howell	18	Monmouth	2.9
24	13	Titmouse Creek at Friendship Rd in Howell	19	Monmouth	1.4
25	13	North Branch Metedeconk River at Lakewood	01408100	Ocean and Monmouth	21.3
26	13	South Branch Metedeconk River near Laurelton	01408152	Ocean and	14.7

TMDL Number	WMA	Station Name/Waterbody	Site ID	County(s)	River Miles
				Monmouth	
27	13	Toms River near Toms River	01408500	Ocean	19.4
28	14	Hammonton Creek at Westcoatville	01409416	Atlantic	8.1
29	15	Hospitality Branch at Blue Bell Road near Ceci	01411035	Gloucester	5.8
30	15	Great Egg Harbor River at Weymouth	01411110	Atlantic	16.5
31	16	Savages Run in Belleplain State Forest	01411441	Cape May	1.9
Total River Miles:					180.8

These thirty-one TMDLs will serve as management approaches or restoration plans aimed at identifying the sources of fecal coliform and for setting goals for fecal coliform load reductions in order to attain applicable surface water quality standards (SWQS).

As stated in N.J.A.C. 7:9B-1.14(c) of the New Jersey Surface Water Quality Standards, "Fecal coliform levels shall not exceed a geometric average of 200 CFU/100 ml nor should more than 10 percent of the total sample taken during any 30-day period exceed 400 CFU/100 ml in FW2 waters." Nonpoint and stormwater point sources are the primary contributors to fecal coliform loads in these streams and can include storm-driven loads transporting fecal coliform from sources such as geese, farms, and domestic pets to the receiving water. Nonpoint sources also include steady-inputs from sources such as failing sewage conveyance systems and failing or inappropriately located septic systems. Because the total point source contribution other than stormwater (i.e. Publicly-Owned Treatment Works, POTWs) is an insignificant fraction of a percent of the total load, these fecal coliform TMDLs will not impose any change in current practices for POTWs and will not result in changes to existing effluent limits.

Using ambient water quality data monitoring conducted by USGS/NJDEP and the Monmouth County Health Department during water years 1994-2002, summer and all season geometric means were determined for each Category 5 listed segment. Given the two surface water quality criteria of 200 CFU/100 ml and 400 CFU/100 ml in FW2 waters, computations were necessary for both criteria and resulted in two values for percent reduction for each stream segment. The higher (more stringent) percent reduction value was selected as the TMDL and will be applied to nonpoint and stormwater point sources as a whole or apportioned to categories of nonpoint and stormwater point sources within the study area. The extent to which nonpoint and stormwater point sources have been identified or need to be identified or verified varies by segment based on data availability, watershed size and complexity, and pollutant sources. Implementation strategies to achieve SWQS are addressed in this report.

Each TMDL shall be proposed and adopted by the Department as an amendment to the appropriate area wide water quality management plan(s) in accordance with N.J.A.C. 7:15-3.4(g).

This TMDL Report is consistent with the United States Environmental Protection Agency's (USEPA's) May 20, 2002 guidance document entitled: "Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992," (Suftin, 2002) which describes the statutory and regulatory requirements for approvable TMDLs.

2.0 Introduction

Sublist 5 (also known as Category 5 or, traditionally, the 303(d) List) of the State of New Jersey's proposed 2002 Integrated List of Waterbodies identified several waterbodies in the Atlantic Water Region as being impaired by pathogens, as evidenced by the presence of high fecal coliform concentrations. This report establishes thirty-one TMDLs, which address fecal coliform loads to the identified waterbodies. These TMDLs serve as management approaches or restoration plans aimed toward reducing loadings of fecal coliform from various sources in order to attain applicable surface water quality standards for the pathogen indication. Several of these waterbodies are listed in Sublist 5 for impairment caused by other pollutants. These TMDLs address only fecal coliform impairments. Separate TMDL evaluations will be developed to address the other pollutants of concern. The waterbodies will remain on Sublist 5 with respect to these pollutants until such time as TMDL evaluations for all pollutants have been completed and approved by USEPA. With respect to the fecal coliform impairment, the waterbodies will be moved to Sublist 4 following approval of the TMDLs by USEPA.

3.0 Background

In accordance with Section 305(b) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of New Jersey is required to biennially 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.

In accordance with Section 303(d) of the CWA, the State is also required to biennially prepare and submit to USEPA a report that identifies waters that do not meet or are not expected to meet surface water quality standards (SWQS) after implementation of technology-based effluent limitations or other required controls. This report is commonly referred to as the 303(d) List. In November 2001, USEPA issued guidance that encouraged states to integrate the 305(b) Report and the 303(d) List into one report. This integrated report assigns waterbodies to one of five categories. In general, Sublists 1 through 4 include waterbodies that are unimpaired, have limited assessment or data availability or have a range of designated use impairments, whereas Sublist 5 constitutes the traditional 303(d) List for waters impaired or threatened by one or more pollutants. The Department chose to develop an Integrated Report for New Jersey. New Jersey's proposed *2002 Integrated List of Waterbodies* is based upon these five categories and identifies water quality limited surface waters in accordance with N.J.A.C. 7:15-6 and Section 303(d) of the CWA. Water quality limited waterbodies require total maximum daily load (TMDL) evaluations.

A Total Maximum Daily Load (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 wasteload allocations (WLAs), load allocations (LAs), and a margin of safety. A TMDL is developed as a mechanism for identifying all the contributors to surface water quality impacts and setting goals for load reductions for pollutants of concern as necessary to meet the SWQS.

Recent EPA guidance (Suftin, 2002) describes the statutory and regulatory requirements for approvable TMDLs, as well as additional information generally needed for USEPA 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.

4.0 Pollutant of Concern and Area of Interest

The pollutant of concern for these TMDLs is pathogens, the presence of which is indicated by elevated concentrations of fecal coliform bacteria. Fecal coliform concentrations were found to exceed New Jersey's Surface Water Quality Standards (SWQS), published at N.J.A.C. 7-9B et seq., for the segments in the Atlantic Water Region identified in Table 2. As reported in the proposed *2002 Integrated List of Waterbodies*, also identified in Table 2 are the river miles and management response associated with each listed segment. All of these waterbodies have a high priority ranking, as described in the *2002 Integrated List of Waterbodies*.

Table 2 Abridged Sublist 5 of the 2002 Integrated List of Waterbodies, listed for fecal coliform impairment in the Atlantic Water Region.

TMDL No.	WMA	Station Name/Waterbody	Site ID	River Miles	Management Response
1	12	Hollow Brook at Rt 35 in Neptune Twp	10	1.7	establish TMDL
2	12	Wreck Pond Brook at Allenwood Rd in Wall	14	5.1	establish TMDL
3	12	Squankum Brook at Easy St in Howell	16	3.0	establish TMDL
4	12	Big Brook at Maywood Drive in Marlboro	21	2.4	establish TMDL
5	12	Whale Pond Brook at Route 35 in Eatontown	31	3.7	establish TMDL
6	12	Lafetras Brook at Hope Rd in Tinton Falls	32	1.8	establish TMDL
7	12	Husky Brook at South St in Eatontown	33	1.7	establish TMDL
8	12	Pine Brook at Hockhockson Rd in Tinton Falls	34	2.9	establish TMDL
9	12	Willow Brook at Willow Brook Rd in Holmdel	52	0.9	establish TMDL
10	12	Ramanessin Brook at Willow Rd in Holmdel	53	9.7	establish TMDL
11	12	Bordens Brook at Route 520 in Holmdel	54	2.3	establish TMDL
12	12	Barren Neck Brook at Long Bridge Rd in Colts Neck	56	2.4	establish TMDL
13	12	Big Brook at Laurelwood Dr in Colts Neck	57	3.5	establish TMDL
14	12	Town Brook at Middletown	01407090	3.7	establish TMDL
15	12	Yellow Brook near Malboro	01407360	4.0	establish TMDL
	12	Shark River near Neptune City	01407705	11.9	water quality monitoring needed to identify if an impairment exists; move to Sublist 3.
	12	Jumping Brook near Neptune City	01407760	2.4	water quality monitoring needed to identify if an impairment exists; move to Sublist 3.
16	12	Poplar Brook at Deal	01407630	3.5	establish TMDL
17	12	Long Brook at Wyckoff Mills	01407868	4.2	establish TMDL
18	12	Marsh Bog Brook at Squankum	01407997	6.4	establish TMDL
19	12	Manasquan River at Squankum	01408000	9.3	establish TMDL
20	12	Mingamahone Brook near Earle	01408009	5.8	establish TMDL
21	13	Toms River at Route 537 in Millstone	7	6.4	establish TMDL
22	13	Muddy Ford Brook at Lakewood-Allenwood Rd in Howell	17	4.4	establish TMDL
23	13	Haystack Brook at Maxim-Southard Rd in Howell	18	2.9	establish TMDL
24	13	Titmouse Creek at Friendship Rd in Howell	19	1.4	establish TMDL
25	13	North Branch Metedeconk River at Lakewood	01408100	21.3	establish TMDL
26	13	South Branch Metedeconk River near Laurelton	01408152	14.7	establish TMDL
27	13	Toms River near Toms River	01408500	19.4	establish TMDL
28	14	Hammonton Creek at Westcoatville	01409416	8.1	establish TMDL
29	15	Hospitality Branch at Blue Bell Road near Ceci	01411035	5.8	establish TMDL
30	15	Great Egg Harbor River at Weymouth	01411110	16.5	establish TMDL
31	16	Savages Run in Belleplain State Forest	01411441	1.9	establish TMDL

These thirty-one TMDLs will address 181 river miles or approximately 93% of the total river miles impaired by fecal coliform (195 total FC impaired river miles) in the Atlantic watershed

region. Based on the detailed county hydrography stream coverage, 541 stream miles, or 8.7% of the stream segments in the Atlantic region (6227 total miles) are directly affected by the 31 TMDLs due to the fact that the implementation plans cover entire watersheds; not just impaired waterbody segments.

Table 2 identifies two segments, Shark River near Neptune City (#01407705) and Jumping Brook near Neptune City (#01407760), for which TMDLs will not be developed at this time based on investigations following the *2002 Integrated List of Waterbodies* proposal. These segments are identified as needing further monitoring to confirm impairment and will be moved to Sublist 3 of the *2002 Integrated List of Waterbodies*. Appendix A provides a further discussion of these segments.

4.1. Description of the Atlantic Water Region and Sublist 5 Waterbodies

4.1.1. Watershed Management Area 12

Watershed Management Area 12 includes watersheds that primarily drain the eastern portions of Middlesex, Monmouth and Ocean Counties and flow in one of two directions: northeast to Sandy Hook/Raritan Bay or southeast to the Atlantic Ocean. WMA 12 is 503 mi^2 in size and lies within the Coastal Plain physiographic province with a low–lying topography. All of WMA 12 streams are tidally influenced usually to the first dam or impoundment above the confluence. Sandy soils and coastal scrub/pine vegetation dominate WMA 12.

WMA 12 includes the following major watersheds: Raritan/Sandy Hook Bay Tributaries, Shark River, Navesink River, Manasquan River, Shrewsbury River, and Wreck Pond Brook.

The **Navesink River** drains an area of 95 mi^2 and includes the following tributaries: Swimming River, Yellow Brook, Big Brook, Mine Brook, and Willow Brook. The Swimming River Reservoir, a major potable water impoundment, is located in this watershed, as are many small ponds. The Navesink estuary supports substantial hard clam (*Mercenaria mercenaria*) and soft clam (*Mya arenaria*) populations

The **Shrewsbury River** drains an area of 27 mi^2. Tributaries to the river include Manhassett Creek, Troutman's Creek, Branchport Creek, Turtle Mill Brook, Parkers Creek, Oceanport Creek, Town Neck Creek, Wardell's Creek and Little Silver Creek. Franklin Lake lies in this area, as do many small ponds. The Shrewsbury and adjoining Navesink Rivers produce almost the entire soft clam fishery for New Jersey.

The **Shark River** drains an area of 23 mi^2. A tributary to the river is Jumping Brook (7 miles long). The Shark River Watershed includes not only the Shark River but also a regional collection of nearby streams most of, which are impounded near their mouths to form coastal ponds before draining into the Atlantic Ocean. Surface waters in this watershed include: Hankins Brook, Hannabrand Brook, Hog Swamp Brook, Polly Pod Brook, Poplar Brook, Shark River, and Whale Pond Brook. Prominent lakes and coastal ponds in this watershed

include: Como Lake, Deal Lake, Fletcher Lake, Spring Lake, Takanassee Lake, Sylvan Lake, Wesley Lake, and Wreck Pond.

The **Manasquan River** drains an area of 81 mi^2 and flows for 23 miles southeasterly from Freehold Township in Central Monmouth County to the Manasquan Inlet to the Atlantic Ocean on the Ocean/Monmouth County line. The headwaters flow from a rural/agricultural area to the densely populated shore. The Manasquan River, in its lower reach, is connected to Barnegat Bay through the Point Pleasant Canal. The major tributaries include Debois Creek, Mingamahone Creek and Marsh Bog Brook. The Manasquan River is tidally influenced up to a point approximately two miles east of the Garden State

There are a number of small lakes and ponds, most of which are used for recreational purposes. The Manasquan Reservoir, a major potable water impoundment, is a pump-storage reservoir situated off the mainstem Manasquan River. It is fed by pumps and pipeline withdrawing water from the Manasquan at peak flow periods for subsequent release during low flow conditions (NJDEP, 1999).

Sublist 5 Waterbodies in WMA 12

Twenty river segments of the thirty-one impaired segments addressed in this report, Barren Neck Brook (#56), Big Brook (#21, #57), Bordens Brook (#54), Hollow Brook (#10), Husky Brook (#33), Lafetras Brook (#32), Long Brook (#01407868), Manasquan River (#01408000), Marsh Bog Brook (#01407997), Mingamahone Brook (#01408009), Pine Brook (#34), Poplar Brook (#01407630), Ramanessin Brook (#53), Squankum Brook (#16), Town Brook (#01407090), Whale Pond Brook (#31), Willow Brook (#52), Wreck Pond Brook (#14), and Yellow Brook (#01407360) are located in WMA 12. The spatial extent of each segment is identified in Figure 1 and described in Table 3. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 4.

Figure 1 **Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 12**

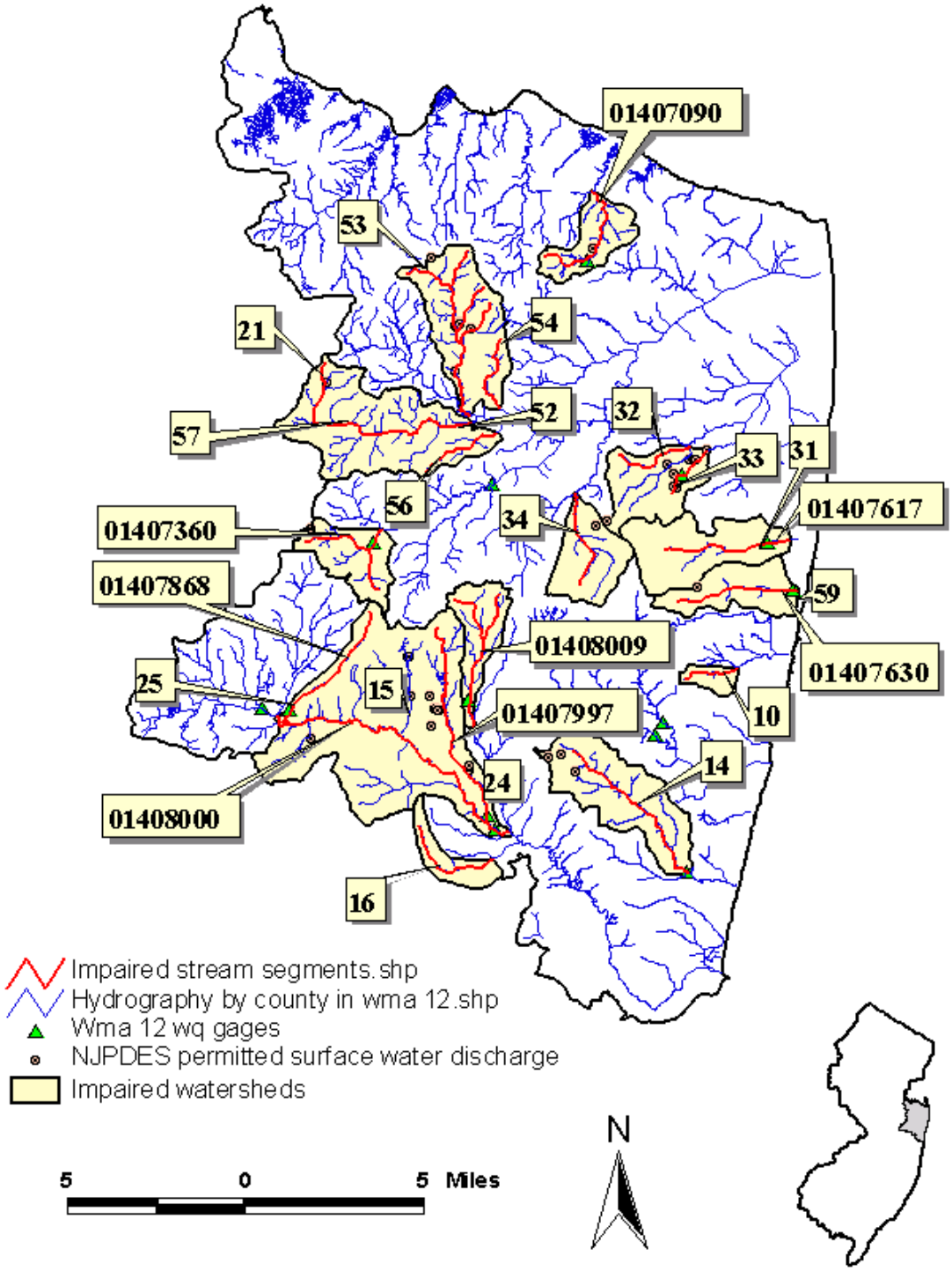


Table 3 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 12.

Segment ID	Watershed area associated with impaired stream segments
10	Southwest Hollow Brook watershed upstream of its confluence with Deal Lake.
14	Wreck Pond Brook watershed upstream of Wreck Pond Brook/Hannabrand Brook.
16	Southwest tributary to Squankum Brook.
31	Whale Pond Brook watershed upstream of Lake Takanassee. Includes data from USGS station #01407617.
32, 33	Parkers Creek Branch and Shrewsbury watersheds upstream of Parkers Creek/North Branch Parkers Creek confluence, and Oceanport Creek upstream of the Shrewsbury River.
34	Pine Brook watershed upstream of the Pine Brook/Hockhockson Brook confluence.
53, 54	Ramanessin Brook and Bordens Brook watersheds upstream of Swimming River Reservoir. Watershed also includes Hop Brook, and Willow Brook.
21, 52, 56, 57	Big Brook watershed upstream of Swimming River Reservoir. Watershed also includes Fulling Mill Brook. The Big Brook watershed and the Swimming River watershed drain to the southwest branch of Navesink River.
01407090	Town Brook watershed upstream of the Town Brook/Mill Creek confluence.
01407360	Southwest branch of Yellow Brook watershed.
01407630	Poplar Brook watershed. Includes MCHD station #59.
01407868, 01407997, 01408000	Manasquan River watershed downstream of the Manasquan River/Debois Creek confluence to the Manasquan River/Mingamahone River confluence. Includes the following tributaries: Long Brook, Marsh Bog Brook, Killtime Brook, and Manasquan Reservoir. Includes MCHD stations #15, #24, and #25.
01408009	Northwest branch watershed of the Mingamahone River; north of Farmingdale.

Table 4 **River miles, Watershed size, and Anderson Land Use classification for three Sublist 5 segments, listed for fecal coliform, in WMA 12.**

	Segment ID												
	10	**14**	**16**	**21, 57, 52, 56**	**31**	**32, 33**	**34**	**53, 54**	**1407090**	**1407360**	**1407630**	**1407868 1407997 1408000**	**1408009**
Sublist 5 impaired river miles (miles)	1.7	5.1	3.0	9.2	3.7	4.1	2.9	12.0	3.7	4.0	3.5	19.8	5.8
Total river miles within watershed and included in the implementation plan (miles)	2.1	13.9	3.4	31.7	5.2	9.0	7.1	22.5	10.1	7.8	4.8	50.1	11.1
Watershed size (acres)	631	4949	1337	7373	4102	3155	2808	5126	2138	2472	2597	15426	2214
Landuse/Landcover													
Agriculture	0.6%	11.8%	14.2%	24.5%	0.9%	0.5%	1.1%	18.6%	1.8%	20.3%	0.4%	13.1%	6.3%
Barren Land	1.1%	4.3%	0.1%	0.6%	0.7%	0.3%	2.1%	1.1%	0.0%	0.4%	0.3%	1.1%	0.0%
Forest	23.4%	23.1%	13.6%	14.2%	15.7%	9.4%	53.6%	15.6%	16.1%	18.5%	5.5%	20.6%	26.5%
Urban	56.4%	42.2%	13.0%	38.9%	62.0%	74.0%	15.4%	43.5%	63.4%	41.2%	77.5%	25.0%	19.9%
Water	0.2%	1.6%	0.4%	0.6%	0.6%	0.6%	0.8%	1.0%	0.3%	0.3%	0.1%	5.6%	0.3%
Wetlands	18.4%	17.0%	58.7%	21.2%	20.0%	15.3%	27.0%	20.3%	18.4%	19.2%	16.2%	34.6%	47.1%

4.1.2. Watershed Management Area 13

WMA 13 includes watersheds draining the central Atlantic drainage of New Jersey. The area lies mostly in Ocean County and includes the Barnegat Bay as well as the following subwatersheds: Metedeconk River, Toms River, Forked River, Cedar Creek.

Toms River drains an area of 124 square miles. It flows from western Ocean and Monmouth Counties southeast to Barnegat Bay at the Town of Toms River, 11 miles north of Barnegat Inlet. This is an area of low relief, containing many small tributaries, which feed into the Toms River. The larger tributaries include Davenports Branch, Union Branch, and Wrangle Brook. The watershed also drains a large area of the Pinelands. Major impoundments include Success Lake and Horicon Lake. Population centers include Toms River, Lakehurst, Dover, and Manchester.

This watershed lies in the Coastal Plain and is about one-half forested, with the remainder in residential developments, a military installation and agriculture. There has been a substantial amount of new residential and commercial development throughout the watershed in the past five years. Of the approximately 9 NJPDES permitted discharges within the watershed, half are industrial/commercial, and half are municipal/institutional. Waters have been classified as Pinelands (some of the Pinelands waters are also designated trout maintenance), FW-l, FW-2 Nontrout, and SE-1.

Sublist 5 Waterbodies inWMA 13

Seven of the thirty-one TMDLs in the Atlantic region are located in WMA 13. Included are segments of Muddy Ford Brook (#17), Haystack Brook (#18), Titmouse Creek (#19), North Branch Metedeconk River (#01408100), South Branch Metedeconk River (#01408152), and Toms River (#7, #01408500). The spatial extent of each segment is identified in Figure 2 and described in Table 5. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 6.

Figure 2 **Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 13**

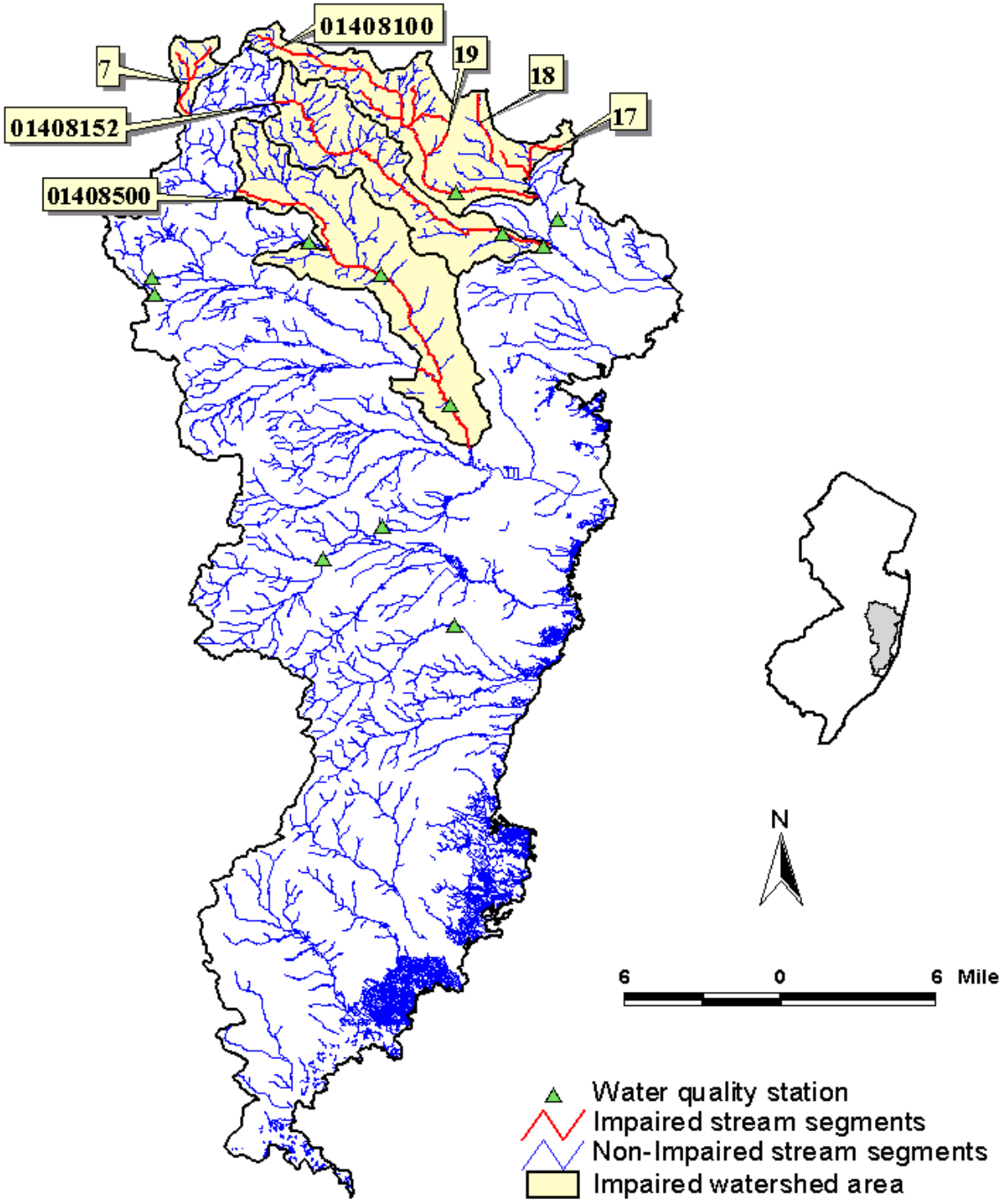


Table 5 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 13.

Segment ID	Watershed area associated with impaired stream segments
7	West branch of Toms River watershed upstream of Anderson Road overpass.
17, 18, 19, 01408100	North Branch Metedeconk River watershed upstream of the Metedeconk River/Hay Stack Brook confluence, Hay Stack Brook watershed upstream of Hay Stack Brook/Muddy Ford Brook confluence, and Muddy Ford Brook watershed upstream of Muddy Ford/Sandy Hill Run confluence. Tributaries include Dicks Brook, Ground Hog Brook, Plove Brook, Weasel Brook, Snipe Creek, Dace Creek, and Marshes Creek. Includes MCHD station #6.
01408152	South Branch Metedeconk River watershed upstream of the South Branch Metedeconk River/North Branch Metedeconk River confluence; excluding watershed upstream of Cedar Swamp Road overpass.
01408500	Toms River watershed upstream of the head of tide near Toms River. Excludes portions of Toms River upstream of Thompson Bridge Road overpass near Saint Vladimirs, Maple Root Branch watershed, and Union Branch watershed upstream of Beacon Street near Pine Lake Park. Impaired watershed includes the following tributaries: Slab Branch, portions of Union Branch, Dove Mill Branch, and Long Brook. Includes USGS station #01408300.

Table 6 River miles, Watershed size, and Anderson Land Use classification for seven Sublist 5 segments, listed for fecal coliform, in WMA 13.

	Segment ID			
	7	**17, 18, 19, 01408100**	**01408152**	**01408500**
Sublist 5 impaired river miles (miles)	6.4	25.5	14.7	19.4
Total river miles within watershed and included in the implementation plan (miles)	11.0	70.4	60.5	70.8
Watershed size (acres)	2404	19574	16567	26525
Landuse/Landcover				
Agriculture	16.1%	4.9%	3.3%	3.8%
Barren Land	0.8%	1.1%	1.3%	6.6%
Forest	33.8%	24.6%	37.0%	43.6%
Urban	28.6%	34.5%	35.4%	24.7%
Water	0.4%	0.3%	1.3%	1.6%
Wetlands	20.3%	34.6%	21.7%	19.7%

4.1.3. Watershed Management Area 14

Watershed management area 14 includes watersheds draining portions of the Pinelands of New Jersey. Major rivers include the Mullica, the Wading River, Nochescatauxin Brook, Atsion Creek, the Bass River, Batsto River, Nescochaque Creek, Landing Creek, Hammonton Creek and the Oswego River. This area lies in Burlington, Atlantic, and Ocean Counties and includes the following watersheds: Mullica River, Mechesactauxin Creek Wading River, Atsion Creek Batsto River, Doughty Creek.

The Mullica River and tributaries are considered the primary drainage system for the Pinelands. The total area of the drainage basin (Mullica River and tributaries) is some 561 square miles. Major tributaries within the watershed include the Wading River, Nochescatauxin Brook, Atsion Creek, the Bass River, Batsto River, Nescochaque Creek, Landing Creek, Hammonton Creek and the Oswego River. The Mullica River empties into Great Bay, a large estuarine system. The population centers are Winslow, Galloway and Hammonton.

About 80 percent of this watershed consists of state parks and forests, with the remainder being agricultural and developed areas. Of the approximately 7 NJPDES permitted discharges here, roughly half are municipal/ institutional and half are industrial/commercial. The streams are classified FW-Pinelands Waters, FW-1, FW-2 Nontrout and SE-1. Much of these waterways are incorporated in the New Jersey Wild and Scenic River System.

Sublist 5 Waterbodies in WMA 14

One of the thirty-one TMDLs in this report is located in WMA 14. Included is Hammonton Creek (#01409416). The spatial extent for this segment is identified in Figure 3 and described in Table 7. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 8.

Figure 3 **Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 14**

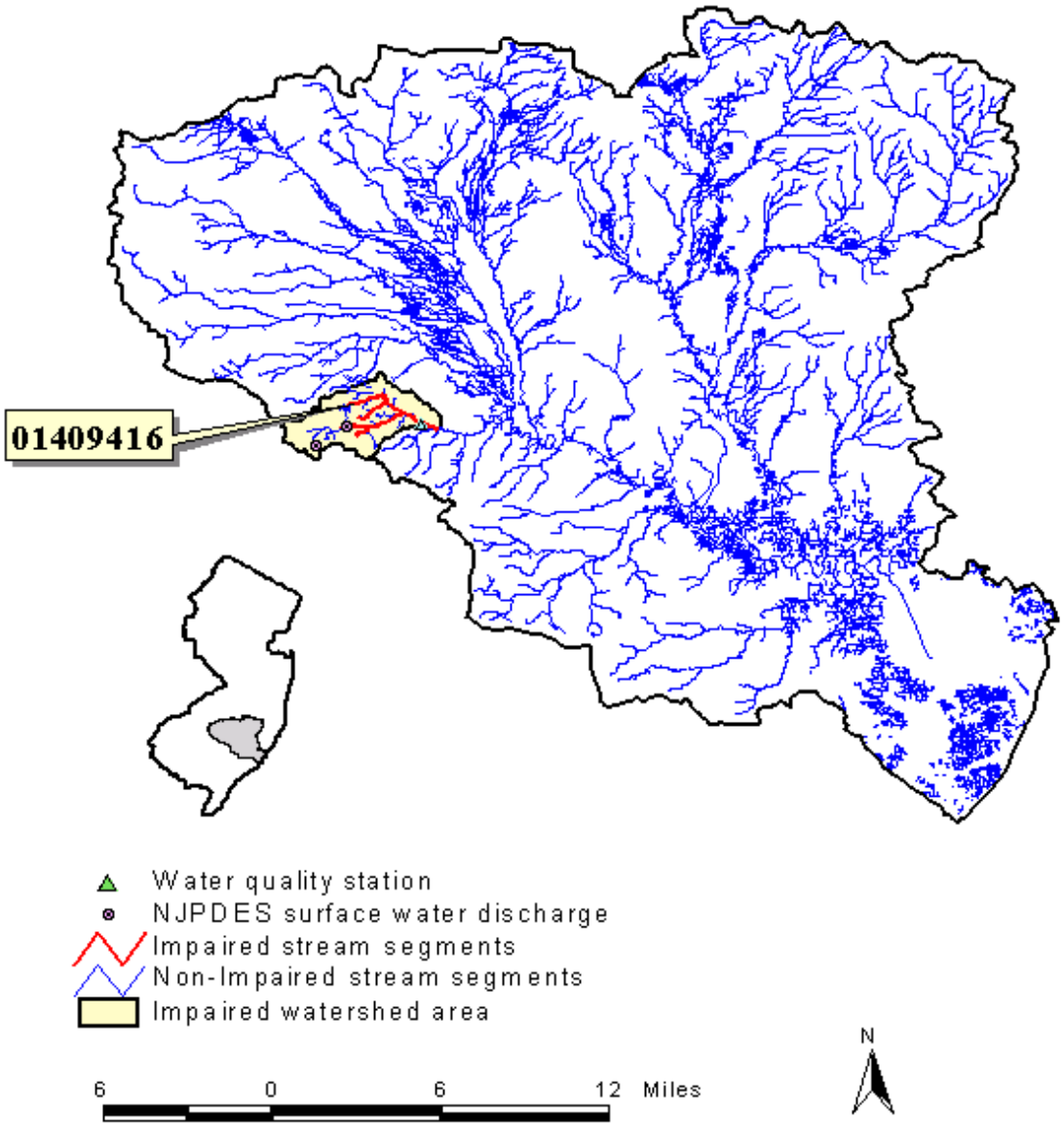


Table 7 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 14.

Segment ID	Watershed area associated with impaired stream segments
01409416	Hammonton Creek watershed from its headwaters to approximately 0.5 miles downstream of USGS station #01409416.

Table 8 River miles, Watershed size, and Anderson Land Use classification for one Sublist 5 segment, listed for fecal coliform, in WMA 14.

	Segment ID 01409416
Sublist 5 impaired river miles (miles)	8.1
Total river miles within watershed and included in the implementation plan (miles)	20.9
Watershed size (acres)	6356
Landuse/Landcover	
Agriculture	34.1%
Barren Land	2.3%
Forest	24.7%
Urban	21.3%
Water	1.8%
Wetlands	15.7%

4.1.4. Watershed Management Area 15

The watershed management area includes watersheds draining to Great Egg Harbor Bay in Atlantic County. The management area encompasses waters draining eastern Gloucester and Camden Counties. The area includes the following watersheds: Great Egg Harbor River, Tuckahoe River Absecon Creek, Patcong Creek

The Great Egg Harbor River is 49 miles long and drains an area of 304 square miles. It originates in eastern Gloucester and Camden Counties, an agricultural and suburban area, before flowing through the Pinelands region. The river drains into Great Egg Harbor Bay before emptying into the Atlantic Ocean. The river is tidal downstream of the dam at Mays Landing.

The watershed's dominant land use is forest, with the remainder being primarily agricultural and developed. Population centers include Berlin, Winslow, Monroe, Mays Landing and Egg Harbor City. The major tributaries are Hospitality Branch, Watering Race, Babcock Creek, Deep Run, South River and Stephens Creek. There are many lakes and ponds in this area, but the largest is Lake Lenape, near Mays Landing. Of the approximately 12 NJPDES permitted

dischargers here, about half are municipal and half are industrial/commercial. Waters in the Great Egg Harbor watershed are classified FW-2 Nontrout, Pinelands Waters, FW-1 and SE-1.

Sublist 5 Waterbodies WMA 15

Two of the thirty-one TMDLs in this report are located in WMA 15. Included are segments in Hospitality Branch (#01411035), and Great Egg Harbor River (#01411110). The spatial extent of each segment is identified in Figure 4 and described in Table 9. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 10.

Figure 4 **Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 15**

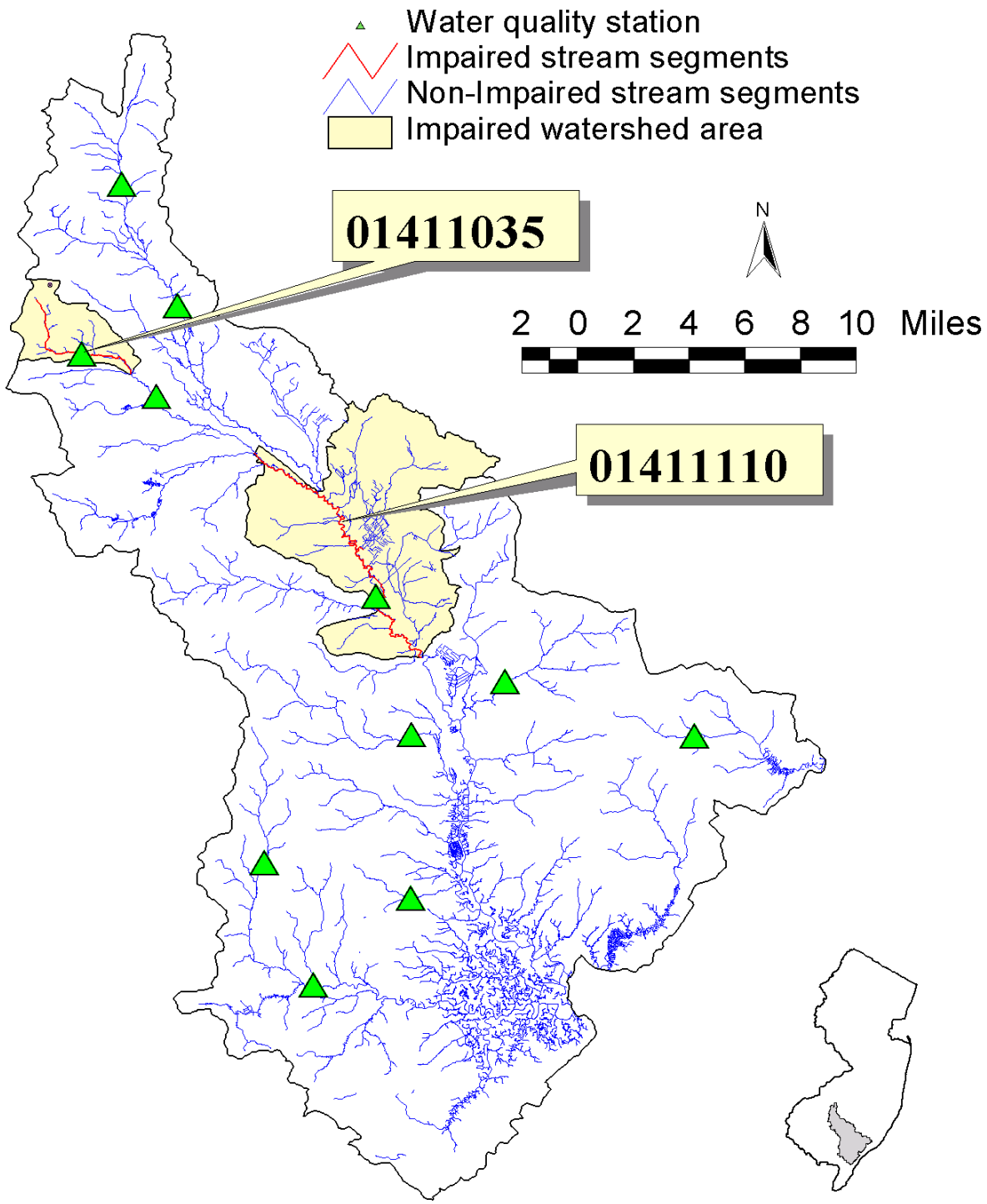


Table 9 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 15.

Segment ID	Watershed area associated with impaired stream segments
01411035	Hospitality Branch headwater watershed to the Hospitality Branch/Victoria Lakes Hospitality Branch confluence near Village Parkway Road.
01411110	Hospitality Branch and Great Egg Harbor watersheds from the Hospitality Branch/Marsh Lake Branch confluence and the Hospitality Branch/Great Egg Harbor River confluence to the inlet of Lenepe Lake near Emmelsville. Includes the following tributaries: Big Ditch, Great Egg Harbor River, Makepeace Stream, Little Mill, Indian Branch, Marsh Lake Branch, and Hospitality Branch.

Table 10 River miles, Watershed size, and Anderson Land Use classification for two Sublist 5 segments, listed for fecal coliform, in WMA 15.

	Segment ID	
	01411035	**01411110**
Sublist 5 impaired river miles (miles)	5.8	16.5
Total river miles within watershed and included in the implementation plan (miles)	13.3	103.1
Watershed size (acres)	5448	29871
Landuse/Landcover		
Agriculture	26.7%	5.3%
Barren Land	1.6%	1.5%
Forest	32.2%	50.2%
Urban	23.9%	7.1%
Water	2.3%	1.8%
Wetlands	13.3%	34.0%

4.1.5. Watershed Management Area 16

Watershed management area 16 includes watersheds draining the Cape May portion of New Jersey. The region includes Cape May County south and east of the Tuckahoe River watershed. The region contains minimal surface water flow. Ground water and shellfish harvesting water quality are the principal water issues. The area includes the following watersheds: Dennis Creek, Delaware Bay Coastal Drainage, Cape May Atlantic Coastal Drainage

Cape May County is located at the southern-most point of New Jersey and represents a continuation of the Atlantic Coastal Plain. The county is 267 square miles in area and is

bounded on the north by Atlantic and Cumberland Counties, on the east by the Atlantic Ocean and on the west and south by the Delaware Bay. The region represents a low lying, gently rolling plain whose highest point is 54 feet above sea level and whose surface is largely covered by wet soils and wetlands. Large swamps (Great Cedar, Timber and Beaver Swamps) occupy the north-central part of the county. Most, if not all, streams are tidal in their lower reaches and terminate by flowing into fresh water swamps that, in turn, discharge into saltwater marshes near the shore.

One of the principal water resource issues within this management area is drinking water supply. The resource is largely dependent upon ground water that is in turn highly vulnerable to saltwater intrusion from the west, south and east, especially in the southern portion of the peninsula. The expected increase in population (an expected 68 percent increase by 2040) is predicted to put further stress on the already overextended water supply.

Sublist 5 Waterbodies WMA 16

One of the thirty-one TMDLs in this report is located in WMA 16. Included is Savages Run (#01411441). The spatial extent of this segment is identified in Figure 4 and described in Table 11. River miles, watershed sizes and land use/land cover by percent area associated with this segment are listed in Table 12.

Figure 5 **Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 16**

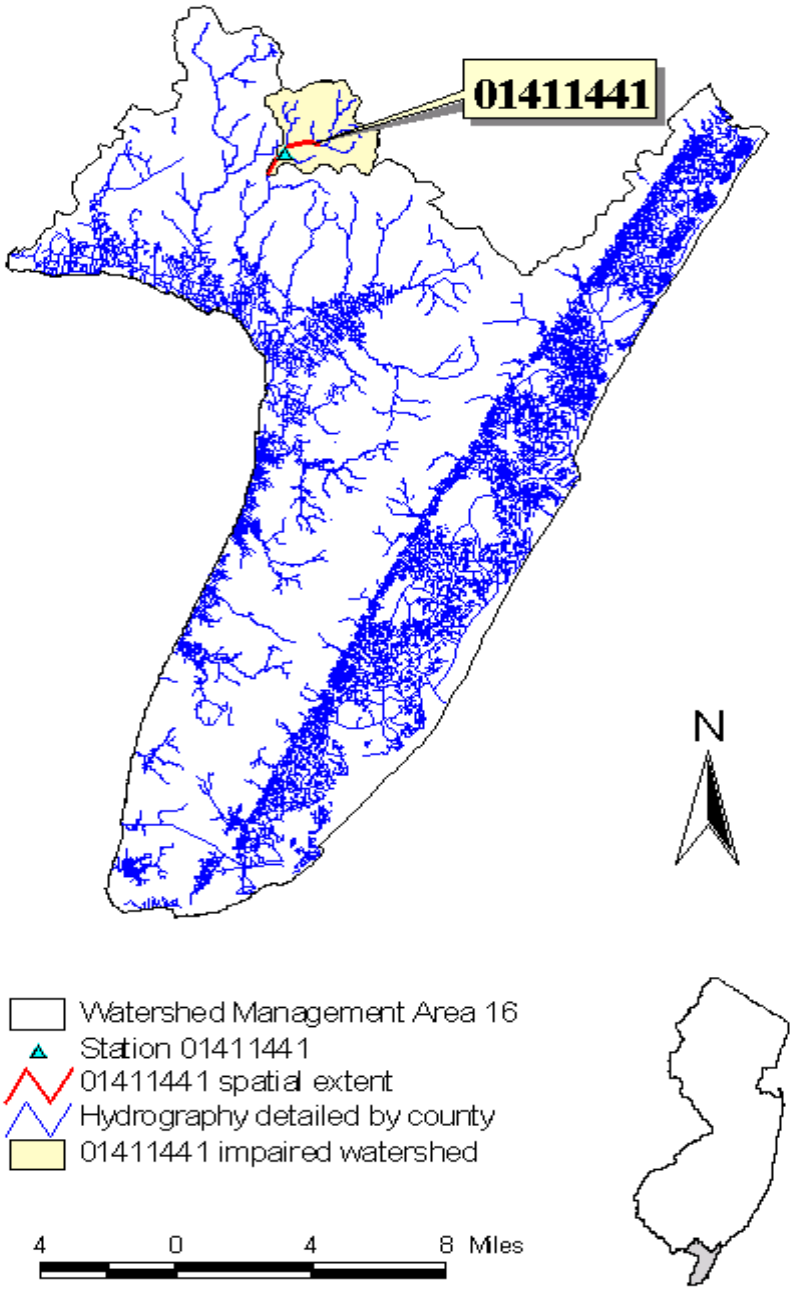


Table 11 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 16.

Segment ID	Watershed area associated with impaired stream segment
01411441	Savages Run/East Creek watershed above East Creek Pond

Table 12 River miles, Watershed size, and Anderson Land Use classification for one Sublist 5 segment, listed for fecal coliform, in WMA 16.

	Segment ID 01411441
Sublist 5 impaired river miles (miles)	1.906
Total river miles within watershed and included in the implementation plan (miles)	12.5
Watershed size (acres)	4062
Landuse/Landcover	
Agriculture	8.3%
Barren Land	0.4%
Forest	62.6%
Urban	6.2%
Water	1.0%
Wetlands	21.5%

4.2. Data Sources

The Department's Geographic Information System (GIS) was used extensively to describe the Atlantic watershed characteristics. In concert with USEPA's November 2001 listing guidance, the Department is using Reach File 3 (RF3) in the 2002 Integrated Report to represent rivers and streams. The following is general information regarding the data used to describe the watershed management area:

- Land use/Land cover information was taken from the 1995/1997 Land Use/Land cover Updated for New Jersey DEP, published 12/01/2000 by Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA), delineated by watershed management area.
- 2002 Assessed Rivers coverage, NJDEP, Watershed Assessment Group, unpublished coverage.
- County Boundaries: Published 11/01/1998 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA), "NJDEP County Boundaries for the State of New Jersey." Online at: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stco.zip
- Detailed stream coverage (RF3) by County: Published 11/01/1998 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic

Information and Analysis (BGIA). "Hydrography of XXX County, New Jersey (1:24000)." Online at: http://www.state.nj.us/dep/gis/digidownload/zips/strm/

- NJDEP 14 Digit Hydrologic Unit Code delineations (DEPHUC14), published 4/5/2000 by Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS) Online at: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dephuc14.zip
- NJPDES Surface Water Discharges in New Jersey, (1:12,000), published 02/02/2002 by Division of Water Quality (DWQ), Bureau of Point Source Permitting - Region 1 (PSP-R1).
- Dams statewide coverage. Published 5/16/2000 by Dam Safety Section. Titled "NJDEP Dams for the State of New Jersey." New Jersey Department of Environmental Protection (NJDEP). Online at: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dams.zip

5.0 Applicable Water Quality Standards

5.1. New Jersey Surface Water Quality Standards for Fecal Coliform

As stated in N.J.A.C. 7:9B-1.14(c) of the New Jersey SWQS, the following are the criteria for freshwater fecal coliform:

> "Fecal coliform levels shall not exceed a geometric average of 200 CFU/100 ml nor should more than 10 percent of the total samples taken during any 30-day period exceed 400 CFU/100 ml in FW2 waters".

All of the waterbodies covered under these TMDLs have a FW2 classification (NJAC 7:9B-1.12). The designated use, i.e. surface water uses, both existing and potential, that have been established by the Department for waters of the State, for all of the waterbodies in the Atlantic Water Region is as stated below:

In all FW2 waters, the designated uses are:

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.

5.2. Pathogen Indicators in New Jersey's Surface Water Quality Standards (SWQS)

A subset of total coliform, fecal coliform originates from the intestines of warm-blooded animals. Therefore, because they do not include organisms found naturally in soils, fecal coliform is preferred over total coliform as a pathogen indicator. In 1986, USEPA published a document entitled *"Implementation Guidance for Ambient Water Quality Criteria for Bacteria – 1986"* that contained their recommendations for water quality criteria for bacteria to protect bathers from gastrointestinal illness in recreational waters. The water quality criteria established levels of indicator bacteria *Escherichia coli* (*E. coli*) for fresh recreational water and enterococci for fresh and marine recreational waters in lieu of fecal coliforms. Historically, New Jersey has listed water bodies for exceedances of the fecal coliform criteria. Therefore, the Department is obligated to develop TMDLs for Sublist 5 water bodies based upon fecal coliform, until New Jersey makes the transition to *E. coli* and enterococci in its SWQS and sufficient data have been collected to assess impairment in accordance with the revised indicators.

6.0 Source Assessment

In order to evaluate and characterize fecal coliform loadings in the waterbodies of interest in these TMDLs, and thus propose proper management responses, source assessments are warranted. Source assessments include identifying the types of sources and their relative contributions to fecal coliform loadings, in both time and space variables.

6.1. Assessment of Point Sources other than Stormwater

Point sources of fecal coliform, namely sewage treatment discharges, for these TMDLs are listed in Appendix B. Sewage treatment plants, whether municipal or industrial, are required to disinfect effluent prior to discharge and to meet surface water quality criteria for fecal coliform in their effluent. In addition, New Jersey's Surface Water Quality Standards at N.J.A.C. 7:9B-1.5(c)4 reads "No mixing zones shall be permitted for indicators of bacterial quality including, but not limited to, fecal coliforms and enterococci". This mixing zone policy is applicable to both municipal and industrial sewage treatment plants.

Since sewage treatment plants routinely achieve essentially complete disinfection (less than 20 CFU/100ml), the requirement to disinfect results in fecal coliform concentrations well below the criteria and permit limit. The percent of the total point source contribution is an insignificant fraction of the total load. Consequently, these fecal coliform TMDLs will not impose any change in current practices for POTWs and industrial treatment plants and will not result in changes to existing effluent limits.

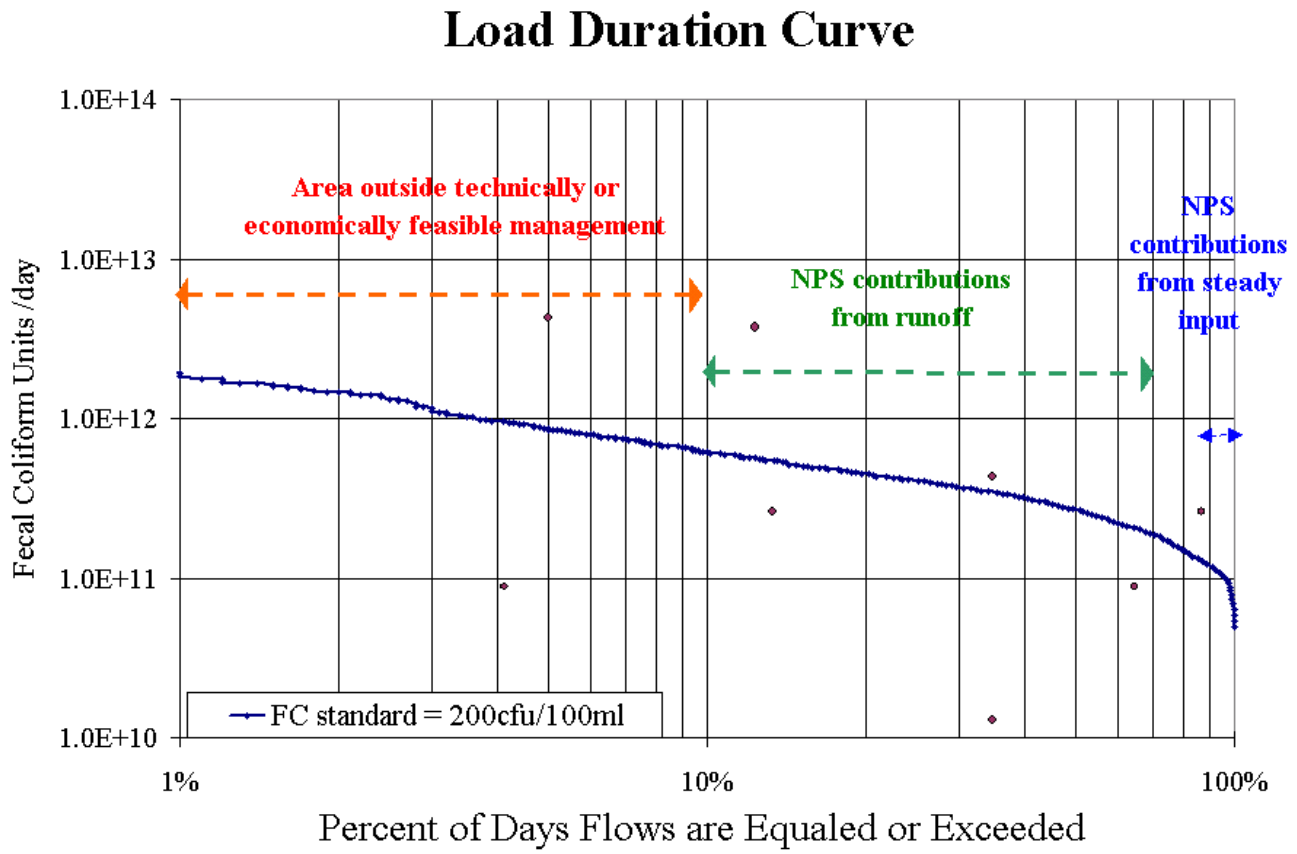
6.2. Assessment of Nonpoint and Stormwater Point Sources

Nonpoint and stormwater point sources include storm-driven loads such as runoff from various land uses that transport fecal coliform from sources such as geese, farms, and domestic pets to the receiving water. Domestic pet waste, geese waste, as well as loading from storm water detention basins will be addressed by the Phase II MS4 program.

Nonpoint sources also include steady-inputs from "illicit" sources such as failing sewage conveyance systems, sanitary sewer overflows (SSOs), and failing or inappropriately located septic systems. When "illicit" sources are identified, either through the Phase II MS4 requirements or trackdown studies conducted by the Department, appropriate enforcement measures will be taken to eliminate them.

When streamflow gage information is available, a load duration curve (LDC) is useful in identifying and differentiating between storm-driven and steady-input sources. As an example, Figure 6 represents a LDC using the 200 CFU/100 ml criterion.

Figure 6 Example Load Duration Curve (LDC)



The load duration curve method is based on comparison of the frequency of a given flow event with its associated water quality load. A LDC can be developed using the following steps:

1. Plot the Flow Duration Curve, Flow vs. % of days flow exceeded.
2. Translate the flow-duration curve into a LDC by multiplying the water quality standard, the flow and a conversion factor; the result of this multiplication is the maximum allowable load associated with each flow.
3. Graph the LDC, maximum allowable load vs. percent of time flow is equaled or exceeded.

4. Water quality samples are converted to loads (sample water quality data multiplied by daily flow on the date of sample).
5. Plot the measured loads on the LDC.

Values that plot below the LDC represent samples below the concentration threshold whereas values that plot above represent samples that exceed the concentration threshold. Loads that plot above the curve and in the region between 85 and 100 percent of days in which flow is exceeded indicate a steady-input source contribution. Loads that plot in the region between 10 and 70 percent suggest the presence of storm-driven source contributions. A combination of both storm-driven and steady-input sources occurs in the transition zone between 70 and 85 percent. Loads that plot above 99 percent or below 10 percent represent values occurring during either extreme low or high flows conditions and are thus considered to be outside the region of technically and economically feasible management. In this report, LDCs are used only for TMDL implementation and not in calculating TMDLs.

LDCs for listed segments in the Atlantic region are located in Appendix D. In each case, thirty (30) years of USGS gage flow data (water years 1970-2000), from the listed station, were used in generating the curve. When a recent 30-year period was not available at the listed station, an adjacent station was selected based on station correlation information in US Geological Survey Open File Report 81-1110 (USGS, 1982). When an adjacent station was used in the manner, flows were adjusted to the station of interest based on a ratio of watershed size. LDCs were not developed for stations in which a satisfactory correlation could not be found.

7.0 Water Quality Analysis

Relating pathogen sources to in-stream concentrations is distinguished from quantifying that relationship for other pollutants given the inherent variability in population size and dependence not only on physical factors such as temperature and soil characteristics, but also on less predictable factors such as re-growth media. Since fecal coliform loads and concentrations can vary many orders of magnitude over short distances and over time at a single location, dynamic model calibrations can be very difficult to calibrate. Options available to control nonpoint sources of fecal coliform typically include measures such as goose management strategies, pet waste ordinances, agricultural conservation management plans, and septic system replacement and maintenance. However, the effectiveness of these control measures is not easily measured. Given these considerations, detailed water quality modeling may not provide adequate insight or guidance toward the development of implementation plans for fecal coliform reductions.

As described in EPA guidance, a TMDL identifies the loading capacity of a waterbody for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 C.F.R. 130.2). The loadings are required to be expressed as either mass-per-time, toxicity, or other appropriate measures (40 C.F.R. 130.2(i)). For these TMDLs, the load capacity is expressed as

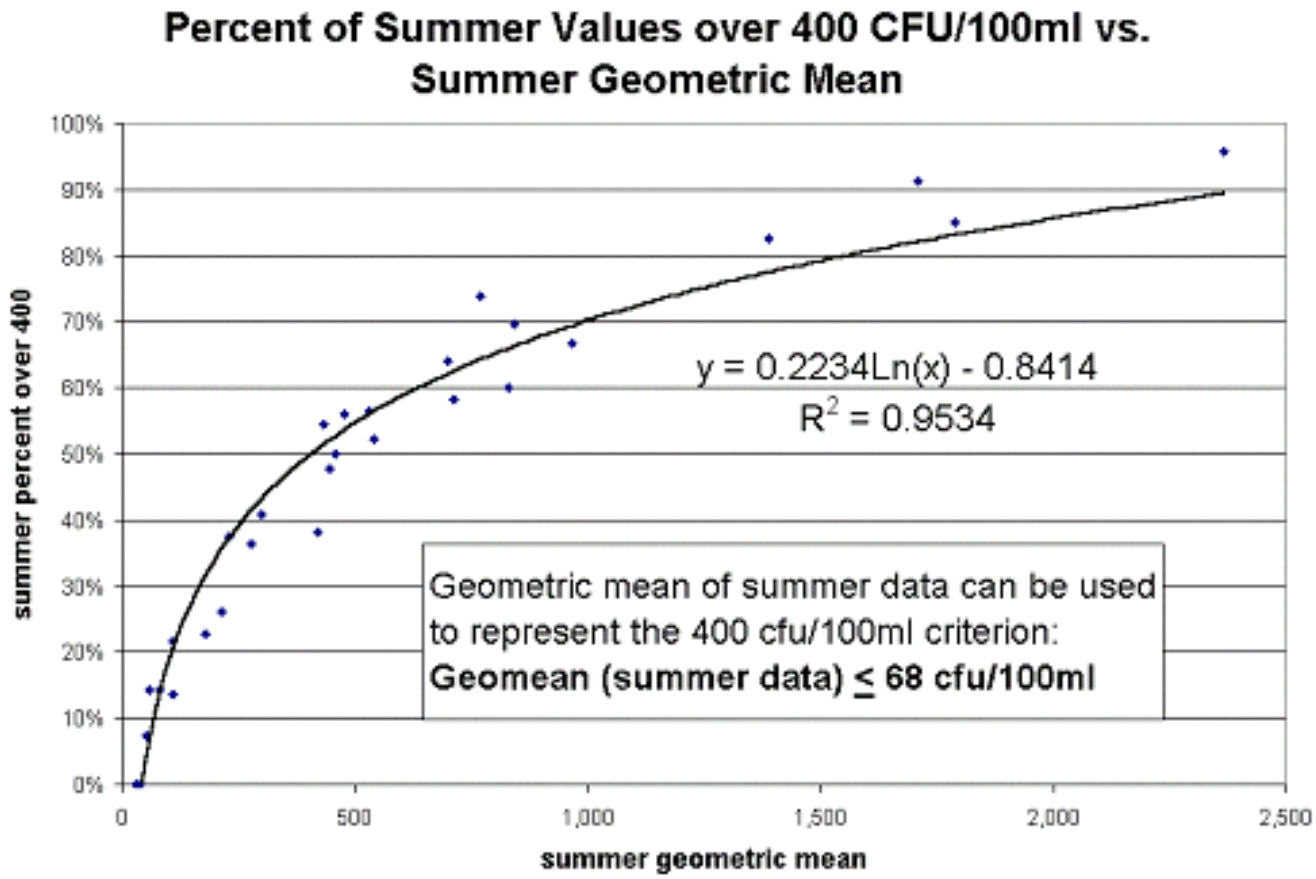
a concentration set to meet the state water quality standard. For bacteria, it is appropriate and justifiable to express the components of a TMDL as percent reduction based on concentration. The rationale for this approach is that:

- expressing a bacteria TMDL in terms of concentration provides a direct link between existing water quality and the numeric target;
- using concentration in a bacteria TMDL is more relevant and consistent with the water quality standards, which apply for a range of flow and environmental conditions; and
- follow-up monitoring will compare concentrations to water quality standards.

Given the two criteria of 200 CFU/100 ml and 400 CFU/100 ml in FW2 waters, computations were necessary for both criteria and resulted in two percent reduction values. The higher percent reduction value was applied in the TMDL so that both the 200 CFU/100 ml and 400 CFU/100 ml criteria were satisfied.

To satisfy the 200 CFU/100ml criteria, the geometric mean of all available data between water years 1994-2002 was compared to an adjusted target concentration. The adjusted target accounts for an explicit margin of safety and is equal to 200 minus the margin of safety. A calculation incorporating all available data is generally conservative since most samples are taken during the summer when fecal coliform is generally higher. A geometric mean of summer data was used to develop a percent reduction to satisfy the 400 CFU/100 ml criteria. A summer geometric mean can be used to represent the 400 criteria by regressing the percent over 400 CFU/100 ml against the geometric mean (Figure 7). Thus, each datapoint on Figure 7 represents all the data from one individual monitoring station. Sites with 20 or more summer data points were used to develop this regression, in order to make use of more significant values for percent exceedance. A statewide regression was used rather than regional regressions because the regression shape was not region-specific and the strength of the correlation was highest when all statewide data were included. The resulting regression has an r-squared value of 0.9534. Solving for X when Y is equal to 10% yields a geometric mean threshold of 68 CFU/100ml. This means that, using summer data, a geometric mean of 68 can be used to represent the 400 CFU/100ml criterion. Since the geometric mean is a more reliable statistic than percentile when limited data are available, 68 CFU/100ml was used to represent the 400 CFU/100ml criterion for all sites. The inclusion of all data from summer months (May through September) to compare with the 30-day criterion is justified because summer represents the critical period when primary and secondary contact with water bodies is most prevalent. A more detailed justification for using summer data can be found in Section 7.1, ”Seasonal Variation and Critical Conditions.”

Figure 7 **Percent of summer values over 400 CFU/100ml as a function of summer geometric mean values**



$y = 0.2234\text{Ln}(x) - 0.8414$ Equation 1

$R^2 = 0.9534$

Geometric mean, and summer geometric mean, and percent reductions were determined at each location for both criteria using Equations 2 through 4. To satisfy the 200 CFU/100ml criteria, equations 2 and 3 were applied. Equations 2 and 4 were used in satisfying the 400 CFU/100ml criteria.

$$Geometric\ Mean\ for\ 200 CFU\ criteria = \sqrt[n]{y_1 y_2 y_3 y_4 .... y_n}$$ Equation 2

where:
y = sample measurement
n = total number of samples

$$200\ CFU\ criteria\ Percent\ \text{Re}duction = \frac{(Geometric\ mean - (200 - e))}{Geometric\ mean} \times 100\ \%$$ Equation 3

$$400\ CFU\ criteria\ Percent\ \text{Re}duction = \frac{(SummerGeometric\ mean - (68 - e))}{SummerGeometric\ mean} \times 100\ \%$$ Equation 4

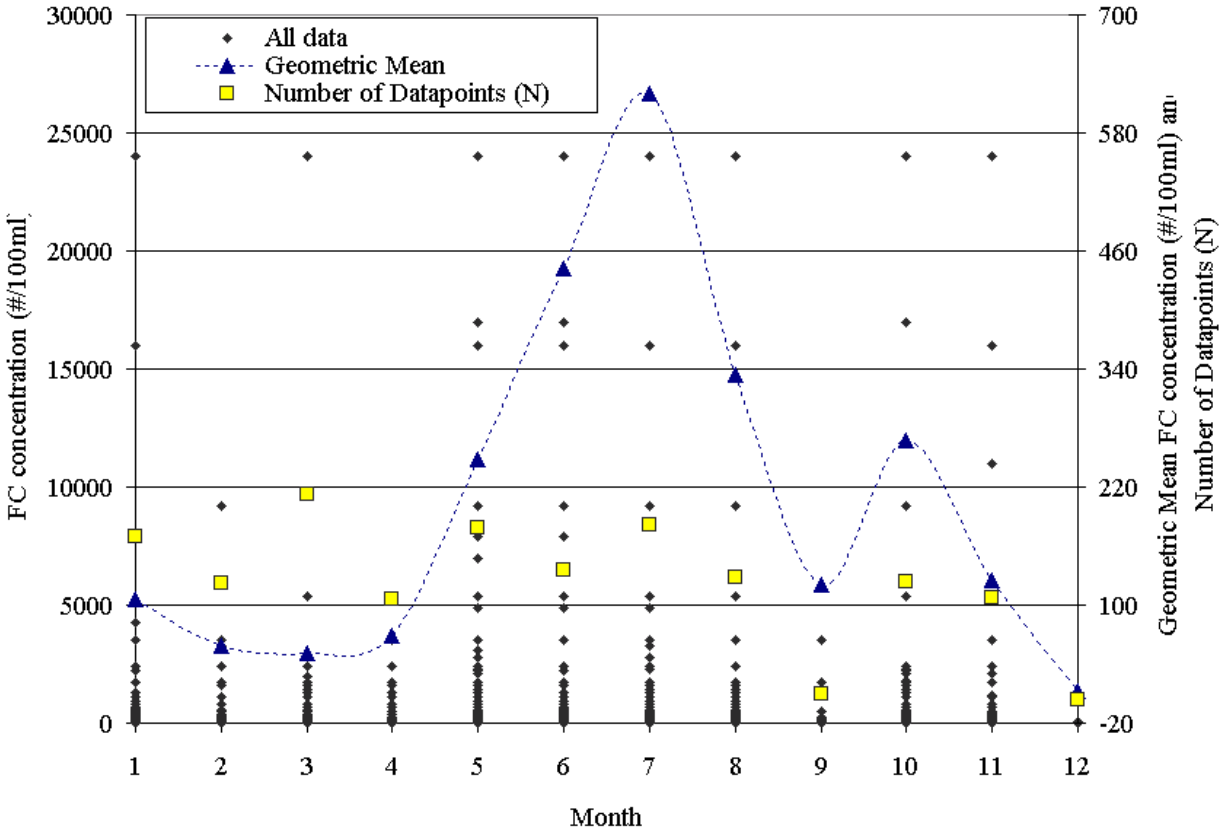
where:
e = (margin of safety)

This percent reduction can be applied to nonpoint and stormwater point sources as a whole or be apportioned to categories of nonpoint and stormwater point sources within the study area. The extent to which nonpoint and stormwater point sources have been identified or need to be identified varies by study area based on data availability, watershed size and complexity, and pollutant sources.

7.1. Seasonal Variation/Critical Conditions

These TMDLs will attain applicable surface water quality standards year round. The approach outlined in this paper is conservative given that in most cases fecal coliform data were collected during the summer months, a time when in-stream concentrations are typically the highest. This relationship is evidenced when calculating, on a monthly basis, the geometric mean of fecal coliform data collected statewide. Statewide fecal coliform geometric means during water years 1994-1997 were compared on a month basis and are shown in Figure 8. The 1994-1997 period was chosen for this analysis so that the significance of the number of individual datapoints for any given month was minimized. During the 1994-1997 period year-round sampling for fecal coliform was conducted by sampling four times throughout the year. Following 1997, the fecal coliform sampling protocol was changed to five samples during a 30-day period in the summer months. As evident in Figure 8, higher monthly geometric means are observed between May and September with the highest values occurring during mid-summer. This relationship is also evident when using the entire 1994-2002 dataset or datasets from individual water years. Given this relationship, summer is considered the critical period for violating fecal coliform SWQS and, as such, sampling during this period is considered adequate for meeting year round protections and designated uses.

Figure 8 **Statewide monthly fecal coliform geometric means during water years 1994-1997 using USGS/NJDEP data.**



7.2. Margin of Safety

A Margin of Safety (MOS) is provided to account for "lack of knowledge concerning the relationship between effluent limitations and water quality" (40 CFR 130.7(c)). For these TMDLs calculations, both an implicit and explicit Margin of Safety (MOS) are incorporated. Implicitly, a MOS is inherent in the estimates of current pollutant loadings, the targeted water quality goals (New Jersey's SWQS) and the allocations of loading. This was accomplished by taking conservative assumptions throughout the TMDL evaluation and development. Examples of some of the conservative assumptions include treating fecal coliform as a conservative substance, applying the fecal coliform criteria to stormwater point sources, and applying the fecal coliform criteria to the stream during all weather conditions. Fecal coliforms decay in the environment (i.e. outside the fecal tract) relatively rapidly, yet this analysis assumes a linear relationship between fecal load and instream concentration. Furthermore, it is generally recognized that fecal contamination from stormwater poses much less risk of illness than fecal contamination from sewage or septic system effluent (Cabelli, 1989). Finally, much of the fecal coliform is flushed into the system during rainfall events and passes through the system in a short time. Primary and secondary recreation generally occur during dry periods.

An explicit MOS is provided by incorporating a confidence level multiplier associated with log-normal distributions in the calculation of the load reduction for both the 200 and 400 standards. Using this method, the 200 and 400 targets are reduced based on the number of data points and the variability within each data set. For these TMDLs, a confidence level of 90% was used in calculating the MOS. As a result, and as identified in Appendix C, the target value will be different for each stream segment or grouped segments. The explicit margin of safety is calculated using the following steps:

1- FC data (x) will transformed to Log form data (y),
2- the mean of the Log- transformed data (y) is determined, $\bar{y}$
3- Determine the standard deviation of the Log-transformed data, S_y using the following equation:

$$S_y = \sqrt{\frac{\sum_i (y_i - \bar{y})^2}{N-1}}$$

4- Determine the Geometric mean of the FC data (GM)
5- Determine the standard deviation of the mean (standard error of the mean), $s_{\bar{y}}$, using the following equation:

$$s_{\bar{y}} = \frac{s_y}{\sqrt{N}}$$

6- For the 200 standard ($x_{standard}$), $y_{standard} = \text{Log}(200) = 2.301$, thus for a confidence level of 90%, the target value will be the lower confidence limit (n= -1.64), $y_{target} = y_{std} - n \cdot s_{\bar{y}}$, for example, the 200 criteria: $y_{target} = 2.301 - n^* s_{\bar{y}}$
7- The target value for x, $x_{target} = 10^{y\ target}$
8- The margin of safety (e) therefore will be $e = x_{standard} - x_{target}$
9- Finally, the load reduction = $\frac{GM - x_{target}}{GM} \cdot 100\%$, for example the 200 criteria will be defined as: $\frac{(GM - (200 - e))}{GM} \cdot 100\%$

The 400 criteria would be defined as: $\frac{(GM - (68 - e))}{GM} \cdot 100\%$

8.0 TMDL Calculations

Because these TMDLs are calculated based on ambient water quality data, the allocations are provided in terms of percent reductions. In the same way, the loading capacity of each stream is expressed as a function of the current load:

$LC = (1 - PR) \times L_o$, where

LC = loading capacity for a particular stream;
PR = percent reduction as specified in Tables 7-10;

L_o = current load.

8.1. Wasteload Allocations and Load Allocations

For the reasons discussed previously, these TMDLs do not include WLAs for traditional point sources (POTWs, industrial, etc.). WLAs are hereby established for all NJPDES-regulated point sources (including NJPDES-regulated stormwater), while LAs are established for all stormwater sources that are not subject to NJPDES regulation, and for all nonpoint sources. Both WLAs and LAs are expressed as percentage reductions for particular stream segments.

Table 13 identifies the required percent reduction necessary for each stream segment or group of segments to meet the fecal coliform SWQS. The reductions reported in these tables include a margin of safety factor and represent the higher percent reduction (more stringent) required of the two criteria. Reductions that are required under each criteria are located in Appendix C. In all cases, the 400 CFU/100ml criteria was the more stringent of the two criteria, thus values reported in Table 13 were equal to the percent required to meet the 400 CFU/100ml criteria.

Table 13 TMDLs for fecal coliform-impaired stream segments in the Atlantic Water Region as identified in Sublist 5 of the 2002 Integrated List of Waterbodies. The reductions reported in this table represent the higher, or more stringent, percent reduction required of the two fecal colifom criteria.

TMDL Number	WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)					Wasteload Allocation (WLA)
					Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	
1	12	10	10	Hollow Brook at Rt 35	7	383	43%	82%	90%	90%
2	12	14	14	Wreck Pond Brook at Allenwood Rd	7	84	40%	19%	51%	51%
3	12	16	16	Squankum Brook at Easy St in Howell	7	595	45%	89%	94%	94%
4	12	31	31, 01407617	Whale Pond Brook at Route 35, Whale Pond Brook at Larchwood Ave at Oakhurst	11	81	42%	16%	51%	51%
5 6	12	32, 33	32, 33	Lafetras Brook at Hope Rd, Husky Brook at South St	14	394	34%	83%	89%	89%
7	12	34	34	Pine Brook at Hockhockson Rd	7	123	40%	45%	67%	67%

TMDL Number	WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)					Wasteload Allocation (WLA)
					Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	
8 9	12	53, 54	53, 54	Ramanessin Brook at Willow Rd, Bordens Brook at Route 520	14	506	34%	87%	91%	91%
10 11 12 13	12	21, 52, 56, 57	21, 52, 56, 57	Big Brook at Maywood Drive, Willow Brook at Willow Brook Rd, Barren Neck Brook at Long Bridge Rd , Big Brook at Laurelwood Drive	28	513	22%	87%	90%	90%
14	12	01407090	01407090	Town Brook at Middletown	5	660	82%	90%	98%	98%
15	12	01407360	01407360	Yellow Brook near Malboro	5	528	37%	87%	92%	92%
16	12	01407630	01407630, 59	Poplar Brook at Deal, Poplar Brook at Ocean Ave.	12	800	33%	92%	94%	94%
17 18 19	12	01407868, 01407997, 01408000	01407868, 01407997, 01408000, 15, 24, 25	Long Brook at Wyckoff Mills, Marsh Bog Brook at Squankum, Manasquan River at Squankum, Yellow Brook at Elton-Adelphia Rd, Marsh Bog Brook at Preventorium Rd, Long Brook at Howell Rd.	69	682	20%	90%	92%	92%
20	12	01408009	01408009	Mingamahone Brook near Earle	20	236	26%	71%	79%	79%
21	13	7	7	Toms River at Route 537	5	288	42%	76%	86%	86%
22 23 24 25	13	17, 18, 19, 01408100	6, 17, 18, 19, 01408100	North Branch Metedeconk River at Jackson Mills Rd., Muddy Ford Brook at Lakewood-Allenwood Rd, Haystack Brook at Maxim-Southard Rd, Titmouse Creek at Friendship Rd, North Branch Metedeconk River at Lakewood	45	557	20%	88%	90%	90%
26	13	01408152	01408152	South Branch Metedeconk River near Laurelton	5	179	73%	62%	90%	90%
27	13	01408500	01408300, 01408500	Toms River at Whitesville, Toms River near Toms River	31	145	40%	53%	72%	72%
28	14	01409416	01409416	Hammonton Creek at Westcoatville	13	140	41%	51%	72%	72%
29	15	01411035	01411035	Hospitality Branch at Blue Bell Road near Ceci	20	262	45%	74%	86%	86%
30	15	01411110	01411110	Great Egg Harbor River at Weymouth	13	147	56%	54%	80%	80%
31	16	01411441	01411441	Savages Run in Belleplain State Forest	5	566	81%	88%	98%	98%

[1] MOS as a percent of target is equal to: $\frac{e}{200\ CFU/100ml}$ or $\frac{e}{68\ CFU/100ml}$ where "e" is defined as the MOS in Section 7.2

8.2. Reserve Capacity

Reserve capacity is an optional means of reserving a portion of the loading capacity to allow for future growth. Reserve capacities are not included at this time. The loading capacity of each stream is expressed as a function of the current load (Section 8.0), and both WLAs and LAs are expressed as percentage reductions for particular stream segments (Section 8.1). Therefore, the percent reductions from current levels must be attained in consideration of any new sources that may accompany future development. Strategies for source reduction will apply equally well to new development as to existing development.

9.0 Follow - up Monitoring

In association with the Water Resources Division of the U.S. Geological Survey, the NJDEP 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. Bacteria monitoring, as part of the ASMN network, are conducted five times during a consecutive 30-day summer period each year. The data from this network has been used to assess the quality of freshwater streams and percent load reductions. Although other units also perform monitoring functions, the ASMN will remain a principal source of fecal coliform monitoring.

10.0 Implementation

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).

Development of effective management measures depends on accurate source assessment. Fecal coliform is contributed to the environment from a number of categories of sources including human, domestic or captive animals, agricultural practices, and wildlife. Fecal coliform from these sources can reach waterbodies directly, through overland runoff, or through sewage or stormwater conveyance facilities. Each potential source will respond to one or more management strategies designed to eliminate or reduce that source of fecal coliform. Each management strategy has one or more entities that can take lead responsibility to effect the strategy. Various funding sources are available to assist in accomplishing the management strategies. The Department will address the sources of impairment through

systematic source trackdown, matching strategies with sources, selecting responsible entities and aligning available resources to effect implementation.

For example, the stormwater discharged to the impaired segments through "small municipal separate storm sewer systems" (small MS4s) will be regulated under the Department's proposed Phase II NJPDES stormwater rules for the Municipal Stormwater Regulation Program. Under those proposed rules and associated draft general permits, many municipalities (and various county, State, and other agencies) in the Atlantic Region will be required to implement various control measures that should substantially reduce bacteria loadings, including measures to eliminate "illicit connections" of domestic sewage and other waste to the small MS4, adopt and enforce a pet waste ordinance, prohibit feeding of unconfined wildlife on public property, clean catch basins, perform good housekeeping at maintenance yards, and provide related public education and employee training. Sewage conveyance facilities are potential sources of fecal coliform in that equipment failure or operational problems may result in the release of untreated sewage. These sources, once identified, can be eliminated through appropriate corrective measures that can be effected through the Department's enforcement authority. Inadequate on-site sewage disposal can also be a source of fecal coliform. Systems that were improperly designed, located or maintained may result in surfacing of effluent and illicit remedies such as connections to storm sewers or streams add human waste directly to waterbodies. Once these problems have been identified through local health departments, sanitary surveys or other means, alternatives to address the problems can be evaluated and the best solution implemented. The Department has committed a portion of its CWA 319(h) pass through grant funds to assist municipalities in meeting Phase II requirements. In addition, The New Jersey Environmental Infrastructure Financing Program, which includes New Jersey's State Revolving Fund, provides low interest loans to assist in correction of water quality problems related to stormwater and wastewater management.

Agricultural activities are another example of potential sources of fecal coliform. Possible contributors are direct contributions from livestock permitted to traverse streams and stream corridors, manure management from feeding operations, or use of manure as a soil fertilizer/amendment. Implementation of conservation management plans and best management practices are the best means of controlling agricultural sources of fecal coliform. Several programs are available to assist farmers in the development and implementation of conservation management plans and best management practices. 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). The New Jersey Departments of Environmental Protection and Agriculture, in partnership with the Farm Service Agency and Natural Resources Conservation Service, has recently submitted a proposal to the USDA to offer financial incentives for agricultural landowners to voluntarily implement conservation practices on agricultural lands through CREP. NJ CREP will be part of the USDA's Conservation Reserve Program (CRP). 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.

- **The Soil & Water Conservation Cost-Sharing Program** is available to participants in a Farmland Preservation Program pursuant to the Agriculture Retention and Development Act. A Farmland Preservation Program (FPP) means any voluntary FPP or municipally approved FPP, the duration of which is at least 8 years, which has as its principal purpose as long term preservation of significant masses of reasonably contiguous agricultural land within agricultural development areas. The maintenance and support of increased agricultural production must be the first priority use of the land. Eligible practices include erosion control, animal waste control facilities, and water management practices. Cost sharing is provided for up to 50% of the cost to establish eligible practices.

10.1. Source Trackdown

Through the watershed management process and New Jersey Watershed Ambassador Program, river assessments and visual surveys of the impaired segment watersheds were conducted to identify potential sources of fecal coliform. Watershed partners, who are intimately familiar with local land use practices, were able to share information relative to potential fecal coliform sources. The New Jersey Watershed Ambassadors Program is a community-oriented AmeriCorps environmental program designed to raise awareness about watershed issues in New Jersey. Through this program, AmeriCorps members are placed in watershed management areas across the state to serve their local communities. Watershed Ambassadors monitor the rivers of New Jersey through River Assessment Teams (RATs) and Biological Assessment Teams (BATs) volunteer monitoring programs. Supplemental training was provided through the fall/winter of 2002 to prepare the members to perform river assessments on the impaired segments. Each member was provided with detailed maps of the impaired segments within their watershed management area. The Department worked

with and through watershed partners and AmeriCorps members to conduct RATs surveys in fall of 2002. The Department reviewed monitoring data, RATs surveys, other information supplied by watershed partners, load duration curves, and aerial photography of the impaired segments to formulate segment specific strategies. Segment specific monitoring strategies in combination with generic strategies appropriate to the sources in each segment will lead to reductions in fecal coliform loads in order to attain SWQS.

10.2. Short-Term Management Strategies

Short-term management measures include projects recently completed, underway and planned. Pertinent measures in the Atlantic are as follows:

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- **Nonpoint Source Pollution Abatement Program for Little Silver Creek**
  Little Silver Borough was awarded $210,000, of which $150,000 is provided by 319H funds and the grantee providing $60,000 (through land donation). The project involves the rehabilitation of two ponds (Upper and Lower Pond) in Little Silver Borough located adjacent to and on an unnamed tributary to Little Silver Creek, which drains to the Navesink/Shrewsbury estuary. The ponds have accumulated sediment. Improvement will be made to the ponds, including dredging and landscaping, and they will function as extended wet pond systems to improve stormwater quality to Little Silver Creek and, thus, the Navesink/Shrewsbury estuary.

- **Best Management Practices for Horse Manure of Small Farms**
  Rutgers University recieved $228,417, of which $110,000 is provided by the 319H funds and the grantee providing $118,417.One of the most important sources of nonpoint source pollution in the coastal Monmouth County drainage basin is horse farms. This project addresses manure management of small horse farms in the Navesink River Watershed. Best management practices will be refined and implemented for horse manure management and an outreach program developed. Two different simple composters will be designed, constructed and monitored at the Rutgers University Animal Farms in New Brunswick for field application. Similar composting units will be constructed on at least two farms in the Navesink River Watershed. Best Management Practices will be developed with the data collected from the literature, the Rutgers University Animal Farms, and the two small-size horse farms in the Navesink River Watershed.

- **Manasquan River Riparian Restoration Project**
  Grantee is Friends of the Monmouth County Park System. The project amount is $135,000, of which $100,000 is provided by 319H funds and the grantee providing $35,000. The project involves the streamside assessment of park system lands to identify damaged riparian areas and BMPs appropriate for their restoration. The NRCS Stream Assessment Protocol combined with components of the Rosgen Analysis will be used as assessment tools. Once streams are assessed and ranked, appropriate BMPs will be identified for these locations. Priority sites will be targeted for restoration first and each site will be addressed as resources allow.

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- **The Development of a Strategic Water Quality Improvement Plan for Lake Carasljo** The Township of Lakewood received $100,000 to conduct a Phase 1 Lake Diagnostic/Feasibilty Study for Lake Carasaljo located in Lakewood, Ocean County. The purpose of the study is to: 1) Identify and assess the extent of pollutants entering the lake system; 2) determine the root cause and sources of pollutants and, 3) evaluate and provide recommendations for the most feasible and cost effective methods and measures for restoring and protecting the lake.

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- **The Borough of Folsom** was given a 319(h) grant for fiscal year 03 in the amount of $52,440 to clean out stormdrains. Most of the storm drains empty directly into the Great Egg Harbor River. Folsom falls in the middle of the impaired segment. Water testing will be done before and after to document differences in water quality. As part of outreach the environmental commission will stencil the cleaned storm drains to promote environmental awareness.

10.3. Long–Term Management Strategies

Long term strategies include source trackdown as well as selection and implementation of specific management measures that will address the identified sources. Source categories and responses are summarized below:

Source Category	Responses	Potential Responsible Entity	Funding options
Human Sources			
Inadequate (per design, operation, maintenance, location, density) on-site disposal systems	Confirm inadequate condition; evaluate and select cost effective alternative, such as rehabilitation or replacement of systems, or connection to centralized treatment system	Municipality, MUA, RSA	CWA 604(b) for confirmation of inadequate condition; Environmental Infrastructure Financing Program for construction of selected option
Inadequate or improperly maintained stormwater facilities; illicit connections	Measures required under Phase II Stormwater permitting program plus Alternative measures as determined needed through TMDL process	Municipalty, State and County regulated entities, stormwater utilities	CWA 319(h)

Source Category	Responses	Potential Responsible Entity	Funding options
Malfunctioning sewage conveyance facilities	Identify through source trackdown	Owner of malfunctioning facility--compliance issue	User fees
Domestic/captive animal sources			
Pets	Pet waste ordinances	Municipalities for ordinance adoption and compliance	
Horses, livestock, zoos	Confirm through source trackdown: SCD/NRCS develop conservation management plans	Property owner	EQIP, CRP, CREP (when approved),
Agricultural practices	Confirm through source trackdown; SCD/NRCS develop conservation management plans	Property owner	EQIP, CRP, CREP (when approved)
Wildlife			
Nuisance concentrations, eg resident Canada geese	Feeding ordinances; Goose Management BMPs	Municipalities for ordinance; Community Plans for BMPs	CBT, CWA 319(h)
Indigenous wildlife	Confirm through trackdown; consider revising designated uses	State	NA

10.4. Segment Specific Recommendations

10.4.1. Watershed Management Area 12

Hollow Brook at Route 35 in Neptune Twp (Site ID # 10)

The watershed is over 50percent urban land uses and 20 percent forested. There is a large amount of residential housing with the potential for domestic pets. There is also a large landfill which attracts a large number birds. Potential fecal sources include domestic pets and wildlife. Monitoring: a fecal survey is recommended to narrow the scope of the sources of impairment. Strategies: Phase II stormwater program.

Wreck Pond Brook at Allenwood Road in Wall (Site ID# 14)

The watershed land use is predominantly residential and agriculture. There are many farm ponds as well as detention ponds for the residential housing that attract large populations of Canadian Geese. In addition Hurley's Pond also attracts large geese populations. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Squankum Brook at Easy St. in Howell (Site ID # 16)

This segment has an extensive riparian buffer. Over 58percent of the land use is wetlands. The remaining land use is split evenly between forest, urban, and agricultural land uses. Sources include suburban stormwater, livestock and wildlife, including geese. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Big Brook at Maywood Drive in Marlboro (Site ID# 21), Willow Brook at Willow Brook Road in Holmdel (Site ID #52), Barren Neck Brook at Long Bridge Rd in Colts Neck (Site ID # 56), and Big Brook at Laurelwood Dr in Colts Neck (Site ID # 57)

The watershed is approximately 38 percent urban and 24 percent agricultural land uses. There are residential areas as well as a large park, evidence of domestic pet waste was observed. Animal husbandry operations and horse farms occur throughout the watershed. There are also many small impoundments. Potential fecal sources include domestic pets, livestock and geese. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Whale Pond Brook at Route 25 in Eatontown (Site ID # 31)

The predomiant land use of this watershed is urban and there is a significant amount of forest. There are scattered horse farms. Potential fecal sources include domestic pets, equine and geese. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Lafetras Brook at Hope Road in Tinton Falls (Site ID # 32) and Husky Brook at South Street in Eatontown (Site ID # 33)

This watershed is over 70 percent urban land uses. Strategies: organize local community based goose management programs. Phase II stormwater program.

Pine Brook at Hockhockson Road in Tinton Falls (Site ID # 34)

The segment flows through a forested area. There are scattered homes within the watershed, as well. The primary source of fecal coliform is wildlife.

Ramanessin Brook at Willow Road in Holmdel (Site ID # 53) and Bordens Brook at Route 520 in Holmdel (Site ID # 54)

The predominant land use of the watershed is urban. There are many detention basins that serve the residential areas that attract large populations of Canada geese. There are also many horse farms throughout the watershed. Potential fecal sources include equine, domestic pets and geese. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Town Brook at Middletown (Site ID # 01407090)

Over 60 percent of the watershed is urban including both residential and commercial land uses. Waterfowl were observed in the brook. The high school athletic fields may attract geese. Potential fecal sources are geese and domestic pets. Monitoring: a fecal coliform survey is recommended to focus on the significant sources of impairment. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Yellow Brook near Marlboro (Site ID # 0107360)

Approximately 41 percent of the watershed is urban and 20 percent is agriculture. Evidence of domestic pets was observed as well as livestock. There is a large open field with a pond that attracts Canada geese. Monitoring: a fecal survey is recommended to narrow the scope of the significant sources of impairment. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Poplar Brook at Deal (Site ID # 01407630)

This is area is primarily residential. Detention basins that serve the residential areas, as well as golf courses within the watershed, attract populations of Canada geese. Potential sources are suburban stormwater and geese. Strategies: organize local community based goose management programs. Phase II stormwater program.

Long Brook at Wyckoff Mills (Site ID #01407868)

This watershed is a mix of residential and agricultural land uses. This area is actively being developed. There are older homes along the stream that are on septic systems Monitoring: coliphage monitoring is needed to determine if human sources are present. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Marsh Bog Brook at Squankum (Site ID # 01407997)

This watershed is mixed urban and agricultural land uses**.** There are many farms with pastureland for livestock including horses, pigs, and sheep. Pastureland observed is within 300 feet of the streambank. Monitoring: a fecal survey is recommended to narrow the scope of the major sources of impairment. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Manasquan River at Squankum (Site ID # 01408000)

Canada geese observed throughout the watershed on fields and in the stream itself. Geese fecal matter was observed along portions of the streambank. The impaired segment flows through a golf course. There are many farms with pastureland for livestock. Potential fecal sources include geese and livestock. Monitoring: a fecal survey is recommended to narrow the scope of the major sources of impairment. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Mingamahoe Brook Near Earle (Site ID # 01408009)

The predominent land use of the watershed is forest. This watershed is rural and does not receive sewer service. There are some homes, including a trailer park that may have septic system problems. Potential fecal coliform sources include wildlife and failing septics. Monitoring coliphage monitoring is needed to determine if human sources are present.

10.4.2. Watershed Management Area 13

Toms River at Route 537 in Millstone (Site ID# 7)

The land use of the watershed is mixed forest, urban and agriculture. There are horses in the upstream portion of the segment. Residential housing is present and the stream is well buffered from the homes. Potential fecal coliform sources include livestock, domestic pets and wildlife. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

North Branch Metedeconk River at Lakewood (Site ID # 01408100), Muddy Ford Brook at Lakewood-Allentown Rd in Howell (Site ID#17), Haystack Brook at Maxim-Southard Road in Howell (Site ID # 18) and Titmouse Creek at Friendship Road in Howell (Site ID #19)

The predominant land use of the watershed is urban which is comprised of mixed residential and commercial facilities. There are agricultural properties, many housing livestock. There are many horse farms along the stream. Geese were observed on inactive farm fields. There is a golf course within the watershed that may attract Canada geese. Aldrich Lake attracts a population of Canada geese for

most of the year. The lake is also an area were residents walk their pets. Monitoring: a fecal survey is recommended to narrow the scope of the major sources of impairment. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

South Branch Metedeconk River near Laurelton (Site ID #01408152)

There are three lakes within this watershed: Lake Enno, Lake Shenandoah, Lake Carasaljo. There are homes surrounding Lake Enno, and the lake attracts Canada geese. Lake Shenandoah is within a park that has a sports complex with ball fields, picnic areas etc. The park is heavily used by geese for most of the year. Lake Carasaljo also is within a park and attracts geese as well. Livestock were also observed within the watershed. Monitoring: a fecal survey is recommended to narrow the scope of the major sources of impairment. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

Toms River near Toms River (Site ID # 01408500) and Tom's River at Whitesville (Site ID # 01408300)

Many of the communities in this streamshed are older homes that are on septic systems. There are instances where these homes are in close proximity to the stream. A portion of the impaired segment flows through Winding River Park. The park has many ball fields that attracted Canada geese and also attract visitors walking their dogs. There are some farms upstream but presence of livestock is unknown. Monitoring: Coliphage monitoring is needed to determine the presence of human sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

10.4.3. Watershed Management Area 14

Hammonton Creek at Westcoatville (Site ID # 01409416)

Hammonton Lake, which frequently has impairment due to fecal coliform level, empties into Hammonton Creek. Hammonton Lake has a swimming beach whichwas closed for almost half of the summer of 2001. The segment flows through the fairway of the Frog Rock Country Club. The southern most branch of the segment ends in a pond on one of the greens. In the middle of the country club grounds, there is housing. The segment runs along Route 542, which is a relatively busy road. There are a number of large housing developments going up along 542. Monitoring: a fecal survey to narrow the scope of the significant sources, as well as coliphage monitoring to determine if human sources are present, are both recommended. Strategies: organize local community based goose management programs. Phase II stormwater program.

10.4.4. Watershed Management Area 15

Great Egg Harbor River at Weymouth (Site ID # 01411110)

There are a number of stormdrains that enter into the stretch. There is a significant amount of wildlife present. An excellent buffer and canopy was observed. The surrounding land use is mostly forest. In general the segment is buffered from the major roads 500-1000 feet, with the exception of a few spots near bridge crossings. Monitoring: additional monitoring needed to confirm impairment.

Hospitality Branch at Blue Bell Road (Site ID # 01411035)

This watershed land use is mixed forest, urban and agriculture. This area is actively being developed. Horses were observed in limited numbers. Timber Lake attracts populations of Canada geese. There is also a day camp within the watershed. Monitoring: coliphage monitoring is needed to determine if human sources are present. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs. Phase II stormwater program.

10.4.5. Watershed Management Area 16

Savages Run (Site ID # 011411441)

Field verification indicated no obvious sources of fecal coliform besides wildlife. In addition no structural stormwater exists in the area of the impaired segment. The watershed of the impaired segment includes Belleplain State Park and Forest. Monitoring: additional monitoring is recommended to confirm impairment.

10.5. Pathogen Indicators and Bacterial Source Tracking

Advances in microbiology and molecular biology have produced several methodologies that discriminate among sources of fecal coliform and thus more accurately identify pathogen sources. The numbers of pathogenic microbes present in polluted waters are few and not readily isolated nor enumerated. Therefore, analyses related to the control of these pathogens must rely upon indicator microorganisms. The commonly used pathogen indicator organisms are the coliform groups of bacteria, which are characterized as gram-negative, rod-shaped bacteria. Coliform bacteria are suitable indicator organism because they are generally not found in unpolluted water, are easily identified and quantified, and are generally more numerous and more resistant than pathogenic bacteria (Thomann and Mueller, 1987).

Tests for fecal organisms are conducted at an elevated temperature (44.5°C), where the growth of bacteria of non-fecal origin is suppressed. While correlation between indicator organisms and diseases can vary greatly, as seen in several studies performed by the EPA and others, two indicator organisms *Esherichia coli* (*E. coli*) and enterococci species showed stronger correlation with incidence of disease than fecal coliform (USEPA, 2001). Recent

advances have allowed for more accurate identification of pathogen sources. A few of these methods, including, molecular, biochemical, and chemical are briefly described in the following paragraph.

Molecular (genotype) methods are based on the unique genetic makeup of different strains, or subspecies, of fecal bacteria (Bowman et al, 2000). An example of this method includes "DNA fingerprinting" (i.e., a ribotype analysis which involves analyzing genomic DNA from fecal *E. coli* to distinguish human and non-human specific strains of *E. coli*.). Biochemical (phenotype) methods include those based on the effect of an organism's genes actively producing a biochemical substance (Graves et al., 2002; Goya et al 1987). An example of this method is multiple antibiotic resistance (MAR) testing of fecal *E. coli*. In MAR testing, *E. coli* are isolated from fecal samples and exposed to 10-15 different antibiotics. In theory, *E. coli* originating from wild animals should show resistance to a smaller number of antibiotics than *E. coli* originating from humans or pets. Given this general trend, MAR patterns or '"signatures" can be defined for each class of *E. coli* species. Chemical methods are based on finding chemical compounds associated with human wastewater, and useful in determining if the sources are human or non-human. Such methods measure the presence of optical brighteners, which are contained in all laundry detergents, and soap surfactants in the water column. Unlike the optical brightener method, the measurement of surfactants may allow for some quantification of the source.

BST methods have already been successfully employed at the NJDEP in the past decade. Since 1988, the Department's Bureau of Marine Water Monitoring has worked cooperatively with the University of North Carolina in developing and determining the application of RNA coliphage as a pathogen indicator. This research was funded through USEPA and Hudson River Foundation grants. These studies showed that the RNA coliphages are useful as an indicator of fecal contamination, particularly in chlorinated effluents and that they can be serotyped to distinguish human and animal fecal contamination. Through these studies, the Department has developed an extensive database of the presence of coliphages in defined contaminated areas (point human, non-point human, point animal, and non-point animal). More recently, MAR and DNA fingerprinting analyses of *E. coli* are underway in the Manasquan estuary to identify potential pathogen sources (Palladino and Tiedemann, 2002). These studies along with additional sampling within the watershed will be used to implement the necessary percent load reduction.

10.6. Reasonable Assurance

With the implementation of follow-up monitoring, source identification and source reduction as described for each segment, the Department has reasonable assurance that New Jersey's Surface Water Quality Standards will be attained for fecal coliform. The Department proposes to undertake the identified monitoring responses beginning in 2003-2004. As a generalized strategy, the Department proposes the following with regard to categorical sources: 1) As septic system sources are identified through the monitoring responses, municipalities will be encouraged to enter the Environmental Infrastructure Financing Program, which includes New Jersey's State Revolving Fund, to evaluate, select and

implement the best overall solution to such problems; 2) To address storm water point sources, the Phase II stormwater permitting program will require control measures to be phased in from the effective date of authorization to 60 months from that date; 3) The locations of impaired segments with significant agricultural land uses will be provided to the State Technical Committee for consideration in the FFY 2004 round of EQIP project selection; 4) Through continuing engagement of watershed partners, measures to identify and address other sources will be pursued, including encouragement and support of community based goose management programs, where appropriate. The Department has dedicated a portion of its Corporate Business Tax and FY 2002 Clean Water Act Section 319(h) funds to carry out the segment specific source trackdown recommendations. A portion of FY 2003 319(h) funds will be dedicated to assisting municipalities in implementing the requirements of the Phase II municipal stormwater permitting program.

The fecal coliform reductions proposed in these TMDLs assume that existing NJPDES permitted municipal facilities will continue to meet New Jersey's Surface Water Quality Standard requirements for disinfection. Any future facility will be required to meet water quality standards for disinfection.

The Department's ambient monitoring network will be the means to determine if the strategies identified have been effective. Where trackdown monitoring has been recommended, the results of this monitoring as well as ambient monitoring will be evaluated to determine if additional strategies for source reduction are needed.

11.0 Public Participation

The Water Quality Management Planning Rules NJAC 7:15-7.2 require the Department to initiate a public process prior to the development of each TMDL and to allow public input to the Department on policy issues affecting the development of the TMDL. Further, the Department shall propose each TMDL as an amendment to the appropriate areawide water quality management plan in accordance with procedures at N.J.A.C. 7:15-3.4(g). As part of the public participation process for the development and implementation of the TMDLs for fecal coliform in the Atlantic Coastal Region, the Department worked collaboratively with a series of stakeholder groups as part of the Department's ongoing watershed management efforts.

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- The PAC executive committee was briefed about the executed MOA between the Department and EPA region 2 and copies of the MOA were distributed at the Executive Committee meeting held on 10/28/02
- Presentation was made to the PAC executive committee on 11/25/02; requested PAC review and comment on the list and maps of the streams scheduled for expedited TMDLs.

- Expedited fecal coliform TMDL presentation was given at a special meeting of interested members of the PAC on 11/26/02.

WMA 13

- A Power Point presentation on the new Integrated List methodology was given to the Barnegat Bay Estuary Program (BBEP) Science and Technical Advisory Committee (STAC) on 12/10/02 and to the BBEP-Advisory Committee (AC) on 2/4/02.
- An overview on the expedited TMDL process and a request for local input and information occurred at the BBEP-AC on 12/17/02.

WMA 14

- A meeting was held with the Technical Advisory Group (TAG), in the Fall of 2002, where multiple issues were discussed, including an overview of the expedited TMDL process and discussion of the new Integrated List methodology. A request was made for local input and participation and the Pinelands Commission subsequently queried their sciences office to research available technical information and disseminated the request for stakeholder input to their members.

WMA 15

- Stakeholder participation and input was coordinated through the Great Egg Harbor River Association. The Department held meetings with the river administrator to discuss the expedited TMDLs on 10/15/02, 11/7/02 and 12/10/02.

WMA 16

- The Integrated Listing Methodology was an ongoing discussion at the TAC meetings beginning 6/14/01. The TAC reviewed the proposed 2002 Integrated Water Quality Monitoring and Assessment Methods Document and the proposed 2002 Integrated List of Waterbodies and submitted comments to the Department on 7/3/2002. Because the only impaired segment is contained within Belleplain State Park and Forest stakeholder input on potential sources was not pursued.

Additional input was received through the NJ EcoComplex (NJEC). The Department contracted with NJEC in July 2001. The NJEC consists of a review panel of New Jersey University professors whose role is to provide comments on the Department's technical approaches for development of TMDLs and management strategies. The New Jersey Statewide Protocol for Developing Fecal TMDLs was presented to NJEC on August 7, 2002 and was subsequently reviewed and approved. The protocol was also presented at the SETAC Fall Workshop on September 13, 2002 and met with approval.

Amendment Process

In accordance with N.J.A.C. 7:15–7.2(g), these TMDLs are hereby proposed by the Department as an amendment to Lower Delaware Water Quality Management Plan (WQMP), Mercer, Monmouth and Ocean Counties WQMP, and Tri-County WQMP.

Notice proposing these TMDLs was published April 21, 2003 in the New Jersey Register and in newspapers of general circulation in the affected area in order to provide the public an opportunity to review the TMDLs and submit comments. In addition, a public hearing will be held on May 22, 2003. Notice of the proposal and the hearing has also been provided to applicable designated planning agencies and to affected municipalities.

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Appendix A: Explanation of stream segments in Sublist 5 of the *2002 Integrated List of Waterbodies* for which TMDLs will not be developed in this report.

River segments to be moved from Sublist 5 to Sublist 3 for fecal coliform.

- **#01407760, Jumping Brook near Neptune City**
- **#01407705, Shark River near Neptune City**

Station #01407705 was included on Sublist 5 based on its inclusion on previous 303(d) lists with no recent data to assess their current attainment status. The Monmouth County Health Department has monitored in the Shark River watershed at Station #30, Shark River Brook data at Shark River Station Rd. The MCHD has collected twenty-seven fecal coliform samples during the years 1995-2002. The geometric mean of this dataset is 31 CFU/100ml with only one value over 400 CFU/100ml and results in a status of non-impairment. Station #01407760 was included on Sublist 5 of the 2002 Integrated List based on less than five data points. Therefore, TMDLs will not be developed for these locations until further monitoring is conducted and indicate violation(s) of the surface water quality standards.

Appendix B: Municipal POTWs Located in the TMDLs' Project Areas

WMA	Station #	NJPDES	Facility Name	Discharge Type[a]	Receiving waterbody
12	57	NJ0022586.001A	Marlboro Psychiatric Hospital	MMI	Big Brook
12	53 & 54	NJ0027031.001A	Holmdel BOE - Village School	MMI	Ramanessin (Hop) Brook
13	1408500	NJ0031267.001A	Oak Tree MHP	MMI	Toms River via unnamed trib
13	1408500	NJ0029513.001A	Jackson Twp BOE STP	MMI	Toms River
14	1409416	NJ0025160.001A	Hammonton WTPF	MMJ	Hammonton Creek

[a] "MMI" indicates a Municipal Minor discharge and "MMJ" indicates Municipal Major discharge.

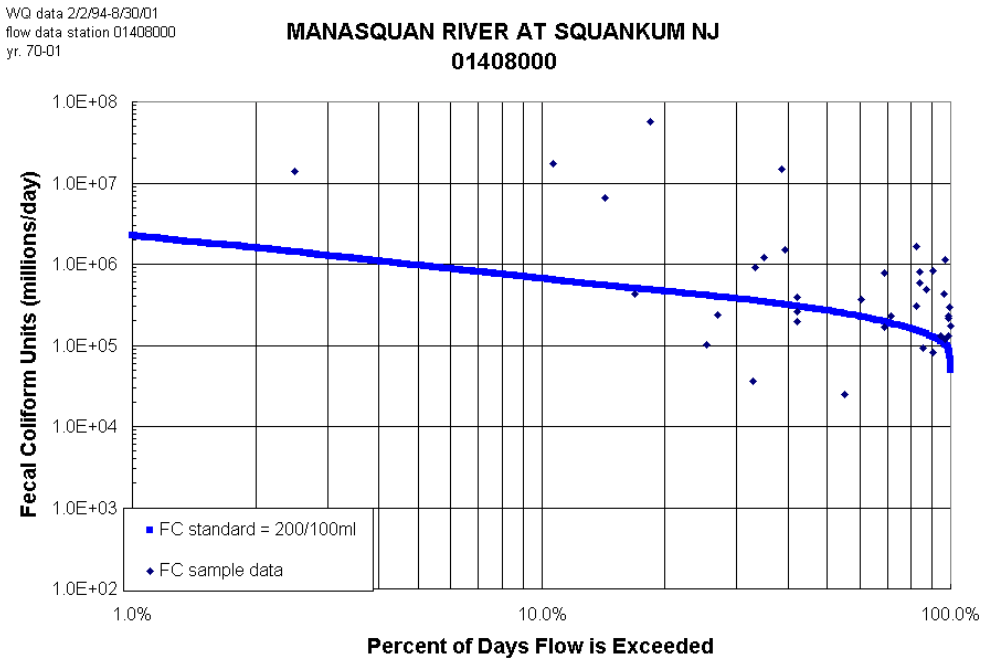
Appendix C: TMDL Calculations

WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)										Wasteload Allocation (WLA)	Period of record used in analysis
				200 FC/100ml Standard					400 FC/100ml Standard						
				N (# of values)	Geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS		
12	10	10	Hollow Brook at Rt 35	30	163	43%	-23%	30%	7	383	43%	82%	90%	90%	10/11/95 - 12/10/02
12	14	14	Wreck Pond Brook at Allenwood Rd	30	66	40%	-205%	-84%	7	84	40%	19%	51%	51%	10/11/95 - 12/10/02
12	16	16	Squankum Brook at Easy St in Howell	29	104	45%	-93%	-7%	7	595	45%	89%	94%	94%	10/17/95 - 12/17/02
12	31	31, 01407617	Whale Pond Brook at Route 35, Whale Pond Brook at Larchwood Ave at Oakhurst	32	43	42%	-364%	-171%	11	81	42%	16%	51%	51%	10/24/95 - 12/17/02
12	32, 33	32, 33	Lafetras Brook at Hope Rd, Husky Brook at South St	54	145	34%	-38%	9%	14	394	34%	83%	89%	89%	10/24/95 - 12/17/02
12	34	34	Pine Brook at Hockhockson Rd	28	82	40%	-145%	-48%	7	123	40%	45%	67%	67%	10/24/95 - 12/17/02
12	53, 54	53, 54	Ramanessin Brook at Willow Rd, Bordons Brook at Route 520	54	135	34%	-49%	2%	14	506	34%	87%	91%	91%	10/10/95 - 12/3/02
12	21, 52, 56, 57	21, 52, 56, 57	Big Brook at Maywood Drive, Willow Brook at Willow Brook Rd, Barren Neck Brook at Long Bridge Rd , Big Brook at Laurelwood Drive	112	124	22%	-62%	-26%	28	513	22%	87%	90%	90%	10/10/95 - 12/17/02
12	01407090	01407090	Town Brook at Middletown	5	660	82%	70%	95%	5	660	82%	90%	98%	98%	6/2/98 - 9/9/98
12	01407360	01407360	Yellow Brook near Malboro	5	528	37%	62%	76%	5	528	37%	87%	92%	92%	7/1/99 - 7/29/99
12	01407630	01407630, 59	Poplar Brook at Deal, Poplar Brook at Ocean Ave.	34	285	33%	30%	53%	12	800	33%	92%	94%	94%	10/24/95 - 12/3/02

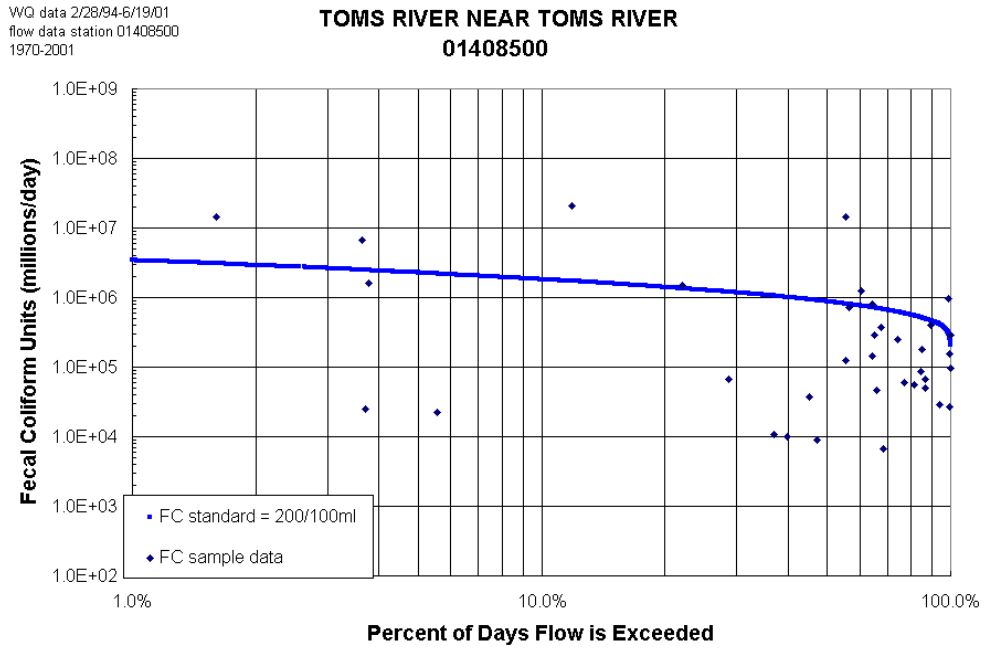
WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)										Wasteload Allocation (WLA)	Period of record used in analysis
				200 FC/100ml Standard					400 FC/100ml Standard						
				N (# of values)	Geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS		
12	01407868, 01407997, 01408000	01407868, 01407997, 01408000, 15, 24, 25	Long Brook at Wyckoff Mills, Marsh Bog Brook at Squankum, Manasquan River at Squankum, Yellow Brook at Elton-Adelphia Rd, Marsh Bog Brook at Preventorium Rd, Long Brook at Howell Rd.	141	162	20%	-23%	1%	69	682	20%	90%	92%	92%	2/2/94 - 12/10/02
12	01408009	01408009	Mingamahone Brook near Earle	20	236	26%	15%	38%	20	236	26%	71%	79%	79%	6/3/98 - 8/30/01
13	7	7	Toms River at Route 537	27	47	42%	-323%	-145%	5	288	42%	76%	86%	86%	10/3/95 - 12/18/02
13	17, 18, 19, 01408100	6, 17, 18, 19, 01408100	North Branch Metedeconk River at Jackson Mills Rd., Muddy Ford Brook at Lakewood-Allenwood Rd, Haystack Brook at Maxim-Southard Rd, Titmouse Creek at Friendship Rd, NB Metedeconk River at Lakewood	133	120	20%	-67%	-34%	45	557	20%	88%	90%	90%	10/3/95 - 12/18/02

WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)										Wasteload Allocation (WLA)	Period of record used in analysis
				200 FC/100ml Standard					400 FC/100ml Standard						
				N (# of values)	Geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS		
13	01408152	01408152	SB Metedeconk River near Laurelton	5	179	73%	-12%	70%	5	179	73%	62%	90%	90%	7/20/99 - 8/5/99
13	01408500	01408300, 01408500	Toms River at Whitesville, Toms River near Toms River	42	65	40%	-208%	-85%	31	145	40%	53%	72%	72%	2/28/94 - 6/19/01
14	01409416	01409416	Hammonton Creek at Westcoatville	23	77	41%	-161%	-53%	13	140	41%	51%	72%	72%	1/25/94 - 9/17/98
15	01411035	01411035	Hospitality Branch at Blue Bell Road near Ceci	20	262	45%	24%	58%	20	262	45%	74%	86%	86%	6/4/98 - 8/7/01
15	01411110	01411110	Great Egg Harbor River at Weymouth	23	31	56%	-551%	-185%	13	147	56%	54%	80%	80%	2/16/94 - 9/17/98
16	01411441	01411441	Savages Run in Belleplain State Forest	5	566	81%	65%	93%	5	566	81%	88%	98%	98%	6/7/99 - 7/6/99

Appendix D: Load Duration Curves for each listed waterbody



Load Duration Curve for Manasquan River At Squankum. Fecal coliform data from USGS station # 01408000 during the period 2/2/94 through 8/30/01. Water years 1970-2001 from USGS station # 01408000 were used in generating the FC standard curve.



Load Duration Curve for Toms River Near Toms River. Fecal coliform data from USGS station # 01408500 during the period 2/28/94 through 6/19/01. Water years 1970-2001 from USGS station # 01408500 were used in generating the FC standard curve.