MUNICIPAL STORMWATER MANAGEMENT PLAN
MASTER PLAN ELEMENT

TOWNSHIP OF MIDDLETOWN
MONMOUTH COUNTY, NEW JERSEY

Adopted: March 30, 2005

Dated: March 18, 2005

PREPARED FOR

MIDDLETOWN TOWNSHIP PLANNING BOARD

PREPARED BY:

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MARCH 2005

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John Deus, Vice Chairman

Bernadette McManus

Cliff Raisch

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Rosemary Minear, Planning and Zoning Board Secretary

T&M Associates, Stormwater Management Consultant

TOWNSHIP OF MIDDLETOWN PLANNING BOARD

RESOLUTION ADOPTING MUNICIPAL STORMWATER MANAGEMENT PLAN MASTER PLAN ELEMENT

WHEREAS, the Planning Board is a duly constituted approving authority created pursuant to the provisions of N.J.S.A. 40:55D-23 of the Municipal Land Use Law; and

WHEREAS, pursuant to N.J.S.A. 40:55D-28, the Planning Board may prepare and after public hearing, may amend a Master Plan or component parts thereof to guide the use of lands within the municipality in a manner which protects public health and safety and promotes the general welfare; and

WHEREAS, pursuant to N.J.A.C. 7:8-4.3(a), a municipality shall adopt a Municipal Stormwater Management Plan as an integral part of its Master Plan; and

WHEREAS, pursuant to N.J.A.C. 7:8-1.1 et. seq., the Planning Board has prepared a Municipal Stormwater Management Plan - Master Plan Element in order to comply with the requirements set forth in the New Jersey Administrative Code for Municipal Stormwater Management Planning; and

WHEREAS, pursuant to the requirements of the Municipal Land Use Law, N.J.S.A. 40:55D-1 et. seq. And specifically N.J.S.A. 40:55D-28 and N.J.S.A. 40:55D-13, the Planning Board conducted a public hearing on the 30th day of March 2005, due notice of said meetings having been given in accordance with New Jersey Statutes, the Open Public Meetings Act and the Municipal Land Use Law and a quorum of the Planning Board being present, the Planning Board reviewed and considered the proposed Municipal Stormwater Management Plan - Master Plan Element along with any public comment thereon and the Planning Board having determined that the Municipal Stormwater Management Plan - Master Plan Element is in compliance with the

requirements of the Municipal Land Use Law and the requirements for Stormwater Management pursuant to the applicable sections of the New Jersey Administrative Code.

NOW THEREFORE BE IT RESOLVED, by the Planning Board of the Township of Middletown on this 30th day of March 2005 that the Municipal Stormwater Management Plan - Master Plan Element prepared by William P. Farrell, Jr., P.E., P.P., Acting Middletown Township Engineer, dated March 2005 is hereby adopted.

ON A MOTION BY Wm. Warters and seconded by Cliff Raisch the amendment to the Master Plan is approved based upon the following vote:

AYES: Deus, McManus, Prewett, Raisch, Rathjen, Stanley Coleman, Strong, Warters
NAYS: None
ABSTAIN:
ABSENT: Peters, Soper, Unsinn

Rosemary Minear

Rosemary Minear, Secretary
Planning Board

I, Rosemary Minear, Secretary to the Township of Middletown Planning Board do hereby certify that the foregoing is a true copy of a Resolution adopted by the Planning Board on this 30th day of March, 2005.

Rosemary Minear

Rosemary Minear, Secretary
Planning Board

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I. INTRODUCTION

As a result of the publication of the United States Environmental Protection Agency (USEPA) Phase II rules in December 1999, the New Jersey Department of Environmental Protection (NJDEP) promulgated new stormwater regulations to address non-point source pollution entering surface and ground waters of the State of New Jersey. Under these regulations, municipalities where issued a New Jersey Pollutant Discharge Elimination System (NJPDES) Permit that established various statewide basic requirements. One of these requirements is the development and adoption of an amendment to their overall Master Plan to address stormwater pollution associated with major development.

As required by the Municipal Stormwater Regulations (N.J.A.C. 7:14A-25), the Township of Middletown has developed this Municipal Stormwater Management Plan (MSWMP) to outline their approach to addressing the impacts resulting from stormwater related issues associated with future development and land use changes. The intent of this MSWMP is to address groundwater recharge, stormwater quantity, and stormwater quality impacts through the incorporation of stormwater design and performance standards for new development and redevelopment projects that disturb one or more acres of land or increase impervious surface by more than 0.25 acres. The design and performance standards will minimize negative or adverse impacts of stormwater runoff such as decreased water quality, increased water quantity and reduction of groundwater recharge that provides base flow to receiving bodies of water. In addition to minimizing these impacts, the Township's MSWMP will provide for long term operation and maintenance measures for existing and proposed stormwater management facilities.

To protect the health, safety, and welfare of the local and regional population, this MSWMP outlines strategies for managing stormwater and conserving the natural resources of the Township and its' watershed area. This element complements other sections of the *Middletown Township Master Plan*, including the Land Use Element, Open Space, Recreation, and Conservation Plan Element, and the Utility Service Element that addresses the sewer infrastructure and storm drainage systems.

This MSWMP also provides recommendations for proposed ordinance modifications in order to implement the NJDEP's stormwater management strategies and includes a full build-out analysis and mitigation strategies to allow the Township to grant variances or exemptions from proposed design and performance standards set forth in this document and by the Municipal Stormwater Regulations (N.J.A.C. 7:8-5.5).

Although they are located within the Township, this plan does not cover the Garden State Parkway, the Gateway National Recreation area (Sandy Hook), Hartshorne Woods Park, Thompson Park, Monmouth Cove Marina, Bayshore Trail System, Bayshore Waterfront Park, and the Earle Naval Base, since these facilities are covered by either the federal government, the New Jersey Highway Authority or the Monmouth County New Jersey Pollutant Discharge Elimination System (NJPDES) permit. Also not included is the Brookdale Community College (BCC) which is covered under the BCC Public Complex Stormwater General Permit.

GOALS AND OBJECTIVES

The goals of this MSWMP are to:

1. Reduce flood damage, including damage to life and property;
2. Minimize, to the extent practical, any increase in stormwater runoff from any new development;
3. Reduce soil erosion from any development or construction project;
4. Encourage the adequacy of existing and proposed culverts and bridges, and other in-stream structures;
5. Maintain groundwater recharge;
6. Prevent, to the greatest extent feasible, an increase in non-point source pollution;
7. Maintain the integrity of stream channels for their biological function, as well as for drainage;
8. Minimize pollutants in stormwater runoff from new and existing development to restore, enhance, and maintain the chemical, physical, and biological integrity of the waters of the

state, to protect public health, to safeguard fish and aquatic life and scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial, commercial and other uses of water;

9. Protect public safety through the proper design and operation of stormwater basins.

In addition to the State mandated goals described above, this MSWMP compliments the *Township of Middletown Master Plan*, dated October 2004, and encourages the goals noted below. This MSWMP also includes broad goals from the *McClees Creek Planning Area Study* included in the 2004 *Master Plan*.

10. Encourage efficient management of stormwater to prevent future drainage problems and promote environmentally sound land use planning.
11. Promote conservation of open space through the protection of wetlands, stream corridors, steep slopes and valuable natural resources and prevent the degradation of the environment through improper use of land.
12. Enhance various neighborhoods by providing appropriate redevelopment, reinvestment, revitalization, and capital improvements designed to strengthen and improve the fabric of the area.
13. Protect the shellfish habitat of the Navesink River.
14. Protect the Swimming River Reservoir.

To achieve these goals, the MSWMP outlines specific stormwater design and performance standards for new development and proposes stormwater management controls for addressing impacts from existing developments. Preventive and corrective maintenance strategies are also included to ensure the long-term effectiveness of stormwater management facilities and the MSWMP outlines safety standards for stormwater infrastructure to be implemented to protect public safety.

II. STORMWATER DISCUSSION

HYDROLOGIC CYCLE

The hydrologic cycle, or water cycle (Figure 1), is the continuous circulation of water between the ocean, atmosphere, and the land. The driving force of this natural cycle is the sun. Water, stored in oceans, depressions, streams, rivers, waterbodies, vegetation and even land surfaces, constantly evaporates due to solar energy. This water vapor then condenses in the atmosphere to form clouds and fog. After water condenses, it precipitates, usually in the form of rain or snow, onto land surfaces and waterbodies. Precipitation falling on land surfaces is often intercepted by vegetation. Plants and trees transpire water vapor back into the atmosphere, as well as aid in the infiltration of water into the soil. The vaporization of water through transpiration and evaporation is called evapo-transpiration. Infiltrated water percolates through the soil as groundwater, while water that flows overland is called surface water. Water flows across or below the surface to reach major water bodies and aquifers and eventually flow to the Earth's seas and oceans. This constant process of evapo-transpiration, condensation, precipitation, and infiltration comprises the hydrologic cycle.

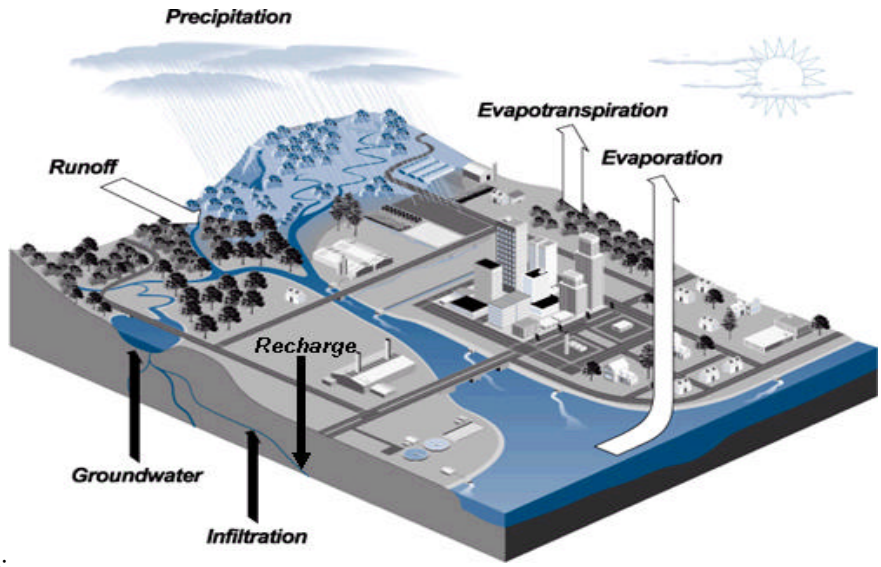
IMPACTS OF STORMWATER

As towns and cities develop from rural agricultural communities, the landscape is altered in dramatic ways. Both residential and non-residential development on former agricultural fields and pastures have a great impact on the hydrologic cycle for the specific site. Localized impacts to the hydrologic cycle will ultimately impact the hydrologic cycle of the entire watershed encompassing the development site.

Prior to any land development, native vegetation often intercepts precipitation directly or absorbs infiltrated runoff into their roots. Development often replaces native vegetation with lawns or impervious cover, such as pavement or structures, thereby reducing the amount of evapo-transpiration and infiltration. Regrading and clearing of lots disturbs the natural topography of rises and depressions that can naturally capture rainwater and allow for infiltration and evaporation. Construction activities often compact soil, thereby decreasing its permeability or

ability to infiltrate stormwater. Development activities also generally increase the volume of stormwater runoff from a given site.

Figure 1: The Hydrologic Cycle



Definitions:
Runoff – water that travels over the ground surface to a channel
Groundwater flow – movement of water through the subsurface
Infiltration – penetration of water through the ground surface
Recharge – water that reaches saturated zone

Source: Kern River Connections http://www.creativille.org/kernriver/watershed.htm

Connected impervious surfaces and storm sewers (such as roof gutters emptying into a paved parking lot that drains into a storm sewer) allow the runoff to be transported downstream more rapidly than natural areas. This shortens travel time and increases the rainfall- runoff response of the drainage area, causing downstream waterways to peak higher and quicker than natural areas, a situation that can cause or exacerbate downstream flooding, and sedimentation in stream channels. Furthermore, connected impervious surfaces do not allow pollutants to be filtered, or for infiltration and ground water recharge to occur prior to reaching the receiving waters. Increased volume combined with reduced base flow results in a greater fluctuation between normal and storm flows causing greater channel erosion. Additionally, reduced base flows, increased fluctuation, and soil erosion can affect the downstream hydrology, impacting ecological integrity.

Water quantity impacts, combined with land development, often adversely affects stormwater quality. Impervious surfaces collect pollutants from the atmosphere, animal wastes, fertilizers and pesticides, as well as pollutants from motor vehicles. Pollutants such as hydrocarbons, metals, floatable solids, suspended solids, pathogens, and organic and nitrogen containing compounds, collect and concentrate on impervious surfaces. During a storm event, these pollutants are washed directly into the storm sewers (Figure 2). In addition to chemical and biological pollution, thermal pollution can occur from water collected or stored on impervious surfaces or in stormwater impoundments, which has been heated by the sun. Additionally, large amounts of impervious coverage can result in "heat islands" where the surface temperatures are up to 10 degrees warmer than the surrounding areas. Thermal pollution can affect aquatic habitats, adversely impacting cold water fish. Removal of shade trees and stabilizing vegetation from stream banks also contributes to thermal pollution.

Figure 2: Connected Impervious Surfaces

Rainwater is intercepted by roofing and collected into gutters. The water then discharges the downspout onto a paved driveway and flows to the gutter and storm drain inlets. Alternatively, the collected water is piped underground directly to the storm sewer.
Photograph source: Titan Gutters

Proper stormwater management will help to mitigate the negative impact of land development and its effect on stormwater. The MSWMP outlines the Township's plan to improve stormwater quality, decrease stormwater quantity, and increase groundwater recharge. By managing stormwater, the Township will improve the quality of aquatic ecosystems and restore some of the natural balance to the environment.

III. BACKGROUND

The Township of Middletown encompasses 41.08 square miles of Monmouth County. The Boroughs of Atlantic Highlands, Highlands, Sea Bright, Rumson and Fair Haven border the Township on the east. To the south, the Township is bordered by Tinton Falls Borough, Red Bank Borough and Colts Neck Township. Holmdel Township, Hazlet Township and Keansburg Borough border the Township to the west and Sandy Hook Bay to the north. Due to its size, the Township's land use is widely varied, from marinas/commercial fishing fleets to major corporate headquarters, private country clubs, large estate homes, a community college, a naval military installation, two public beaches, several historic districts and Sandy Hook National Park. However, Middletown Township is primarily a township of residential neighborhoods, villages, and hamlets. See Figure 3 for the Township's boundary delineated on a United States Geological Survey (U.S.G.S.) quadrangle map.

Of the Township's 41.08 square mile area, 2.8 square miles are located in the Gateway National Recreation Area, or Sandy Hook. It should be noted that the Sandy Hook area has been excluded from land use calculations, since it is not contiguous to the rest of the Township and is under the jurisdiction of the National Park Service. Land use calculations will be based on a land area of 38.2 square miles (24,448 Ac.).

In 2004, the Middletown Township Planning Board updated their master plan. This updated *Master Plan* included a special area study for McClees Creek performed in 2003. A detailed study of existing conditions and trends within the Township was performed as part of this comprehensive update and includes numerous goals, objectives, and recommendations for the future development of Middletown Township.

DEMOGRAPHICS

This MSWMP is a new element of the recently adopted comprehensive Master Plan. It is intended to build on the goals, objectives and recommendations included in the *Township of Middletown Master Plan*, dated October 2004.

Figure 3: Topographic Map

Middletown, prior to 1950, was a predominantly an agrarian-rural community. With the opening of the Garden State Parkway and the New Jersey Turnpike, which attracted homebuyers from northern New Jersey and New York City, the Township experienced a population growth transforming the Township into a metropolitan-suburban community. The Township's population in 1970 (see Table 1) was 54,623 and continued to grow to 62,574 in 1980 and 68,183 in 1990. The population then decreased in 2000 to 66,327.

Table 1 : Population Trends

	Middletown		**Monmouth County**		**New Jersey**	
Year	*Population*	*% Change*	*Population*	*% Change*	*Population*	*% Change*
1970	54,623	-	461,849	-	6,066,782	-
1980	62,574	14.6	503, 173	8.9	7,364,823	18.2
1990	68,183	9.0	553,124	9.9	7,730,118	5.0
2000	67,479*	- 1.0	615,305	11.2	8,414,350	8.9

* US Census Bureau updated this number from 66,327 in Dec. 2003.
Source: 1990, 2000 US Census

In recent years, available land resources have been reduced as a result of recent development. Housing trends have also increased since the 1970's. As shown in Table 2: General Housing Characteristics, there has been a slight increase in housing units from 1990.

LAND USE

According to the Township's Master Plan (Oct. 2004), the Township has very diverse land use, including marinas, corporate headquarters, country clubs, large estate homes, smaller lot older residential neighborhoods, a community college, a naval military installation, public beaches, historic districts, and the Gateway National Recreation Area, known as Sandy Hook. The Township has encouraged its historical pattern of the development of villages and neighborhoods. Many of these villages and hamlets have their own commercial centers, post offices and zip codes. These areas include Belford, Lincroft, North Middletown, Port Monmouth, New Monmouth, Chapel Hill, Navesink, Locust, Middletown Village, Oak Hill, Fairview, River Plaza and Leonardo.

Table 2: General Housing Characteristics

	1990		2000		Change
	Number	Percent	Number	Percent	Number
OCCUPANCY STATUS					
Total Housing Units	23,495	100	23,841	100	346
Occupied Housing Units	22,637	96.3	23,236	97.5	599
Vacant Housing Units	858	3.7	605	2.5	- 253
Tenure					
Occupied Housing Units	22,637	100	23,236	100	599
Owner- Occupied Housing Units	19,157	84.6	20,065	86.4	908
Renter- Occupied Housing Units	3,480	15.4	3,171	13.6	- 309
Vacancy Status					
Vacant Housing Units	858	100	605	100	- 253
Population	68,183	100	67,479	100	- 1856
Households	22,637	100	23,236	100	599
Family Household	18,245	80.6	18,109	37.9	- 136
1 Person Household	3,762	16.6	4,397	18.9	635
Persons/ Household	3.0		2.84		- 0.16

Source: 1990, 2000 US Census

As illustrated in Table 3: Existing Land Use, the majority of the land use in the Township is single family residential, followed by public parks and open spaces. It should be noted, however, that 10% of the Township's land is devoted to transportation right-of-ways. This includes the Garden State Parkway, which has two exits (Exits 109 and 114) located within the Township. The Township's roads vary in size from highways, such as the Garden State Parkway, to local streets. The Middletown train station, located near the intersection of Middletown Lincroft Road (CR-50) and Railroad Avenue provides NJ Transit passenger rail service via the New Jersey Coastline. The Township also encompasses the Earle Naval Weapons Station, operated by the United States Navy.

Table 3: Existing Land Use

Usage	Area (Ac)	% of the Township
Vacant/ Undeveloped	1,419	6%
Single Family Residential	9,516	39%
Multi-Family Residential	563	2%
Commercial	1,561	6%
Industrial	5	0%
Active Farmland	1,927	8%
Military Land	705	3%
Public Parks/ Open Spaces	3,671	15%
Public Schools	587	2%
Other Land Uses	2,076	8%
Streets, Highways, & Railroads	2,418	10%
Total	24,448	100%

Source: Middletown Township Master Plan, Oct. 2004

OPEN SPACE AND NATURAL RESOURCES

As outlined in the Township's 2004 Master Plan, Middletown established an Open Space Committee to develop an Open Space Preservation Plan geared towards the preservation of natural areas, wetlands, steep slopes and woodlands, water access, farmland, and historic areas. Since inception, the Committee has actively been working towards the identification and acquisition of various open space projects. The Township's strategy for preservation of conservation includes selected acquisition of critically important sites and control of new development within those areas. Additional detailed information can be found in the Open Space, Recreation and Conservation Element of the *Township of Middletown Master Plan.*

WATERWAYS

The Township falls within two major watersheds, the Navesink River Watershed, and the Bayshore Watershed. Middletown has numerous water resources including the named waterways and waterbodies listed in Table 4 and other unnamed ponds within its boundary's. Figure 4 depicts these waterways.

Figure 4: Waterways Map

Table 4: Township Waterbodies

Waterbody Type	Name	
Stream Corridors	Claypit Creek	Navesink River
	McClees Creek	Mahoras Brook
	Swimming River	Poricy Brook
	Comptons Creek	Many Mind Creek
	Hartshorn Woods Brook	Waackaack Creek
	Nut Swamp Brook	Jumping Brook
	Ware Creek	Mill Brook
	Thompson Brook	Wagner Creek
	Little Falls Brook	Shadow Brook
	Wigwam Creek	Browns Brook
	Thimble Brook	Grist Mill Brook
	Pews Creek	Blossom Cove
Bodies of Water	Shadow Lake	Bennetts Pond
	Swimming River Reservoir	Comptons Pond
	Poricy Pond	Sandy Hook Bay
	Haskell Pond	Hartshorne Woods Pond
	Marion Lake	
Tidal Wetlands	Pews Creek	McClees Creek
	Comptons Creek	Claypit Creek
	Ware Creek	Swimming River

The Navesink River, including its tributaries, the Swimming River and Willow Brook, drains an area of 95 square miles. The Swimming River Reservoir, a major potable water impoundment for the Township, is located in this watershed, as are many small ponds.

The McClees Creek watershed is a tributary of the Navesink River. The McClees Creek Area is located in the north shore of the Navesink River. McClees Creek drains an area of 4,896 Ac., excluding the area of the Navesink, or approximately 20% of the land area within the Township. The area is home to various natural resources including lakes, streams, shellfish habitat, steep slopes, wetlands and high groundwater recharge areas. The McClees Creek area has been

designated within NJDEP's Coastal Areas Facility Review Act (CAFRA) boundary due to its environmental sensitivity. In 2003, T&M Associates performed a Planning Area Study on this region to characterize the watershed and its environmental resources. The study described the waterways, groundwater recharge, endangered and threatened species, water and sanitary sewer services, as well as historic and scenic sites. The Environmental Resources Map (A-3) included in this study also illustrated environmental resources such as wetlands and steep slopes within the study area. Based on the study, it was determined that the McClees Creek watershed should be preserved and protected.

In addition to the Navesink watershed, the Township is a part of the Bayshore watershed. The Bayshore watershed drains to the Raritan Bay, and includes several major tributary streams within Monmouth County. Tributaries within the Township include Waackaack (Waycake) Creek, Pews Creek, Comptons Creek, Ware Creek, Wagner Creek, Many Mind Creek, and Mahoras Brook.

WATER QUALITY

The Ambient Biomonitoring Network (AMNET) was established by the NJDEP to monitor and document the health of New Jersey's waterways. AMNET currently has 820 sites in five drainage basins that it monitors for benthic macroinvertebrates on a five-year cycle. Waterways are scored based on the data to generate the New Jersey Impairment Score (NJIS) and then categorized as severely impaired, moderately impaired, and non-impaired. The NJIS is based on biometrics and benthic macroinvertebrate health. (http://www.state.nj.us/dep/wmm/bfbm/). McClees Creek at Whippoorwill Road, and Town Brook (a branch of Compton's Creek) at Spruce Road, Nut Swamp Brook at North Normandy Road, Poricy Brook at Navesink Road are moderately impaired according to the AMNET report. The Swimming River at Swimming River Road is considered severely impaired. (http://www.state.nj.us/dep/wmm/bfbm/downloads.html#atl) (See Table5).

The Township's waterbodies listed in the 2004 Integrated List are shown below in Table 5. This list prioritizes waterbodies by water quality; where Sublist 1 has the highest water quality and

Sublist 5 has the poorest quality.

Table 5: 2004 Integrated List of Waterbodies

Waterbody Type	Name	2004 Integrated List #	Site ID	Impairment
Stream Corridors	McClees Creek @ Whippoorwill Rd	3	AN0462	Benthic Microinvertabrates
	Swimming River (tidal)	1	R01	Dissolved Oxygen
	Navesink River	5	Navesink River	Fish: PCB, Dioxin
	Mahoras Brook @ Holland Rd	3	MB-PARK3	Benthic Microinvertabrates
	Mahoras Brook @ Rt. 35	1, 3	EWQ0460	Dissolved Solids, Dissolved Oxygen
	Mahoras Brook, Tidal	1	R67	Dissolved Oxygen, Total Coliform
	Town Brook	1, 3, 4	01407090	Phosphorous, pH, Temp., Dissolved Oxygen, TSS, unionized Ammonia, Fecal Coliform
	Town Brook @ Spruce Rd	3	AN0461	Benthic Microinvertabrates
Bodies of Water	Shadow Lake	5 1	Shadow Lake	Fish: Mercury Fish Community

Source: 2004 Integrated List of Waterbodies

The NJDEP also provides a list of Category One (C1) waterways. Category One waterways are areas with a special level of protection. Waterways can be designated C1 because of exceptional significance for ecological, water supply, recreational, shellfish or fisheries resources. Currently, the Swimming River Reservoir, along with its tributaries in Lincroft, are C1 waterways. Claypit Creek, from the widening of the creek to the Navesink River, and sections of the Navesink River northeast of Blossom Cove to the Riverview Hospital with some exceptions, and its tributaries Claypit and McClees Creeks are also listed as C1 waters, as defined NJDEP. (http://www.nj.gov /dep/cleanwater/c1_waters_list.pdf)

In addition to biological health data, chemical data are gathered by the NJDEP and other

organizations, and used to determine the health of waterways. The water quality data are used by NJDEP to determine which waters require the development of Total Maximum Daily Loads (TMDL). A TMDL is the quantity of a pollutant that can enter a waterbody without exceeding water quality standards or interfering with the ability to use the waterbody for its designated usage. Point and non-point source pollution, surface water withdrawals and natural background levels are included in the determination of a TMDL, as required by Section 303(d) of the Clean Water Act. Point source pollution includes, but is not limited to NJPDES permitted discharges, while non-point source pollution can include stormwater runoff from agricultural lands or impervious surfaces. TMDLs determine the allowable load from each source, with a factor of safety, for the pollutant entering the waterbody. TMDLs can be used to limit further deterioration of a waterbody, or to improve the current water quality.

An implementation plan is typically developed to identify how the each of the various sources of pollution will be reduced to the levels specified in the TMDL. Some of the strategies implemented may include stormwater treatment, implementation of updated ordinances, restriction of impervious surfaces, retrofitting stormwater systems, disconnection of impervious surfaces, and use of other best management practices (BMPs). Town Brook currently has a proposed TMDL for fecal coliform extending for 3.1 river miles upstream of the confluence of Town Brook and Mill Creek. According to the Division of Watershed Management of NJDEP, however, this is not a specific stormwater TMDL, and as such is not governed by this MSWMP.

Impacts from agriculture, development and urban runoff are believed to have contributed to non-point sources of pollution in the Navesink River. These impacts include siltation of rivers, streams and ponds, increased nutrient levels in water bodies and increased bacterial levels. Bacteria from agricultural and urban runoff have contaminated many shellfish-harvesting beds in the downstream reaches of the Navesink River.

The Navesink estuary supports substantial, commercially harvested hard clam (*Mercenaria mercenaria*), soft clam (*Mya arenaria*), and blue crab (*Callinectes sapidus Rathbun)* populations. Within the shellfish-harvesting portions of the Navesink River, the major pollution problem is

high bacterial loadings from non-point sources. According to the NJDEP, water quality improves as one proceeds downstream along the Navesink River. Significant improvements in water quality in the Navesink River have occurred from reducing non-point source loading into the river that led to the reopening of shellfish harvesting in the downstream-most section of the Navesink in the late 1990's, which was previously closed for over twenty-five years.

The Bureau of Marine Water Monitoring also monitors the Navesink River. This bureau publishes triennial Shellfish Sanitary Surveys. These surveys determine the classification of the waters, in terms of shellfish, based on data gathered from 52 monitoring stations throughout the River. The stations upstream of McClees Creek are classified as *Special Restricted*, while stations between McClees Creek and the Oceanic Bridge nearly make the *Approved* classifications. As a result, 677 acres east of the Oceanic Bridge have been upgraded to *Seasonally Approved (Nov. – Apr.).* The *Special Restricted* classification requires a special permit for the commercial harvest of shellfish when the beds are "open," and that any shellfish harvested be purified through depuration or relay prior to consumption. *Seasonally Approved* allows for commercial harvesting during a given season, while *Approved* allows for harvesting.

The Monmouth County Health Department monitors the Navesink River at five locations in Red Bank, Rumson, and Fair Haven on a quarterly basis. Each location is monitored for fecal coliform bacteria; total phosphorous, total suspended solids, turbidity, and pH. The County results show levels of fecal coliform bacteria, total phosphorous, total suspended solids and pH that are slightly above recommended standards. The *McClees Creek Planning Area Study, a* component of the 2004 *Master Plan,* delineates the shellfish classification of the waters in the Township on Map A-4 – Shellfish Classification.

The Bayshore Subwatershed Regional Council and Monmouth County Planning Board compiled an Issues List for the Bayshore watershed (2001). Some of the topics noted include erosion and sedimentation. Additionally, it was noted that the Many Mind Creek has poor water quality, and the Sandy Hook Bay has impacts from boats discharging waste into the Bay. The Council also notes that the entire watershed has a need to eliminate non-point source pollution and identify

hazard areas, along with general waterway cleanup and maintenance needs. Monmouth Coastal Watersheds Partnership and the Monmouth County Planning Board have also prepared an Issues List for the Navesink/Swimming River subwatershed. There are several stormwater-related issues indicated. These include water quality, sedimentation, infrastructure, water quantity, erosion, and public awareness. The preservation of natural, scenic, historic and cultural resources is also included.

The Monmouth County Health Department, in Cooperation with the Cooperative Coastal Monitoring Program also monitors seven (7) beach sites located within the Township. These beaches are monitored for *enterococci* bacteria on a weekly basis during the summer season, and monthly during the rest of the year.

WATER QUANTITY

In addition to water quality issues, the MSWMP also addresses water quantity or flooding issues within the Township. The Township does experience flood plain area flooding, however this flooding is mainly tidal. In some areas, this tidal flooding can be exacerbated by heavy rain events. There is no structure or roadway flooding in the Township due to storm events.

GROUNDWATER RECHARGE

Impervious surface is increased, as vacant sites are developed. Impervious surface is that portion of a site covered with structures and paving, which prevents the underlying soil from absorbing rainwater. Instead of entering the soil, rainwater from rooftops and pavement flow onto the adjacent ground, where it is partially absorbed into the ground (depending upon hydraulic soil classifications) or into drainage facilities and streams. The greater the amount of impervious surface on a site, the greater volume of stormwater runoff that drains away from a site. Greater volumes of stormwater can result in high water elevations in some locations along streams and can exacerbate streambed erosion, with the added impact of downstream siltation. These dynamics alter the floodplain and have negative impacts on the stream and river ecosystems, as well as the reservoir.

It should be noted that there are several areas within the Township, including the McClees Creek planning area, which are currently unsewered. Groundwater recharge within these areas is important to maintain in order to dilute the nutrient loading from septic systems. The McClees Creek component of the 2004 *Master Plan* maps the sanitary sewer system and sewer service areas in the study area in Map A-6 – Sanitary Sewer System/Sewer Service Area.

In addition to impacting streamflows, decreased groundwater recharge impacts the draw and quality of both public and private wells within the watershed. Drinking water wells often have designated buffer areas to protect current and future water quality. These areas are known as wellhead protection areas. The Township's groundwater recharge and wellhead protection areas are delineated in Figures 5 and 6, respectively. As shown in Figure 6, a well is located in the southern portion of the Township adjacent to the Swimming River Reservoir.

Figure 5: Groundwater Recharge Areas

Figure 6: Wellhead Protection Areas

IV. DESIGN AND PERFORMANCE STANDARDS

The Township will adopt the applicable design and performance standards for stormwater management measures as outlined in N.J.A.C. 7:8-5 to reduce the negative impact of stormwater runoff on water quality and quantity, and loss of groundwater recharge in receiving waterbodies. The design and performance standards will be created to contain the necessary language to maintain stormwater management measures consistent with the applicable stormwater management rules, N.J.A.C. 7:8-5.8 - Maintenance Requirements. This includes language for safety standards consistent with N.J.A.C. 7:8-6 - Safety Standards for Stormwater Management Basins. Ordinances will be submitted to the Monmouth County Planning Board for review and approval within 12 months of adoption of this MSWMP.

Proper inspection and maintenance are critical components to the successful performance of a stormwater management system. The Township is presently preparing a Stormwater Pollution Prevention Plan (SPPP) that establishes an inspection and maintenance schedule for existing municipally owned and operated stormwater infrastructures. Also included in the SPPP is the development of a Local Public Education Program to educate property owners on methods to reduce non-point source stormwater pollution such as proper waste disposal, solids and floatable controls, fertilizer and pesticide use, pet waste, goose waste, wildlife feeding, etc. For regulated new development and redevelopment projects meeting the stormwater management threshold for major development (more than 1 acre of disturbance or more than 1/4 acre of new impervious cover), the Township will require submittal of an operation and maintenance plan in accordance with N.J.A.C. 7:8 - 5.8 and the NJDEP's *New Jersey Stormwater Best Management Practices Manual* (BMP Manual). Copies of each maintenance plan(s) will be filed with the Township Department of Public Works.

A number of structural and non-structural strategies require water to be retained for long periods of time. These requirements may increase the promulgation of mosquito breeding habitats. New development and redevelopment activities should be coordinated with the Monmouth County

Mosquito Extermination Commission so that proposed structural and non-structural strategies are properly maintained.

Personnel from the Township Engineer's Office will monitor construction of the BMP project to ensure that the appropriate stormwater management measures are constructed and function as designed. Township personnel will conduct inspections as needed to ensure public systems are functioning properly and to identify maintenance needs, if any. For privately owned and operated BMPs, the Owner shall inspect the BMPs as needed. After this, annual checks should be done to identify any additional maintenance needs required. This may include clearing of blockages from inlets and/or outlet structures, removal of unhealthy vegetation or accumulated debris/materials.

Township ordinances should indicate that the inspection of systems is permissible on private property, provided the necessary easements are in place, upon giving reasonable notice. Ordinances should also indicate a time frame for maintenance procedures to occur upon receiving notice from the Township that maintenance is required. Additionally, ordinances should require Maintenance Plans for privately owned BMPs which include information such as contact information for the responsible party, schedule of required maintenance, estimated costs of maintenance, etc in accordance with State regulations.

V. PLAN CONSISTENCY

REGIONAL STORMWATER MANAGEMENT PLANS

Currently, there are no Regional Stormwater Management Plans (RSWMP) developed for waters "within" the Township. However, RSWMPs for the Many Mind Creek watershed is being prepared and should be adopted in the near future. This plan will be updated to be consistent with any RSWMP that is established in the future and the Township shall take part in the development of any proposed RSWMP that affects its waterbodies

TOTAL MAXIMUM DAILY LOADS

The NJDEP has established a TMDL for one of the waterbodies in the Township. Town Brook currently has an established TMDL for fecal coliform extending for 3.1 river miles upstream of the confluence of Town Brook and Mill Creek. According to the Division of Watershed Management of NJDEP, this is not a specific stormwater TMDL, and as such is not governed by this MSWMP. However, the Township will update this MSWMP to be consistent with any stormwater TMDLs as they are established by the NJDEP.

RESIDENTIAL SITE IMPROVEMENT STANDARDS (RSIS)

This MSWMP is consistent with regulations established under the Residential Site Improvement Standards (RSIS) at N.J.A.C. 5:21 and will be updated to remain consistent with any future updates of RSIS. Additionally, the Township will use the latest update of RSIS during its reviews of residential area development for stormwater management.

SOIL CONSERVATION

The Township's Stormwater Management Control Ordinance will require that all new development and redevelopment projects, including renovations, comply with the Soil Erosion and Sediment Control Standards of New Jersey. In cooperation with the Freehold Soil Conservation District, Township inspectors will observe on-site soil erosion and sediment control measures as part of construction site inspections.

All development and redevelopment projects shall use the most recent DelMarVa unit hydrograph for stormwater calculations. In addition the Freehold Soil Conservation District requires the use of the most recent design storm rainfall data for stormwater calculations. The National Oceanographic and Atmospheric Administration (NOAA), the agency that develops statistical estimates of rainfall amounts, has increased its estimates for the majority of storm events, particularly the larger events. The following table indicates the old and new twenty-four hour rainfall amounts in inches for Monmouth County.

Table 6: NRCS 24 Hour Design Storm Rainfall Depth (inches) – September 2004

Storm Period	1 yr.		2 yr.		5 yr.		10 yr.		25 yr.		50 yr.		100 yr.	
	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New
Monmouth County	2.8	**2.9**	3.4	**3.4**	4.4	**4.4**	5.3	**5.2**	6.0	**6.6**	6.5	**7.7**	7.5	**8.9**

Source: NOAA, NJ Department of Agriculture

VI. STORMWATER MANAGEMENT STRATEGIES

The Township reviewed its 2004 Master Plan and Township Ordinances for consistency with the new stormwater regulations. Based on its review, the Township found that the following sections must be further evaluated and modified as needed to incorporate non-structural stormwater management strategies:

- **Chapter 16-5.28 Performance Standards:** This section describes the performance standards required by the Township and should be evaluated and updated as needed to include the design and performance standards outlined in this MSWMP and as outlined in N.J.A.C. 7:8.

- **Chapter 16-6.6 Buffer Areas and Screening:** This section states the Township's requirements for buffers. This section should be evaluated and updated as needed to encourage the use of native vegetation prior to structural screening.

- **Chapter 16-6.11 Curb and Gutters:** This section requires the construction of curbing along all streets in major subdivision and in most minor subdivisions. This section also requires that if curbs and gutters are required anywhere along the street, it will be installed along both sides of the entire street. This section should be evaluated and modified as needed to encourage the use of curb cuts or flush curbs with curb stops and limit the use of curb and gutter to where it is required.

- **Chapter 16-6.28 Public Open Space and Common Space:** This section describes the open space regulations within the Township. This section should be reviewed with regards to establishing a maximum impervious coverage area.

- **Chapter 16-6.12 Driveways and Access Aisles:** This section describes the Township's design requirements for driveways and motor vehicle access aisles. This section should be evaluated and updated as needed to allow landscape islands to receive stormwater flow and

help in the disconnection of impervious surfaces.

- **Chapter 16-6.27 Offstreet Parking and Loading:** This section describes the parking requirements in the Township, including the use of multi-level parking structures. This section should be evaluated and modified as needed to allow for permeable paving systems to be used in overflow parking lots. Additionally, this section should be reviewed with regards to reducing parking ratios where feasible.

- **Chapter 16-6.34 Sidewalks and Aprons** : This section requires sidewalks to be built on both sides of the street. Sidewalks are to be made of impervious paving. This section should be evaluated and reviewed to investigate the use of permeable paving systems as well as grading sidewalks to allow stormwater to flow into lawns or buffers rather than gutters and storm drains.

- **Chapter 16-6.39 Storm Drainage Facilities:** This section should be reviewed and updated as needed to be in compliance with the design, performance and safety standards described in this MSWMP and as outlined in N.J.A.C.7:8. Additionally, this section should be reviewed in terms of encouraging the disconnection of impervious surfaces, increase groundwater recharge and stormwater quality, and decrease stormwater quantity.

Revisions of the ordinances identified above will allow the incorporation of the non-structural strategies. Amended ordinances will be submitted to the County for review and approval within 12 months of the plan adoption. A copy will also be forwarded to the Department of Environmental Protection Agency at that time.

NON-STRUCTURAL STRATEGIES

This MSWMP encourages the use of low impact design methods and recommends the practical use of the following non-structural strategies for all major developments in accordance with the NJDEP BMP Manual:

1. Protect areas that provide water quality benefits or areas particularly susceptible to erosion and sediment loss.
2. Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces.
3. Maximize the protection of natural drainage features and vegetation.
4. Minimize the decrease in the pre-construction "time of concentration."
5. Minimize land disturbance including clearing and grading.
6. Minimize soil compaction.
7. Provide vegetated open-channel conveyance systems that discharge into and through stable vegetated areas.
8. Provide preventative source controls.

In addition, the NJDEP BMP Manual further requires an applicant seeking approval for a major development[1] to specifically identify how these non-structural strategies have been incorporated into the development's design. Finally, for each of those non-structural strategies that were not able to be incorporated into the development's design due to engineering, environmental, or safety reasons, the applicant must provide a basis for this contention.

Recommendations in the BMP Manual may be implemented through the use of:

- **Vegetated Filter Buffers**

  Vegetated filter strips are best utilized adjacent to a buffer strip, watercourse or drainage swale since the discharge will be in the form of sheet flow, making it difficult to convey the stormwater downstream in a normal conveyance system (swale or pipe).

- **Stream Corridor Buffer Strips**

  Buffer strips are undisturbed areas between development and the receiving waters. There

[1] Major Development – means any 'development' that provides for ultimately disturbing one or more acres of land or increasing impervious surface by one-quarter acre or more. Disturbance for the purpose of this rule is the placement of impervious surface or exposure and/or movement of soil or bedrock or clearing, cutting, or removing of vegetation. Projects undertaken by any government agency which otherwise meet the definition of 'major development' but which do not require approval under the Municipal Land Use Law, N.J.S.A. 40:55D-1 et seq., are also considered "major development".

are two management objectives associated with stream and valley corridor buffer strips:

- To provide buffer protection along a stream and valley corridor to protect existing ecological form and functions; and
- To minimize the impact of development on the stream itself (filter pollutants, provide shade and bank stability, reduce the velocity of overland flow).

Buffers only provide limited benefits in terms of stormwater management; however, they are an integral part of a system of best management practices.

- **The Stabilization of Banks, Shoreline and Slopes**

  The root systems of trees, shrubs and plants effectively bind soils to resist erosion. Increasing the amount of required plant material for new and redeveloped residential and non-residential sites should be encouraged throughout the Township. Planting schemes should be designed by a certified landscape architect to combine plant species that have complementary rooting characteristics to provide long-term stability.

- **Pond Configuration**

  In Middletown, many estate homes create ponds for aesthetic purposes. Many of these ponds are shallow and suffer from eutrophic conditions. This leads to a large amount of weed and algae growth that depletes the amount of dissolved oxygen in the water. Through proper design, increases in water temperature during summer months can be minimized.

  The configuration of a pond will affect its temperature. The length-to-width ratio should be maximized to prevent the occurrence of large open areas of water that cannot be shaded by vegetation. The pond should provide one area at least 4 to 6 feet deep to keep pond waters cool and to maintain an area sustaining a fish population, which provides natural mosquito control. The positioning of vegetation along the edges of a pond, channel or wetland and the introduction of water movement devices can assist in

mitigating undesirable increases in water temperature and contribute to the maintenance of dissolved oxygen levels by inhibiting the growth of algae. Special consideration should be given to the type of vegetation installed, since leaves and other vegetative debris can clog the pond creating other problems, as well as maintenance and access to the pond.

Middletown may also host numerous vernal pools, which are confined wetland depressions, either natural or man-made, that hold water for at least two consecutive months out of the year, and are devoid of breeding fish populations. These unique ecosystems provide habitat to many species of amphibians, insects, reptiles, plants, and other wildlife. Projects proposed that would impact vernal pools may need to be redesigned to avoid adversely impacting them. All new development should identify whether a potential vernal pool is located on-site. Additionally, the Township should seek to identify, map and certify all vernal pools in coordination with the NJDEP

- **Deterrence of Geese and Deer (Where Applicable)**

  Maintaining or planting dense woody vegetation around the perimeter of a pond or wetland is the most effective means of deterring geese from taking over and contaminating local lakes and ponds. Minimizing the amount of land that is mowed will limit the preferred habitat for geese. Also the planting of deer tolerant vegetation adjacent to waterbodies is a means of deterring deer by minimizing food sources. Uncontrolled deer grazing or browsing results in tremendous loss of vegetation.

- **Fertilizers (Where Applicable)**

  The use of fertilizers to create the "perfect lawn" is an increasing common problem in many residential areas. Fertilizer run-off increases the level of nutrients in water bodies and can accelerate eutrophication[2] in the lakes and rivers and continue on to the coastal areas. The excessive use of fertilizers causes nitrate contamination of groundwater and

[2] Eutrophication – The normally slow aging process by which a lake evolves into a bog or marsh and ultimately assumes a completely terrestrial state and disappears.

may lead to levels in drinking water that are above recommended safety levels. Good fertilizer maintenance practices help in reducing the amount of nitrates in the soil and thereby lower its content in the water. Initially, the Township should work with the NJDEP to educate homeowners of the impacts of the overuse of fertilizers. This discussion should include other techniques to create a "green lawn" without over-fertilizing. Almost as important as the use of fertilizer is the combination of over-fertilizing and over-watering lawns. In many cases this leads to nutrient rich runoff, which ultimately migrates to a nearby stream, lake or other water body. If fertilizer is applied correctly, the natural characteristics of the underlying soils will absorb or filter out the nutrients in the fertilizer.

STRUCTURAL STORMWATER MANAGEMENT STRATEGIES[3]

In Chapter 9 of its BMP Manual, the NJDEP identifies several structural stormwater management options. Each of these structures has its advantages and disadvantages to managing stormwater.

The Township recommends the following structural devices. Specifically, the Township encourages the use of structural stormwater management systems in a manner that maximizes the preservation of community character:

- **Bioretention Systems**

  A bioretention system consists of a soil bed planted with native vegetation located above an underdrained sand layer. It can be configured as either a bioretention basin or a bioretention swale. Stormwater runoff entering the bioretention system is filtered first through the vegetation and then the sand/soil mixture before being conveyed downstream by the underdrain system. Runoff storage depths above the planting bed surface are typically shallow. The adopted Total Suspended Solids (TSS) removal rate for bioretention systems is 90%.

[3] Definitions provided in the NJDEP – Stormwater Best Management Practices Manual at: http://www.njstormwater.org/tier_A/ bmp_manual.htm

- **Constructed Stormwater Wetlands**

  Constructed stormwater wetlands are wetland systems designed to maximize the removal of pollutants from stormwater runoff through settling and both uptake and filtering by vegetation. Constructed stormwater wetlands temporarily store runoff in relatively shallow pools that support conditions suitable for the growth of wetland plants. The adopted removal rate for constructed stormwater wetlands is 90%.

- **Dry Wells**

  A dry well is a subsurface storage facility that receives and temporarily stores stormwater runoff from roofs of structures. Discharge of this stored runoff from a dry well occurs through infiltration into the surrounding soils. A dry well may be either a structural chamber and/or an excavated pit filled with aggregate. Due to the relatively low level of expected pollutants in roof runoff, a dry well cannot be used to directly comply with the suspended solids and nutrient removal requirements contained in the NJDEP Stormwater Management Rules at N.J.A.C. 7:8. However, due to its storage capacity, a dry well may be used to reduce the total stormwater quality design storm runoff volume that a roof would ordinarily discharge to downstream stormwater management facilities.

- **Extended Detention Basins**

  An extended detention basin is a facility constructed through filling and/or excavation that provides temporary storage of stormwater runoff. It has an outlet structure that detains and attenuates runoff inflows and promotes the settlement of pollutants. An extended detention basin is normally designed as a multistage facility that provides runoff storage and attenuation for both stormwater quality and quantity management. The adopted TSS removal rate for extended detention basins is 40 to 60%, depending on the duration of detention time provided in the basin.

- **Infiltration Basins**

  An infiltration basin is a facility constructed within highly permeable soils that provides temporary storage of stormwater runoff. An infiltration basin does not normally have a

structural outlet to discharge runoff from the stormwater quality design storm. Instead, outflow from an infiltration basin is through the surrounding soil. An infiltration basin may also be combined with an extended detention basin to provide additional runoff storage for both stormwater quality and quantity management. The adopted TSS removal rate for infiltration basins is 80%. It should be noted that a dry well is a specialized infiltration facility intended only for roof runoff.

- **Manufactured Treatment Devices**

  A manufactured treatment device is a pre-fabricated stormwater treatment structure utilizing settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to remove pollutants from stormwater runoff. The TSS removal rate for manufactured treatment devices is based on the NJDEP certification of the pollutant removal rates on a case-by-case basis. Other pollutants, such as nutrients, metals, hydrocarbons, and bacteria can be included in the verification/certification process if the data supports their removal efficiencies.

- **Pervious Paving Systems**

  Pervious paving systems are paved areas that produce less stormwater runoff than areas paved with conventional paving. This reduction is achieved primarily through the infiltration of a greater portion of the rain falling on the area than would occur with conventional paving. This increased infiltration occurs either through the paving material itself or through void spaces between individual paving blocks known as pavers. Pervious paving systems are divided into three general types. Each type depends primarily upon the nature of the pervious paving surface course and the presence or absence of a runoff storage bed beneath the surface course. Porous paving and permeable paver with storage bed systems treat the stormwater quality design storm runoff through storage and infiltration. Therefore, these systems have adopted TSS removal rates similar to infiltration structures.

- **Sand Filters**

  A sand filter consists of a forebay and underdrained sand bed. It can be configured as either a surface or subsurface facility. Runoff entering the sand filter is conveyed first through the forebay, which removes trash, debris, and coarse sediment, and then through the sand bed to an outlet pipe. Sand filters use solids settling, filtering, and adsorption processes to reduce pollutant concentrations in stormwater. The adopted TSS removal rate for sand filters is 80%.

- **Vegetative Filters**

  A vegetative filter is an area designed to remove suspended solids and other pollutants from stormwater runoff flowing through a length of vegetation called a vegetated filter strip. The vegetation in a filter strip can range from turf and native grasses to herbaceous and woody vegetation, all of which can either be planted or indigenous. It is important to note that all runoff to a vegetated filter strip must both enter and flow through the strip as sheet flow. Failure to do so can severely reduce and even eliminate the filter strip's pollutant removal capabilities. The total suspended solid (TSS) removal rate for vegetative filters will depend upon the vegetated cover in the filter strip.

- **Wet Ponds**

  A wet pond is a stormwater facility constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff. It has an outlet structure that creates a permanent pool and detains and attenuates runoff inflows and promotes the settlement of pollutants. A wet pond, also known as a retention basin, can also be designed as a multi-stage facility that provides extended detention for enhanced stormwater quality design storm treatment and runoff storage and attenuation for stormwater quantity management. The adopted TSS removal rate for wet ponds is 50 to 90% depending on the permanent pool storage volume in the pond and, where extended detention is also provided, and the duration of detention time provided in the pond.

Table 7, below, summarizes the approximate TSS removal rates for these structures. Final TSS removal rates should be calculated for each structure based on its final design parameters.

Table 7: TSS Removal Rates for BMPs

Best Management Practice (BMP)	Adopted TSS Removal Rate (%)
Bioretention System	90
Constructed Stormwater Wetland	90
Dry Well	Volume Reduction Only
Extended Detention Basin	40-60*
Infiltration Structure	80
Manufactured Treatment Device	See N.J.A.C 7:8-5.7(d)
Pervious Paving System	Volume Reduction Or 80 (with infiltration bed)
Sand Filter	80
Vegetative Filter	60-80
Wet Pond	50-90*

*based on volume and detention time
Source: NJDEP BMP Manual, Apr. 2004.

VII. LAND USE/ BUILD-OUT ANALYSIS

The Township has more than 1 square mile of vacant or developable land. As a result, the NJDEP requires the Township perform a land use build-out analysis as part of their MSWMP. The purpose of this analysis is to calculate the amount of additional pollutant loading that may be anticipated within each watershed. The 1995/1997 Geographic Information System (GIS) data from the NJDEP is shown in Figure 7. Figure 8 illustrates the current land use within the Township, based on the 2004 *Master Plan.*

In December 2004, the Township performed a build-out analysis as part of its Cross Acceptance process. The 2004 Cross Acceptance build-out analysis was dissimilar from the build-out methodology utilized for this MSWMP. Cross Acceptance build-out projected total residential units and commercial square footage, and did not employ the methodology described below. The build-out analysis for this MSWMP was formulated using ArcGIS software, particularly ArcINFO v. 9. A new feature class was created by clipping the NJDEP Hydrologic Unit Code 14 (HUC 14) file with the Township's zoning layer. A composite constraints layer was then developed using NJDEP wetlands information, 100-year flood hazard areas, the Township's recreation and open space inventory (including municipal, county and federal parkland), and required buffers from C1 waters and mapped tributaries within Special Water Resource Protection Areas. This information is illustrated in Figure 9. This methodology provided an acreage calculation of constrained and developable land by HUC 14. Impervious cover limits by municipal zone district were then applied to developable land area to calculate the total build-out square footage of impervious cover.

In order to determine the amount of developable land within each of the Township's nine HUC 14 watersheds, the Township build-out analysis was sorted by watershed. The locations of the HUC 14 watersheds are shown in Figure 10. Land areas were then summarized based on expected build-out zoning for each watershed area. See Figure 11 for the Township's Zoning Map. These land areas were then adjusted to account for environmentally constrained lands and roadways, since these lands will not be developed further, as described earlier. See Figure 12,

Figure 7: Existing Land Cover 1995-1997

Figure 8: Existing Land Use

Figure 9: Developable Land

Figure 10: Hydrologic Units (HUC 14s) within the Township

Figure 11: Zoning Districts

Figure 12: Environmentally Constrained Lands

for land areas constrained by wetlands and waterways.

In order to determine the amount of additional impervious coverage anticipated at full build-out, the amount of developable land remaining was multiplied by the maximum permitted lot coverage permitted in each zone. It is emphasized that the National Park Service has entered into a lease agreement with Sandy Hook partners for the adaptive reuse and rehabilitation of numerous structures at Historic Fort Hancock at Gateway National Recreation Area. Since the Principal focus of the agreement is upon reuse and rehabilitation, and since parking is abundant at both Fort Hancock and throughout Gateway National Recreation Area, additional impervious surfaces are not anticipated, and Table 8 does not include land area calculations for this area. Table 8 summarizes the build-out calculations and the anticipated amount of additional impervious coverage for each HUC within the Township.

Table 8: Build-Out Calculations

Zone	Total Land Area (acres)	Constrained Land Area (acres)	Developable Land Area (acres)	Allowable Impervious (%)	Build-Out Impervious (acres)
HUC 14 #02030104060050 (Waackaack Creek)					
B-1	6.97	0.00	6.97	0.9	6.28
B-2	46.88	6.04	40.84	0.7	28.59
B-3	185.70	37.68	148.03	0.7	103.62
OR-2	17.42	6.75	10.67	0.5	5.33
OR-3	272.71	81.54	191.17	0.45	86.03
R-10	156.63	0.73	155.90	0.25	38.98
R-22	652.50	144.38	508.12	0.2	101.62
R-30	13.74	0.02	13.72	0.15	2.06
R-45	477.60	388.42	89.17	0.15	13.38
R-5	268.26	88.03	180.23	0.4	72.09
R-7	28.25	3.69	24.57	0.4	9.83
RGA-2	12.83	0.06	12.77	0.4	5.11
RTF	48.93	3.25	45.68	0.35	15.99
RTH	36.49	4.05	32.44	0.35	11.35
RTH-3	17.57	3.56	14.01	0.4	5.60
RTH-6	3.42	1.36	2.06	0.4	0.83
Totals	2245.90	769.57	1476.34		506.67
HUC 14 #02030104060060 (Pews Creek to Shrewsbury River)					
AAC	51.25	32.46	18.79	0.6	11.27
B-1	36.15	6.85	29.31	0.8	23.44
B-1A	0.33	0.00	0.33	0.9	0.30
B-2	166.31	50.06	116.25	0.7	81.37

Zone	Total Land Area (acres)	Constrained Land Area (acres)	Developable Land Area (acres)	Allowable Impervious (%)	Build-Out Impervious (acres)
B-3	351.94	81.03	270.91	0.7	189.64
FL	703.04	637.39	65.65	0	0.00
M-1	282.85	281.17	1.68	0.7	1.18
MC	116.75	91.75	25.00	0.7	17.50
OR-3	2.27	0.12	2.15	0.45	0.97
R-10	900.81	140.52	760.29	0.25	190.07
R-110	2.79	0.00	2.79	0.12	0.33
R-15	385.44	131.52	253.92	0.25	63.48
R-22	2370.58	481.74	1888.84	0.2	377.77
R-220	10.15	4.24	5.91	0.11	0.65
R-30	225.78	50.19	175.59	0.15	26.34
R-45	663.80	230.09	433.71	0.15	65.06
R-5	182.71	121.54	61.17	0.4	24.47
R-7	1021.87	644.48	377.39	0.4	150.96
R-90	123.74	10.27	113.47	0.12	13.62
RGA	59.31	4.18	55.12	0.4	22.05
RGA-1	15.26	8.49	6.77	0.4	2.71
RGA-4	0.27	0.05	0.22	0.75	0.17
RHA	24.15	11.75	12.39	0.75	9.30
R-O	57.41	12.63	44.77	0.5	22.39
RTF	36.23	23.04	13.20	0.35	4.62
RTH	28.26	0.09	28.17	0.35	9.86
RTH-2	18.85	4.39	14.46	0.4	5.78
RTH-5	2.01	0.26	1.75	0.75	1.31
RTH-6	10.70	8.52	2.17	0.4	0.87
Totals	7850.99	3068.83	4782.17		1317.46
HUC 14 #02030104070010 (Hop Brook)					
R-45	11.75	3.86	7.89	0.15	1.18
Totals	11.75	3.86	7.89		1.18
HUC 14 #02030104070070 (Swimming River Reservoir/Slope Brook)					
R-130	5.90	1.55	4.35	0.11	0.48
R-220	459.17	331.29	127.88	0.11	14.07
R-45	45.59	18.86	26.74	0.15	4.01
Totals	510.66	351.69	158.97		18.56
HUC 14 #02030104070090 (Nut Swamp Brook)					
B-1	24.11	3.52	20.59	0.8	16.48
BP	12.36	0.00	12.36	0.7	8.65
OR	40.52	11.93	28.58	0.35	10.00
OR-1	68.81	44.56	24.25	0.25	6.06
R-1	154.38	26.00	128.38	0.25	32.09
R-10	93.70	40.42	53.29	0.25	13.32
R-130	180.49	100.89	79.60	0.11	8.76
R-2	103.99	35.17	68.82	0.35	24.09
R-22	553.30	93.72	459.58	0.2	91.92
R-220	709.21	490.11	219.11	0.11	24.10
R-22A	48.92	3.16	45.77	0.35	16.02
R-30	1367.51	336.75	1030.76	0.15	154.61

Zone	Total Land Area (acres)	Constrained Land Area (acres)	Developable Land Area (acres)	Allowable Impervious (%)	Build-Out Impervious (acres)
R-45	804.18	337.22	466.96	0.15	70.04
R-45A	20.09	2.61	17.48	0.3	5.24
R-90	33.19	32.80	0.39	0.12	0.05
RHA-1	7.02	1.96	5.06	0.6	3.03
R-O	26.92	5.61	21.31	0.5	10.65
Totals	4248.69	1566.43	2682.27		495.12
HUC 14 #02030104070100 (Poricy Brook/Swimming River below Swimming River Rd.)					
B-1	27.26	0.00	27.26	0.8	21.81
B-2	5.38	0.00	5.38	0.7	3.77
B-3	64.37	1.15	63.22	0.7	44.25
BP	125.43	39.73	85.70	0.7	59.99
R-10	369.83	70.79	299.04	0.25	74.76
R-22	871.98	384.50	487.49	0.2	97.50
R-220	155.24	51.11	104.13	0.11	11.45
R-22A	10.58	0.00	10.58	0.35	3.70
R-30	1211.16	285.09	926.07	0.15	138.91
R-45	83.48	28.05	55.42	0.15	8.31
R-45A	0.16	0.00	0.16	0.3	0.05
R-O	46.24	3.40	42.84	0.5	21.42
Totals	2971.10	863.81	2107.28		485.92
HUC 14 #02030104070110 (Navesink River below Rt. 35/Lower Shrewsbury)					
AAC	36.54	9.52	27.01	0.35	9.45
B-2	0.37	0.00	0.37	0.7	0.26
B-3	209.62	35.98	173.64	0.7	121.55
M-1	91.18	52.91	38.27	0.6	22.96
PRH	25.43	21.54	3.89	0.5	1.94
R-10	623.42	150.84	472.58	0.25	118.14
R-110	1155.80	429.17	726.63	0.12	87.20
R-15	79.12	11.19	67.94	0.25	16.98
R-22	439.64	87.86	351.78	0.2	70.36
R-220	2667.76	1488.89	1178.87	0.11	129.68
R-30	201.17	37.65	163.52	0.15	24.53
R-45	432.20	192.46	239.75	0.15	35.96
R-90	410.62	121.07	289.55	0.12	34.75
RGA	39.23	6.52	32.71	0.38	12.43
R-O	23.76	1.02	22.74	0.5	11.37
RTF	6.85	1.48	5.37	0.35	1.88
RTH	42.17	29.36	12.81	0.35	4.48
RTH-1	35.57	16.30	19.27	0.3	5.78
RTH-2	62.80	18.40	44.41	0.4	17.76
RTH-4/B-3	15.01	0.00	15.01	0.4	6.00
Totals	6598.25	2712.14	3886.10		733.47
HUC 14 #02030104910020 (Sandy Hook Bay, east of Storm Creek)					
FL	1.35	1.27	0.08	0	0.00
M-1	2.40	2.40	0.00	0.6	0.00
R-15	0.68	0.64	0.04	0.25	0.01

Zone	Total Land Area (acres)	Constrained Land Area (acres)	Developable Land Area (acres)	Allowable Impervious (%)	Build-Out Impervious (acres)
R-5	6.27	6.27	0.00	0.4	0.00
R-7	0.34	0.34	0.00	0.4	0.00
Totals:	11.05	10.93855.51	0.12		0.01
TOTALS					
Totals:	**24,448.39**	**9,347.26**	**15,101.13**		**3,558.39**

It should be noted that the total build-out acreage calculation includes both developed and undeveloped land. Developed land has limited potential for additional impervious lot cover. It is estimated that up to 80% of Middletown exclusive of exempt property (i.e. parks, federal land) has already been developed to maximum zoning capacity. While stormwater runoff associated with developed land may already be incorporated into existing stormwater management facilities that sufficiently address water quality, this MSWMP presents recommendations and opportunities to incorporate BMPs for new development and redevelopment.

Table 9: Pollutant Loading Coefficients

Land Cover	Total Phosphorus (lbs/acre/yr)	Total Nitrogen Load (lbs/acre/year)	Total Suspended Solids Load (lbs/acre/yr)
High, Medium Density Residential	1.4	15	140
Low Density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, mixed urbane, Other Urban	1	10	120
Agricultural	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland / Transitional Area	0.5	5	60

Source: *NJDEP Stormwater BMP Manual*, 2004

In order to calculate the amount of pollutants that can be expected to enter each waterway as a

result of future development, the amount of additional lot coverage was multiplied by the NJDEP pollutant loading coefficient for Total Phosphorous, Total Nitrogen, and Total Suspended Solids. These coefficients, which are summarized in Table 9 above, represent the anticipated amount of pollutant per acre per year which can be anticipated as a result of future development.

The total pollutant loading for the Township as a result of future development for each watershed or HUC 14 area summarized in Table 10.

HUC-14 # 02030104920010, encompassing the Atlantic Coast from Sandy Hook to the Navesink, contains the area known as Sandy Hook. This area has no available land are for development, and therefore was excluded from these calculations. The Township's eight remaining HUC-14 watershed areas have a total area of 24,448.39 acres or 38.2 square miles. Of this over 24,000 acres a total of 15,101 acres (23.59 mi^2) of land area will be available for development. At Build-Out there will be 3,558.59 acres (5.56mi^2) of impervious surface. This impervious surface will allow for a pollutant loading of 13,476 lbs/year of Total Phosphorous to be added to the Township's waterbodies. A total of 128,970 lbs/year (64.5 tons/year) of Total Nitrogen will be added to the Township's waterbodies through stormwater runoff, as well as 1,757,641 lbs/year (878.8 tons/year) of Total Suspended Solids.

Table 10: Township Pollutant Loads by HUC-14 Area

Zone	Build-Out Zoning	Developable Land Area (acres)	TP (lbs/acre/yr)	TP (lbs/yr)	TN (lbs/acre/yr)	TN (lbs/yr)	TSS (lbs/acre/yr)	TSS (lbs/yr)
HUC 14 #02030104060050 (Waackaack Creek)								
B-1	Urban, Mixed Urban, Other Urban	7	1.0	7	10	70	120	837
B-2	Commercial	41	2.1	86	22	898	200	8,167
B-3	Commercial	148	2.1	311	22	3,257	200	29,605
OR-2	Commercial	11	2.1	22	22	235	200	2,133
OR-3	Urban, Mixed Urban, Other Urban	191	1.0	191	10	1,912	120	22,941
R-10	High Density Residential	156	1.4	218	15	2,339	140	21,826
R-22	Low Density Residential	508	0.6	305	5	2,541	100	50,812

Zone	Build-Out Zoning	Developable Land Area (acres)	TP (lbs/acre/yr)	TP (lbs/yr)	TN (lbs/acre/yr)	TN (lbs/yr)	TSS (lbs/acre/yr)	TSS (lbs/yr)
R-30	Low Density Residential	14	0.6	8	5	69	100	1,372
R-45	Low Density Residential	89	0.6	54	5	446	100	8,917
R-5	High Density Residential	180	1.4	252	15	2,703	140	25,232
R-7	High Density Residential	25	1.4	34	15	369	140	3,439
RGA-2	High Density Residential	13	1.4	18	15	192	140	1,788
RTF	High Density Residential	46	1.4	64	15	685	140	6,395
RTH	High Density Residential	32	1.4	45	15	487	140	4,542
RTH-3	High Density Residential	14	1.4	20	15	210	140	1,961
RTH-6	High Density Residential	2	1.4	3	15	31	140	289
Total		1,476		1,638		16,441		190,256
HUC 14 #02030104060060 (Pews Creek to Shrewsbury River)								
AAC	Medium Density Residential	19	1.4	26	15	282	140	2,630
B-1	Urban, Mixed Urban, Other Urban	29	1.0	29	10	293	120	3,517
B-1A	Urban, Mixed Urban, Other Urban	0.33	1.0	0.3	10	3	120	40
B-2	Commercial	116	2.1	244	22	2,557	200	23,249
B-3	Commercial	271	2.1	569	22	5,960	200	54,182
FL	Urban, Mixed Urban, Other Urban	66	1.0	66	10	657	120	7,878
M-1	Industrial	2	1.5	3	16	27	200	336
MC	Urban, Mixed Urban, Other Urban	25	1.0	25	10	250	120	3,000
OR-3	Commercial	2	2.1	5	22	47	200	429
R-10	High Density Residential	760	1.4	1,064	15	11,404	140	106,440
R-110	Rural Residential	3	0.6	2	5	14	100	279
R-15	Medium Density Residential	254	1.4	355	15	3,809	140	35,549
R-22	Low Density Residential	1,889	0.6	1,133	5	9,444	100	188,884

Zone	Build-Out Zoning	Developable Land Area (acres)	TP (lbs/acre/yr)	TP (lbs/yr)	TN (lbs/acre/yr)	TN (lbs/yr)	TSS (lbs/acre/yr)	TSS (lbs/yr)
R-220	Rural Residential	6	0.6	4	5	30	100	591
R-30	Low Density Residential	176	0.6	105	5	878	100	17,559
R-45	Low Density Residential	434	0.6	260	5	2,169	100	43,371
R-5	High Density Residential	61	1.4	86	15	918	140	8,564
R-7	High Density Residential	377	1.4	528	15	5,661	140	52,835
R-90	Low Density Residential	113	0.6	68	5	567	100	11,347
RGA	High Density Residential	55	1.4	77	15	827	140	7,717
RGA-1	High Density Residential	7	1.4	9	15	101	140	947
RGA-4	High Density Residential	0.22	1.4	0	15	3	140	31
RHA	High Density Residential	12	1.4	17	15	186	140	1,735
R-O	Urban, Mixed Urban, Other Urban	45	1.0	45	10	448	120	5,373
RTF	High Density Residential	13	1.4	18	15	198	140	1,847
RTH	High Density Residential	28	1.4	39	15	423	140	3,944
RTH-2	High Density Residential	14	1.4	20	15	217	140	2,024
RTH-5	High Density Residential	2	1.4	2	15	26	140	245
RTH-6	High Density Residential	2	1.4	3	15	33	140	304
Total		4,782		4,805		47,431		584,849
HUC 14 #02030104070010 (Hop Brook)								
R-45	Low Density Residential	8	0.6	5	5	39	100	789
Total		8		5		39		789
HUC 14 #02030104070070 (Swimming River Reservoir/Slope Brook)								
R-130	Rural Residential	4	0.6	3	5	22	100	435
R-220	Rural Residential	128	0.6	77	5	639	100	12,788
R-45	Low Density Residential	27	0.6	16	5	134	100	2,674
Total		159		95		795		15,897

Zone	Build-Out Zoning	Developable Land Area (acres)	TP (lbs/acre/yr)	TP (lbs/yr)	TN (lbs/acre/yr)	TN (lbs/yr)	TSS (lbs/acre/yr)	TSS (lbs/yr)
HUC 14 #02030104070090 (Nut Swamp Brook)								
B-1	Urban, Mixed Urban, Other Urban	21	1.0	21	10	206	120	2,471
BP	Commercial	12	2.1	26	22	272	200	2,472
OR	Commercial	29	2.1	60	22	629	200	5,716
OR-1	Commercial	24	2.1	51	22	533	200	4,850
R-1	High Density Residential	128	1.4	180	15	1,926	140	17,973
R-10	High Density Residential	53	1.4	75	15	799	140	7,460
R-130	Rural Residential	80	0.6	48	5	398	100	7,960
R-2	High Density Residential	69	1.4	96	15	1,032	140	9,635
R-22	Low Density Residential	460	0.6	276	5	2,298	100	45,958
R-220	Rural Residential	219	0.6	131	5	1,096	100	21,911
R-22A	Medium Density Residential	46	1.4	64	15	686	140	6,407
R-30	Low Density Residential	1,031	0.6	618	5	5,154	100	103,076
R-45	Low Density Residential	467	0.6	280	5	2,335	100	46,696
R-45A	Low Density Residential	17	0.6	10	5	87	100	1,748
R-90	Low Density Residential	0.39	0.6	0	5	2	100	39
RHA-1	High Density Residential	5	1.4	7	15	76	140	708
R-O	Urban, Mixed Urban, Other Urban	21	1.0	21	10	213	120	2,557
Total		2,682		1,965		17,742		287,636
HUC 14 #02030104070100 Poricy Brook/Swimming River below Swimming River Rd.)								
B-1	Urban, Mixed Urban, Other Urban	27	1.0	27	10	273	120	3,272
B-2	Commercial	5	2.1	11	22	118	200	1,076
B-3	Commercial	63	2.1	133	22	1,391	200	12,644
BP	Commercial	86	2.1	180	22	1,885	200	17,139
R-10	High Density Residential	299	1.4	419	15	4,486	140	41,865
R-22	Low Density Residential	487	0.6	292	5	2,437	100	48,749
R-220	Rural Residential	104	0.6	62	5	521	100	10,413

Zone	Build-Out Zoning	Developable Land Area (acres)	TP (lbs/acre/yr)	TP (lbs/yr)	TN (lbs/acre/yr)	TN (lbs/yr)	TSS (lbs/acre/yr)	TSS (lbs/yr)
R-22A	Medium Density Residential	11	1.4	15	15	159	140	1,481
R-30	Low Density Residential	926	0.6	556	5	4,630	100	92,607
R-45	Low Density Residential	55	0.6	33	5	277	100	5,542
R-45A	Low Density Residential	0.16	0.6	0	5	1	100	16
R-O	Urban, Mixed Urban, Other Urban	43	1.0	43	10	428	120	5,141
Total		2,107		1,772		16,606		239,944
HUC 14 #02030104070110 (Navesink River – below Rt. 35/Lower Shrewsbury)								
AAC	Medium Density Residential	27	1.4	38	15	405	140	3,782
B-2	Commercial	0.37	2.1	1	22	8	200	73
B-3	Commercial	174	2.1	365	22	3,820	200	34,728
M-1	Industrial	38	1.5	57	16	612	200	7,654
PRH	Urban, Mixed Urban, Other Urban	4	1.0	4	10	39	120	466
R-10	High Density Residential	473	1.4	662	15	7,089	140	66,161
R-110	Rural Residential	727	0.6	436	5	3,633	100	72,663
R-15	Medium Density Residential	68	1.4	95	15	1,019	140	9,511
R-22	Low Density Residential	352	0.6	211	5	1,759	100	35,178
R-220	Rural Residential	1,179	0.6	707	5	5,894	100	117,887
R-30	Low Density Residential	164	0.6	98	5	818	100	16,352
R-45	Low Density Residential	240	0.6	144	5	1,199	100	23,975
R-90	Low Density Residential	290	0.6	174	5	1,448	100	28,955
RGA	High Density Residential	33	1.4	46	15	491	140	4,579
R-O	Urban, Mixed Urban, Other Urban	23	1.0	23	10	227	120	2,729
RTF	High Density Residential	5	1.4	8	15	81	140	752
RTH	High Density	13	1.4	18	15	192	140	1,794

	Residential							
Zone	**Build-Out Zoning**	**Developable Land Area (acres)**	**TP (lbs/acre/yr)**	**TP (lbs/yr)**	**TN (lbs/acre/yr)**	**TN (lbs/yr)**	**TSS (lbs/acre/yr)**	**TSS (lbs/yr)**
RTH-1	High Density Residential	19	1.4	27	15	289	140	2,698
RTH-2	High Density Residential	44	1.4	62	15	666	140	6,217
RTH-4/B-3	High Density Residential	15	1.4	21	15	225	140	2,102
Total		3,886		3,195		29,914		438,255
HUC 14 #02030104910020 (Sandy Hook Bay – east of Storm Creek)								
FL	Urban, Mixed Urban, Other Urban	0.08	1.0	0	10	1	120	10
M-1	Industrial	0	1.5	0	16	0	200	0
R-15	Medium Density Residential	0.04	1.4	0	15	1	140	5
R-5	High Density Residential	0	1.4	0	15	0	140	0
R-7	High Density Residential	0	1.4	0	15	0	140	0
Total		0.1		0.1		1.4		15.2
	Totals:	**15,101**		**13,476**		**128,970**		**1,757,641**

HUC-14 # 02030104060060, the area encompassing Pews Creek to the Shrewsbury River, has a developable area of 4,782 acres. This area is expected to contribute the greatest annual amount of pollutants, with 4,805 lbs/year TP, 47,431 lbs/year TN, and 584,849 lbs/year TSS. However, HUC 14 #02030104910020 encompassing sections of Sandy Hook Bay, east of Storm Creek has only 0.1 acres available land for development, and therefore contributes the smallest amount of stormwater pollution in the Township. This area will contribute less than 3 lbs/yr phosphorous and nitrogen combined, and approximately 15 lbs/yr of TSS.

VIII. MITIGATION PLAN

This mitigation plan is to provide potential solutions to offset stormwater related impacts to groundwater recharge, stormwater quantity control, and/or stormwater quality control for proposed development and establishes the criteria to grant a variance or exemption from the stormwater management design and performance standards set forth in this MSWMP and in N.J.A.C. 7:8-5.

MITIGATION PROJECT CRITERIA

For applications in which stormwater criteria can not be met the NJDEP regulations allow the Township Planning Board to grant variances subject to the following conditions. Mitigation for major development as defined by N.J.A.C. 7:8 – 1.2 et seq. must be implemented in the same drainage area, as the proposed development, and must provide groundwater recharge benefits, or protection from stormwater runoff quality and quantity within previously developed property. Performance standards must ensure the long-term maintenance of the approved mitigation system, which include the maintenance requirements under Chapters 8 and 9 of the NJDEP BMP Manual. The Township does not anticipate granting variances or exemptions for “major developments” until a detailed mitigation plan is developed and approved. The Township will consider granting variances or exemptions for "major developments" subject to:

1. The Developer demonstrating that alternate measures proposed achieve substantially similar benefits to the required measures; and
2. Showing that literal compliance is technically impractical or presents a substantial economic hardship; and
3. Providing mitigation by implementing stormwater management improvements identified by the Township elsewhere within the basin, which achieves substantially similar stormwater management benefits.

DEVELOPER MITIGATION PLAN REQUIREMENTS

Proposed mitigation projects shall have Mitigation Plans submitted to the Township for review and approval prior to granting final approval for site development. Developers should include the following in a Mitigation Plan:

- Mitigation Project Name, Owner name and address, Developer name and address, Mitigation Project Location, Drainage Area, Cost Estimate;
- Proposed mitigation strategy and impact to sensitive receptor. What is being impacted, mitigated, and how;
- Legal authorization required for construction and maintenance;
- Responsible Party including: required maintenance, who will perform the maintenance, proposed cost of maintenance, and how it will be funded;
- All other permits required for construction of the mitigation project;
- Cost estimate of construction inspection; and
- Reason a waiver or exemption is required and supporting evidence.

The Applicant may also select one of the following strategies, identified by the Township, to be developed into potential mitigation projects. Additional information may be available from the Township or the Township's Engineer. It is the developer's responsibility to provide a detailed study of any proposed mitigation project, and provide the Township with a proposed mitigation plan for review and approval.

Groundwater Recharge

✧ Maintenance of detention basins.

✧ Installation of permeable pipe underdrains.

Water Quality & Water Quantity

✧ De-silting and De-snagging of the ditches/culverts in the major watershed basins. These include, but are not limited to Compton's Creek, McClees Creek, Mahoras Brook, Pews Creek and Ware Creek.

- ✧ De-silting of Shadow Lake and Poricy Pond.
- ✧ Construction of structural BMPs on the Township's storm sewer system and discharge points.

Stream Corridor Protection

- ✧ Preservation of floodplain lands.

IX. RECOMMENDATIONS

The following are additional recommendations associated with this Stormwater Management Plan Element of the Master Plan.

- ***Recommendation A: The Planning Board and Township Committee shall review, discuss, update and amend the Township's existing development ordinances to be in compliance with the design, performance and safety standards outlined in this MSWMP and in the NJDEP's stormwater regulations. Additionally, to require the adoption of a Stormwater Management Control Ordinance.***

  Portions of the existing development ordinances are inconsistent with recently adopted New Jersey Department of Environmental Protection (NJDEP) Stormwater Management Regulations and the NJDEP's BMP Manual. Some of these inconsistencies are identified in the Stormwater Management Strategies section above. The Township shall update their existing regulations to be in conformance with these regulations and to minimize inconsistencies or conflicts. In addition, NJDEP requires the Municipal Stormwater Control Ordinance that supports this plan be adopted within twelve months of the adoption date of this MSWMP.

- ***Recommendation B: Educate residents on the impacts of the overuse of fertilizers and good fertilizer maintenance practices.***

  As stated in the Stormwater Management Strategies section above, the overuse of fertilizers has a significant detrimental impact on surface water bodies and groundwater. The Township should work with the NJDEP to educate residents and lawn care or landscaping professionals on these impacts and encourage them to use techniques to create a “green lawn” without over-fertilizing and/or to convert lawn areas to other kinds of vegetation that do not require fertilization and other chemical treatments. Many lawn services also “overspray” fertilizer onto roadways and adjacent properties. The Township should

investigate methods to minimize the application of fertilizers beyond property lines.

✧ ***Recommendation C: Evaluate the need to adopt a Stream Corridor Buffer Ordinance.***

The NJDEP Stormwater Regulations requires any development with more than 1 acre of disturbance or ¼ acre of impervious coverage to provide a 300-foot Buffer along a Category-1 stream from the center line of the stream. Category-1 streams include sections of the Navesink River, the Swimming River Reservoir, and Claypit Creek. The Township's should evaluate the need to adopt a 300-foot Category 1 Stream Corridor Buffer Ordinance or amend any existing buffer ordinance to comply with the NJDEP regulations.

The Township should encourage the use of BMPs to the extent feasible to allow the filtering of all stormwater runoff through vegetation or vegetative filter strips prior to discharge of stormwater runoff into a stream or water body.

✧ ***Recommendation D: Seek to ensure the inspection, monitoring, and maintenance of all stormwater management facilities and develop strategies for all existing and future maintenance and improvements.***

Stormwater facilities require regular maintenance to ensure effective and reliable performance. Failure to perform the necessary maintenance can lead to diminished performance, deterioration and failure. In addition, a range of health and safety problems, including mosquito breeding and the potential for drowning, can result from improperly maintained facilities. To minimize these risks, the Township should implement a procedure for regular inspection, monitoring, and maintenance of Township owned stormwater facilities.

Additionally, there are a number of privately maintained stormwater facilities within the Township. The Township should work with the various property owners, residents and business owners to identify maintenance and/or improvements needs and develop strategies

for regular inspection and maintenance of these facilities. This MSWMP also places the responsibility for long-term operation and maintenance for privately owned stormwater management facilities on the owner/applicant. However, the Township is ultimately responsible for discharges from publicly owned outfalls. Therefore, it is important to have the ability to perform maintenance and assess the applicant fees should it become necessary.

The Township should also encourage the use of low impact design methods and non-structural strategies that require less maintenance.

✧ ***Recommendation E: Evaluate redefining the thresholds for "Major Development" within environmentally sensitive or fully developed areas.***

Residential tear downs and smaller site development or redevelopment could have a major impact on stormwater management. Not all of these sites will meet the will meet the current NJDEP thresholds for "Major Development" of one acre disturbance or ¼ acre additional impervious. Reducing the threshold definitions of "major development" will include more development and redevelopment projects in certain sensitive areas.

✧ ***Recommendation F: Evaluate the NJDEP recommended BMPs for use within the Township.***

The NJDEP provides several structural and non-structural strategies for stormwater management. Some of these facilities, however, may not be cost effective methods of stormwater management for the Township. Each strategy should be investigated to determine the long-term feasibility and effectiveness of each BMP for use within the Township.

✧ ***Recommendation G: Evaluate the need to make stormwater mitigation measures a consideration for all application reviews.***

There are many smaller applications that come before the Planning or Zoning Boards. Individually, these smaller applications and certain variances do not meet the definition of "major development" and therefore fall outside the scope of this MSWMP. However, collectively these lot coverage variances and building variances do have an impact on stormwater management through out the Township. Allowing for mitigation measures to be considered for all applications will decrease the negative impacts from these smaller projects.

✧ ***Recommendation H: Map all existing and future Conservation Easements.***

There are many privately and publicly owned Conservation Easements currently established within the Township. These easements should be mapped and their relationship to the watersheds of the Township explored. This map can then be used to establish future greenways and conservation corridors along environmentally sensitive or scenic areas.

✧ ***Recommendation I: Revise the Build-Out Analysis to combine all conservation easements with constrained lands layer.***

As noted earlier, there are many privately and publicly owned Conservation Easements within the Township. These easements are non-developable lands and, therefore, should be added to the constrained lands layer of the Build-Out Analysis. These additional constrained lands may alter the amounts of total developable land area, built-out impervious coverage area, and the respective pollution loading calculations.

✧ ***Recommendation J: Develop, prioritize, and maintain detailed descriptions of allowable mitigation projects for each of the Township's drainage basins.***

Mitigation projects should be developed in detail for each Township drainage basin. These projects should be classified into water quality, water quantity, and groundwater recharge mitigation projects. In addition, projects within each basin should be prioritized to maximize positive impact to the Township's stormwater management system.

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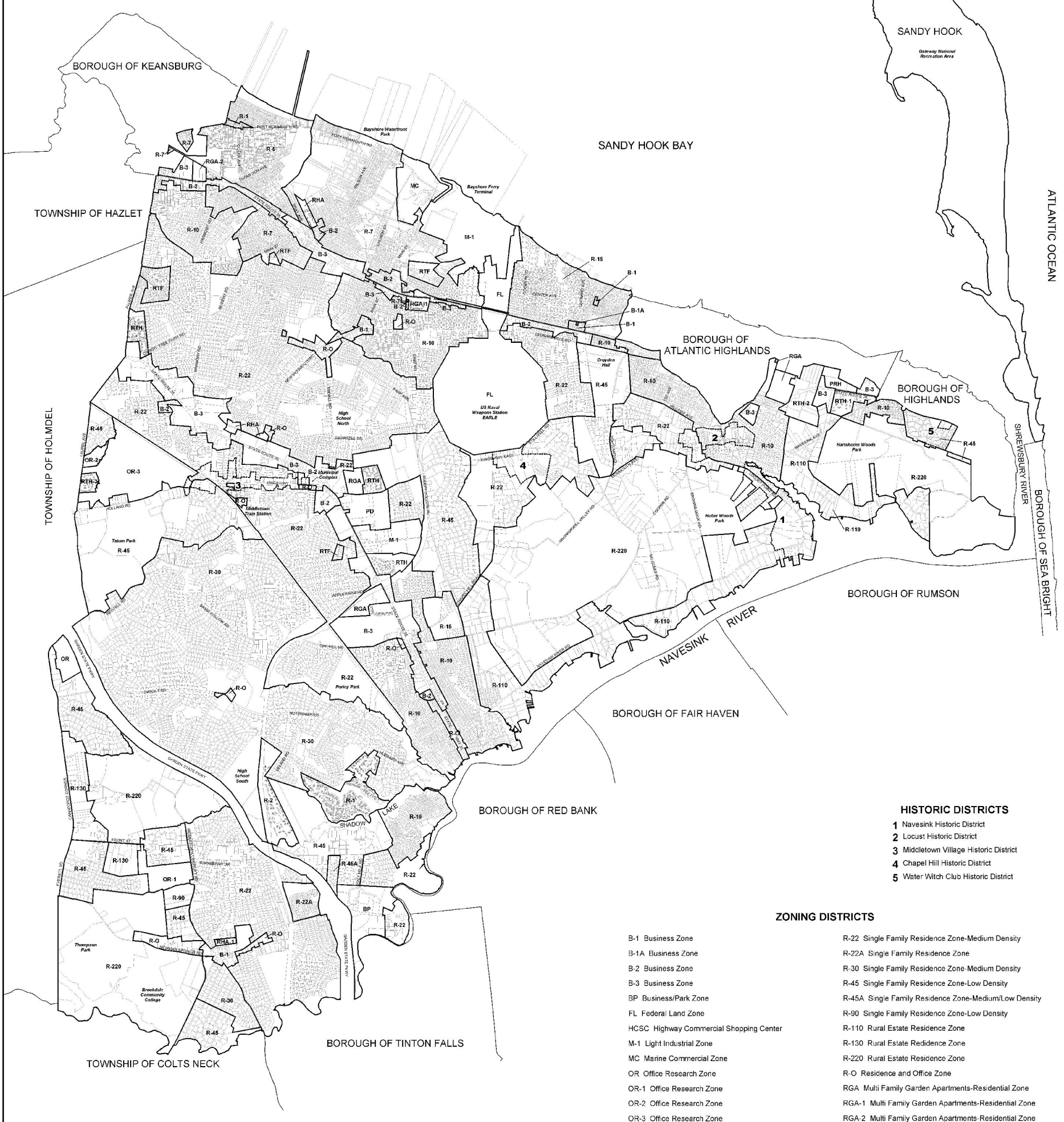
ZONING MAP
TOWNSHIP OF MIDDLETOWN
MONMOUTH COUNTY, NEW JERSEY

Organized December 14, 1667
"Pride in Middletown"



HISTORIC DISTRICTS

1. Navesink Historic District
2. Locust Historic District
3. Middletown Village Historic District
4. Chapel Hill Historic District
5. Water Witch Club Historic District

ZONING DISTRICTS

B-1 Business Zone
B-1A Business Zone
B-2 Business Zone
B-3 Business Zone
BP Business/Park Zone
FL Federal Land Zone
HCSC Highway Commercial Shopping Center
M-1 Light Industrial Zone
MC Marine Commercial Zone
OR Office Research Zone
OR-1 Office Research Zone
OR-2 Office Research Zone
OR-3 Office Research Zone
PD Planned Development District
PRH Planned Residential Housing
R-1 Planned Adult Community
R-2 Planned Adult Community
R-5 Single Family Residence Zone-High Density
R-7 Single Family Residence Zone-High Density
R-10 Single Family Residence Zone Medium Density
R-15 Single Family Residence Zone-Medium Density
R-22 Single Family Residence Zone-Medium Density
R-22A Single Family Residence Zone
R-30 Single Family Residence Zone-Medium Density
R-45 Single Family Residence Zone-Low Density
R-45A Single Family Residence Zone-Medium/Low Density
R-90 Single Family Residence Zone-Low Density
R-110 Rural Estate Residence Zone
R-130 Rural Estate Redidence Zone
R-220 Rural Estate Residence Zone
R-O Residence and Office Zone
RGA Multi Family Garden Apartments-Residential Zone
RGA-1 Multi Family Garden Apartments-Residential Zone
RGA-2 Multi Family Garden Apartments-Residential Zone
RHA Multi Family Mid-Rise Apartment Residential Zone
RHA-1 Senior Mid-Rise Apartment Residential Zone
RTF Two Family-Residence Zone
RTH Multi-Family Townhouses-Residential Zone
RTH-1 Multi-Family Townhouse-Residential Zone
RTH-2 Multi-Family Townhouse-Residential Zone
RTH-3 Multi-Family Townhouse-Residential Zone

GRAPHIC SCALE

5,000 0 2,500 5,000 10,000

(IN FEET)
1 inch = 5,000ft.

NOTE: MIDDLETOWN TOWNSHIP ZONING MAP WAS PROVIDED COURTESY OF MASER CONSULTING P.A.

TOWNSHIP OF MIDDLETOWN

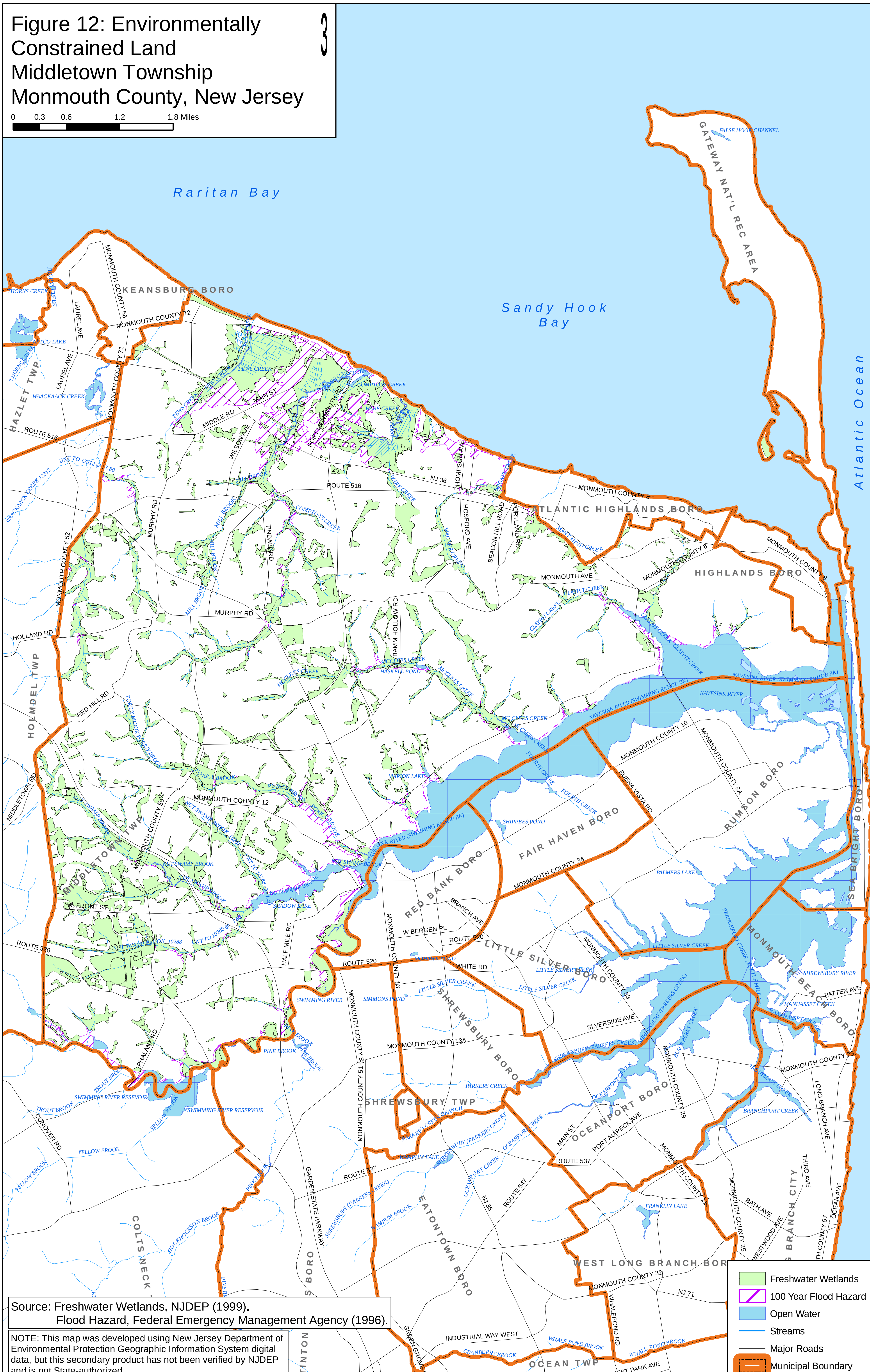
T&M ASSOCIATES
11 TINDALL ROAD
MIDDLETOWN, NJ 07748
TEL 732-671-6400
FAX 732-671-7365

TOWNSHIP OF MIDDLETOWN
ZONING MAP

FIGURE NO. 11

MIDD.09840 | MIDD984-ZONE | FEB. 2005

Figure 12: Environmentally Constrained Land
Middletown Township
Monmouth County, New Jersey


0 0.3 0.6 1.2 1.8 Miles
Raritan Bay
Sandy Hook Bay
Atlantic Ocean
GATEWAY NAT'L REC AREA
FALSE HOOK CHANNEL
KEANSBURG BORO
ATLANTIC HIGHLANDS BORO
HIGHLANDS BORO
HAZLET TWP
HOLMDEL TWP
MIDDLETOWN TWP
RUMSON BORO
FAIR HAVEN BORO
RED BANK BORO
LITTLE SILVER BORO
SHREWSBURY BORO
SHREWSBURY TWP
OCEANPORT BORO
MONMOUTH BEACH BORO
SEA BRIGHT BORO
WEST LONG BRANCH BORO
LONG BRANCH CITY
EATONTOWN BORO
COLTS NECK TWP
TINTON FALLS BORO
OCEAN TWP
MONMOUTH COUNTY 56
MONMOUTH COUNTY 72
MONMOUTH COUNTY 71
MONMOUTH COUNTY 52
MONMOUTH COUNTY 50
MONMOUTH COUNTY 12
MONMOUTH COUNTY 8
MONMOUTH COUNTY 10
MONMOUTH COUNTY 8A
MONMOUTH COUNTY 34
MONMOUTH COUNTY 13
MONMOUTH COUNTY 13A
MONMOUTH COUNTY 51
MONMOUTH COUNTY 33
MONMOUTH COUNTY 29
MONMOUTH COUNTY 11
MONMOUTH COUNTY 25
MONMOUTH COUNTY 32
MONMOUTH COUNTY 57
ROUTE 516
ROUTE 520
ROUTE 537
ROUTE 547
NJ 36
NJ 35
NJ 71
GARDEN STATE PARKWAY
LAUREL AVE
MIDDLE RD
MAIN ST
WILSON AVE
PORT MONMOUTH RD
THOMPSON AVE
HOSFORD AVE
BEACON HILL ROAD
PORTLAND RD
MONMOUTH AVE
MURPHY RD
TINDALL RD
BAMM HOLLOW RD
HOLLAND RD
RED HILL RD
MIDDLETOWN RD
W. FRONT ST
HALF MILE RD
PHALANX RD
CONOVER RD
BUENA VISTA RD
BRANCH AVE
W BERGEN PL
WHITE RD
SLVERSIDE AVE
PORT AU PECK AVE
PATTEN AVE
LONG BRANCH AVE
THIRD AVE
OCEAN AVE
BATH AVE
WESTWOOD AVE
WHALEPOND RD
INDUSTRIAL WAY WEST
WEST PARK AVE
GREEN GROVE RD
THORNS CREEK
NATCO LAKE
WAACKAACK CREEK
PEWS CREEK
COMPTONS CREEK
WARE CREEK
MILL BROOK
WAGNER CREEK
MANY MIND CREEK
CLAYPIT CREEK
MCCLEES CREEK
HASKELL POND
PORICY BROOK
NUT SWAMP BROOK
MARION LAKE
SHADOW LAKE
NAVESINK RIVER (SWIMMING R)(HOP BK)
NAVESINK RIVER
FOURTH CREEK
SHIPPEES POND
PALMERS LAKE
LITTLE SILVER CREEK
BRANCHPORT CREEK (TURTLEMILL CK)
SHREWSBURY RIVER
MANHASSET CREEK
MOHAWK POND
SIMMONS POND
SWIMMING RIVER
PINE BROOK
TROUT BROOK
SWIMMING RIVER RESEVOIR
SWIMMING RIVER RESERVOIR
YELLOW BROOK
HOCKHOCKSON BROOK
PARKERS CREEK
SHREWSBURY (PARKERS CREEK)
OCEANPORT CREEK
BLACKBERRY CREEK
TROUTMANS CREEK
WAMPUM LAKE
WAMPUM BROOK
FRANKLIN LAKE
WHALE POND BROOK
CRANBERRY BROOK
Freshwater Wetlands
100 Year Flood Hazard
Open Water
Streams
Major Roads
Municipal Boundary

Source: Freshwater Wetlands, NJDEP (1999).
Flood Hazard, Federal Emergency Management Agency (1996).

NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

Figure 10: Hydrologic Units (HUC-14s)
Middletown Township
Monmouth County, New Jersey

0 0.5 1 2 Miles

Raritan Bay

Atlantic Ocean

Sandy Hook Bay (east of Thorns Ck)
HUC14 #02030104910020

Pews Creek to Shrewsbury River
HUC14 #02030104060060

Weackaack Creek
HUC14 #02030104060050

Navesink R (below Rt 35)/LowerShrewsbury
HUC14 #02030104070110

Poricy Bk/Swimming R (below SwimmingR Rd)
HUC14 #02030104070100

Hop Brook
HUC14 #02030104070010

Nut Swamp Brook
HUC14 #02030104070090

Swimming River Reservoir / Slope Bk
HUC14 #02030104070070

FALSE HOOK CHANNEL
GATEWAY NAT'L REC AREA
KEANSBURG BORO
THORNS CREEK
LAUREL AVE
MONMOUTH COUNTY 56
MONMOUTH COUNTY 72
MONMOUTH COUNTY 71
HAZLET TWP
WACKAACK CREEK
PEWS CREEK
MAIN ST
MIDDLE RD
ROUTE 516
WILSON AVE
PORT MONMOUTH RD
COMPTONS CREEK
WARE CREEK
WAGNER CREEK
NJ 36
ROUTE 516
HOSFORD AVE
BEACON HILL ROAD
PORTLAND RD
MANY MIND CREEK
MONMOUTH COUNTY 8
ATLANTIC HIGHLANDS BORO
MONMOUTH COUNTY 52
MURPHY RD
MILL BROOK
TINDALL RD
KINGS HWY EAST
MONMOUTH AVE
CLAYPIT CREEK
HOLLAND RD
BAMM HOLLOW RD
MCCLEES CREEK
HASKELL POND
RED HILL RD
MARION LAKE
FOURTH CREEK
SHIPPEES POND
FAIR HAVEN BORO
BUENA VISTA RD
MONMOUTH COUNTY 10
MONMOUTH COUNTY 8A
RUMSON BORO
NAVESINK RIVER
NAVESINK RIVER (SWIMMING R)(HOP BK)
MONMOUTH COUNTY 50
MIDDLETOWN TWP
NUT SWAMP BROOK
PORICY BROOK
MONMOUTH COUNTY 12
MONMOUTH COUNTY 34
PALMERS LAKE
RED BANK BORO
BRANCH AVE
W BERGEN PL
ROUTE 520
HALF MILE RD
MONMOUTH COUNTY 13
LITTLE SILVER BORO
LITTLE SILVER CREEK
WHITE RD
SHADOW LAKE
SWIMMING RIVER
SIMMONS POND
SHREWSBURY BORO
SHREWSBURY RIVER
MANHASSET CREEK
PATTEN AVE
SLVERSIDE AVE
MONMOUTH COUNTY 13A
PHALANX RD
SWIMMING RIVER RESERVOIR
PINE BROOK
MONMOUTH COUNTY 51
SHREWSBURY TWP
PARKERS CREEK
SHREWSBURY (PARKERS CREEK)
BRANCHPORT CREEK
MONMOUTH COUNTY 29
LONG BRANCH AVE
TROUT BROOK
CONOVER RD
YELLOW BROOK
OCEANPORT CREEK
OCEANPORT BORO
MAIN ST
PORT AU PECK AVE
ROUTE 537
GARDEN STATE PARKWAY
WAMPUM LAKE
WAMPUM BROOK
NJ 35
ROUTE 547
MONMOUTH COUNTY 11
THIRD AVE
BATH AVE
WESTWOOD AVE
OCEAN AVE
LONG BRANCH CITY
HOCKHOCKSON BROOK
COLTS NECK TWP
EATONTOWN BORO
MONMOUTH COUNTY 32
WEST LONG BRANCH BORO
NJ 71
NJ 18
INDUSTRIAL WAY WEST
WHALEPOND RD
WHALE POND BROOK
CRANBERRY BROOK
OCEAN TWP
WEST PARK AVE
GREEN GROVE RD
TINTON FALLS BORO
SEA BRIGHT BORO

Source: Subwatersheds (HUC 14), New Jersey Geological Survey (NJGS) (2000).

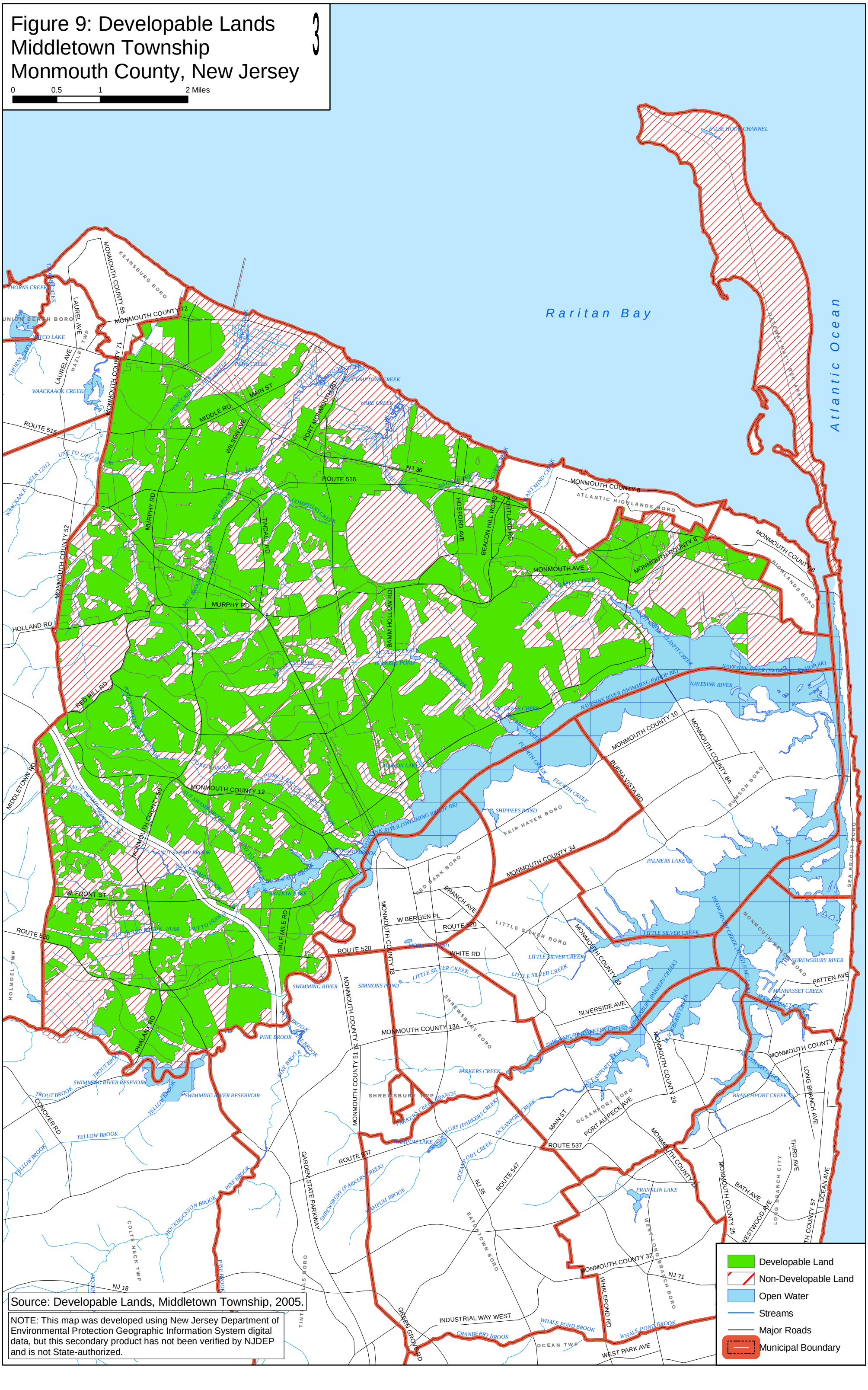
NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

Subwatersheds
Open Water
Streams
Major Roads
Municipal Boundary

Figure 9: Developable Lands
Middletown Township
Monmouth County, New Jersey

3

0 0.5 1 2 Miles



Source: Developable Lands, Middletown Township, 2005.

NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

- Developable Land
- Non-Developable Land
- Open Water
- Streams
- Major Roads
- Municipal Boundary

Figure 7: Existing Land Use
Middletown Township
Monmouth County, New Jersey

Source: Existing Land Use, NJDEP (1995-1997).

NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

Figure 6: Wellhead Protection Areas
Middletown Township
Monmouth County, New Jersey

0 0.5 1 2 Miles

Raritan Bay

Sandy Hook Bay

Atlantic Ocean

GATEWAY NAT'L REC AREA

UNION BEACH BORO

KEANSBURG BORO

HAZLET TWP

HOLMDEL TWP

MIDDLETOWN TWP

ATLANTIC HIGHLANDS BORO

HIGHLANDS BORO

FAIR HAVEN BORO

RUMSON BORO

SEA BRIGHT BORO

RED BANK BORO

LITTLE SILVER BORO

MONMOUTH BEACH BORO

SHREWSBURY BORO

SHREWSBURY TWP

OCEANPORT BORO

WEST LONG BRANCH BORO

EATONTOWN BORO

COLTS NECK TWP

TINTON FALLS BORO

OCEAN TWP

LONG BRANCH AVE

PORT MONMOUTH RD

MAIN ST

MIDDLE RD

ROUTE 516

WILSON AVE

NJ 36

THOMPSON AVE

ROUTE 520

MURPHY RD

TINDALL RD

HOSFORD AVE

BEACON HILL ROAD

PORTLAND RD

MONMOUTH AVE

HOLLAND RD

BAMM HOLLOW RD

RED HILL RD

MIDDLETOWN RD

W. FRONT ST

HALF MILE RD

W BERGEN PL

BRANCH AVE

WHITE RD

SLVERSIDE AVE

PATTEN AVE

PHALANX RD

CONOVER RD

GARDEN STATE PARKWAY

NJ 35

ROUTE 547

ROUTE 537

MAIN ST

PORT AU PECK AVE

BATH AVE

THIRD AVE

OCEAN AVE

WESTWOOD AVE

NJ 71

NJ 18

WHALEPOND RD

GREEN GROVE RD

INDUSTRIAL WAY WEST

WEST PARK AVE

BUENA VISTA RD

MONMOUTH COUNTY 56

MONMOUTH COUNTY 52

MONMOUTH COUNTY 50

MONMOUTH COUNTY 12

MONMOUTH COUNTY 8

MONMOUTH COUNTY 8A

MONMOUTH COUNTY 10

MONMOUTH COUNTY 34

MONMOUTH COUNTY 33

MONMOUTH COUNTY 13

MONMOUTH COUNTY 51

MONMOUTH COUNTY 13A

MONMOUTH COUNTY 11

MONMOUTH COUNTY 29

MONMOUTH COUNTY 25

MONMOUTH COUNTY 15

MONMOUTH COUNTY 57

MONMOUTH COUNTY 32

LAUREL AVE

PEWS CREEK

UNT TO PEWS CREEK

COMPTONS CREEK

WARE CREEK

WAGNER CREEK

MILL BROOK

UNT TO 12136 @ 3.50

COMPTONS CREEK 12136

MC CLEES CREEK

HASKELL POND

CLAYPIT CREEK

NAVESINK RIVER

SHREWSBURY RIVER

MC CLEES CREEK

NAVESINK RIVER (SWIMMING R)(HOP BK)

MARION LAKE

PORICY BROOK

PORICY POND

NUT SWAMP BROOK 10288

UNT TO 10288 @ 3.40

NUT SWAMP BROOK

UNT TO 10288 @ 3.60

NUT SWAMP BROOK

UNT TO 10288 @ 1.60

SHADOW LAKE

SWIMMING RIVER

UNKNOWN

SWIMMING RIVER RESERVOIR

Public Well #29-21612

Open Water

Streams

Major Roads

Municipal Boundary

Source: Public Community Water Supply Wells , NJGS

NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

Figure 5: Groundwater Recharge Areas
Middletown Township
Monmouth County, New Jersey

0 0.35 0.7 1.4 2.1 Miles

Raritan Bay

Sandy Hook Bay

Atlantic Ocean

GATEWAY NAT'L REC AREA

UNION BEACH BORO

KEANSBURG BORO

HAZLET TWP

LAUREL AVE

MONMOUTH COUNTY 56

MONMOUTH COUNTY 71

PORT MONMOUTH RD

MAIN ST

MIDDLE RD

ROUTE 516

WILSON AVE

NJ 36

THOMPSON AVE

ATLANTIC HIGHLANDS BORO

MONMOUTH COUNTY 8

HIGHLANDS BORO

MONMOUTH COUNTY 52

MURPHY RD

MONMOUTH COUNTY 50

TINDALL RD

DEEP HOLLOW RD

HOSFORD AVE

BEACON HILL ROAD

PORTLAND RD

MONMOUTH AVE

HOLLAND RD

RED HILL RD

NAVESINK RIVER

SHREWSBURY RIVER

DAMM HOLLOW RD

MONMOUTH COUNTY 12

MARCY LAKE

PORICY POND

MIDDLETOWN RD

MIDDLETOWN TWP

MONMOUTH COUNTY 10

FAIR HAVEN BORO

BUENA VISTA RD

MONMOUTH COUNTY 8A

ROMSON BORO

SEA BRIGHT BORO

MONMOUTH COUNTY 34

RED BANK BORO

BRANCH AVE

W FRONT ST

HALF MILE RD

SHADOW LAKE

ROUTE 520

W BERGEN PL

MONMOUTH COUNTY 13

LITTLE SILVER BORO

WHITE RD

PATTERSON AVE

MONMOUTH BEACH BORO

BITTEN AVE

SWIMMING RIVER

SWIMMING RIVER RESERVOIR

UNKNOWN

HOLMDEL TWP

NJ 35

SHREWSBURY BORO

SLVERSIDE AVE

MONMOUTH COUNTY 13A

MONMOUTH COUNTY 11

OCEANPORT BORO

PORT AU PECK AVE

FLORENCE AVE

LONG BRANCH AVE

MONMOUTH COUNTY 29

PHALANX RD

CONOVER RD

COLTS NECK TWP

SHREWSBURY TWP

GARDEN STATE PARKWAY

ROUTE 537

MAIN ST

MONMOUTH COUNTY 21

ROUTE 547

EATONTOWN BORO

WEST LONG BRANCH BORO

MONMOUTH COUNTY 32

NJ 71

WHALEPOND RD

INDUSTRIAL WAY WEST

TINTON

Source: Groundwater Recharge Areas, NJ Geological Survey (1995-1997)

NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

- 16 to 19 in/yr
- 12 to 15 in/yr
- 9 to 11 in/yr
- 1 to 8 in/yr
- 0 in/yr
- Hydric Soils
- Wetlands/Open Water
- No Recharge Calculated
- Open Water
- Streams
- Major Roads
- Municipal Boundary

Figure 4: Waterways Map
Middletown Township
Monmouth County, New Jersey

3

0 0.5 1 2 Miles

Raritan Bay

Sandy Hook Bay

Atlantic Ocean

GATEWAY NAT'L REC AREA

UNION BEACH BORO

KEANSBURG BORO

HAZLET TWP

MIDDLETOWN TWP

HOLMDEL TWP

COLTS NECK TWP

ATLANTIC HIGHLANDS BORO

HIGHLANDS BORO

FAIR HAVEN BORO

ROSEMONT BORO

SEA BRIGHT BORO

RED BANK BORO

LITTLE SILVER BORO

MONMOUTH BEACH BORO

OCEANPORT BORO

WEST LONG BRANCH BORO

EATONTOWN BORO

SHREWSBURY BORO

SHREWSBURY TWP

TINTON FALLS BORO

OCEAN TWP

LONG BRANCH AVE

MONMOUTH AVE

PORT MONMOUTH RD

MAIN ST

MIDDLE RD

ROUTE 516

WILSON AVE

LAUREL AVE

MONMOUTH COUNTY 56

MONMOUTH COUNTY 52

MURPHY RD

MONMOUTH COUNTY 50

TINDALL RD

SLEEPY HOLLOW RD

HOLLAND RD

RED HILL RD

MIDDLETOWN RD

MONMOUTH COUNTY 12

BAMM HOLLOW RD

HOSFORD AVE

BEACON HILL ROAD

PORTLAND RD

THOMPSON AVE

NJ 36

MONMOUTH COUNTY 8

MONMOUTH COUNTY 10

MONMOUTH COUNTY 8A

MONMOUTH COUNTY 34

BUENA VISTA RD

BRANCH AVE

W BERGEN PL

ROUTE 520

W. FRONT ST

HALF MILE RD

WHITE RD

MONMOUTH COUNTY 13

MONMOUTH COUNTY 33

SLVERSIDE AVE

PATTEN AVE

MONMOUTH COUNTY 11

MONMOUTH COUNTY 29

MONMOUTH COUNTY 15

MONMOUTH COUNTY 25

MONMOUTH COUNTY 57

MONMOUTH COUNTY 32

NJ 71

WHALEPOND RD

MONMOUTH COUNTY 15

BATH AVE

WESTWOOD AVE

OCEAN AVE

THIRD AVE

ROUTE 537

MAIN ST

PORT AU PECK AVE

NJ 35

ROUTE 547

GARDEN STATE PARKWAY

CONOVER RD

MONMOUTH COUNTY 13A

MONMOUTH COUNTY 51

PHALANX RD

NJ 18

INDUSTRIAL WAY WEST

GREEN GROVE RD

WEST PARK AVE

SWIMMING RIVER

SWIMMING RIVER RESERVOIR

UNKNOWN

PEWS CREEK

UNT TO PEWS CREEK

COMPTONS CREEK

WARE CREEK

MILL BROOK

WAGNER CREEK

UNT TO 12136 @ 3.50

COMPTONS CREEK 12136

MC CLEES CREEK

HASELL POND

CLAYPIT CREEK

NAVESINK RIVER

SHREWSBURY RIVER

MC CLEES CREEK

NAVESINK RIVER (SWIMMING R)(HOP BK)

MARION LAKE

PORICY BROOK

PORICY POND

NUT SWAMP BROOK 10288

UNT TO 10288 @ 1.60

NUT SWAMP BROOK

UNT TO 10288 @ 1.40

SHADOW LAKE

UNT TO 10288 @ 1.60

Source: Streams and Open Water, NJDEP (1998).

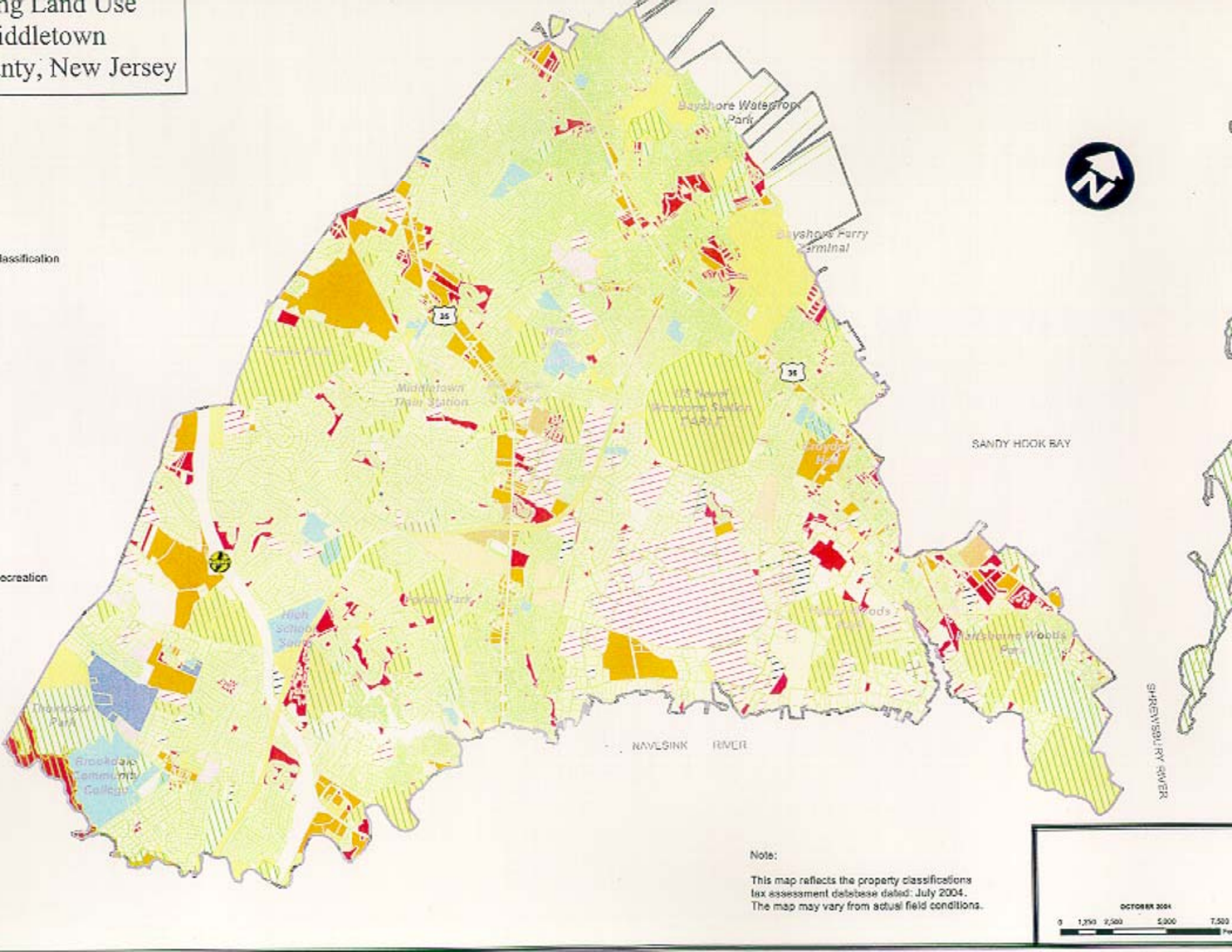
NOTE: This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

Open Water
Streams
Major Roads
Municipal Boundary

ng Land Use
iddletown
nty, New Jersey

lassification

ecreation

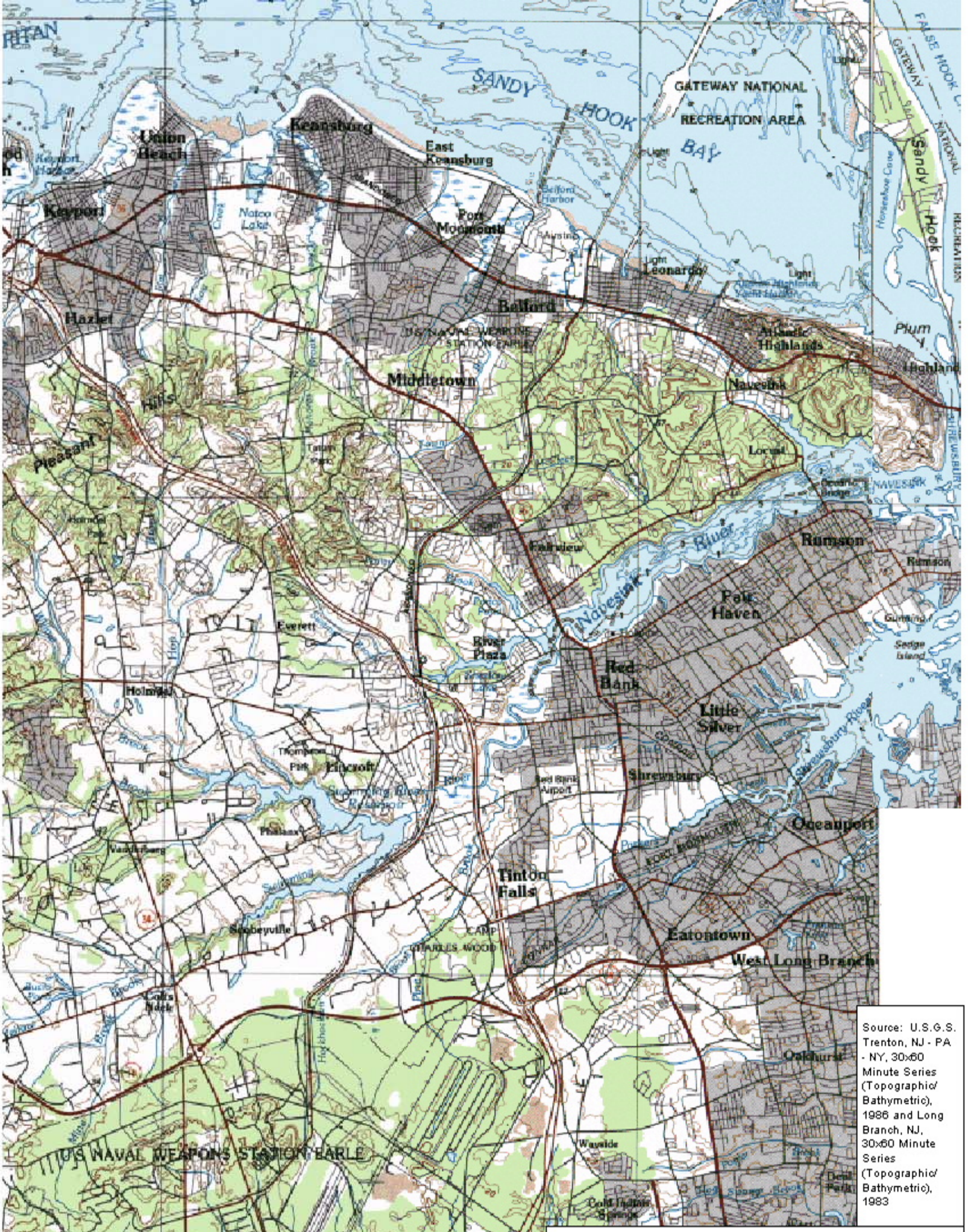


Note:

This map reflects the property classifications
tax assessment database dated: July 2004.
The map may vary from actual field conditions.

OCTOBER 2004

0 1,250 2,500 5,000 7,500



Source: U.S.G.S. Trenton, NJ - PA - NY, 30x60 Minute Series (Topographic/ Bathymetric), 1986 and Long Branch, NJ, 30x60 Minute Series (Topographic/ Bathymetric), 1983

Figure 3: Topographic Map