MUNICIPAL STORMWATER MANAGEMENT PLAN
MASTER PLAN ELEMENT

TOWNSHIP OF HOLMDEL
MONMOUTH COUNTY, NEW JERSEY

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PREPARED BY THE

HOLMDEL TOWNSHIP PLANNING BOARD

IN CONSULTATION WITH:

TM ASSOCIATES

11 Tindall Road
Middletown, New Jersey 07748
(732) 671-6400

EDWARD G. BROBERG, P.E., P.P
HOLMDEL TOWNSHIP ENGINEER
Licensed Professional Engineer No GE 18001
Licensed Professional Planner No 1000

BONNIE L. HEARD, P.E.
HOLMDEL TOWNSHIP
PLANNING BOARD ENGINEER
Licensed Professional Engineer No GE 42475

The original of this document has been signed and sealed in accordance with NJSA 45:14A-1 et. seq.

Members of the 2005 Planning Board

Dr. Ralph B. Blumenthal, Chairman

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Dr. Janet Jackel

Santo Arena

Paul Phillips, AICP, PP, Phillips Preiss Shapiro Associates, Inc., Planning Board Planner

Charles Starks, AICP, PP, Phillips Preiss Shapiro Associates, Inc.

Louis P. Rago, Esq., Planning Board Attorney

Bonnie Heard, PE, T&M Associates, Planning Board Engineer

Bonnie Imposimato, Planning Board Secretary and Administrative Officer

Jolene Conner, Assistant Planning Board Secretary

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1.0 INTRODUCTION

As required by the Municipal Stormwater Regulations (N.J.A.C. 7:14A-25), the Township of Holmdel has developed this Municipal Stormwater Management Plan (Plan) to outline their approach to addressing the impacts resulting from stormwater related issues associated with future development and land use changes. The Plan addresses 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 results in more than ¼ acres of additional impervious cover. The standards are intended to 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 Plan provides 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, the Municipal Stormwater Management Plan puts forth strategies for managing stormwater and conserving the natural resources of Holmdel and the Swimming River Reservoir watershed. This element complements other sections of the *Holmdel Township Master Plan*, including the Farmland Preservation Element, the Conservation Plan Element, the Land Use Element, and the Utility Service Plan Element that addresses the sewer infrastructure and storm drainage systems. The Element also builds upon the research and background information included in the Holmdel Environmental Commission's *Natural Resource Inventory,* and *Holmdel Township's Wastewater Management Plan* as well as the Planning Board's *Holmdel Township Master Plan: Background Studies*.

Ordinance changes are recommended to expedite the implementation of stormwater management strategies. Since the Township has more than one square mile of developable or vacant land, a build-out analysis is included. The Plan also includes a mitigation plan to permit

the Township to grant variances or exemptions from proposed design and performance standards set forth in this document. Although they are located within the Township, this plan does not cover the Garden State Parkway, the PNC Bank Arts Center, adjacent New Jersey Highway Authority property including the Vietnam Memorial, Holmdel Park and Thompson Park and the Ramanessin Brook Conservation Area, since these facilities are covered by either the New Jersey Highway Authority or Monmouth County Stormwater Management Plan and Permits.

1.1 GOALS & OBJECTIVES

The goals of this Plan are to:

Goal A: Reduce flood damage, including damage to life and property;

Goal B: Minimize, to the extent practicable, any increase in stormwater runoff from a new development;

Goal C: Reduce soil erosion from development, redevelopment, or construction projects;

Goal D: Encourage the adequacy of existing and proposed culverts, bridges, and other in-stream structures;

Goal E: Maintain groundwater recharge and base flow of streams during periods of drought;

Goal F: Prevent, to the greatest extent feasible, an increase in non-point source pollution;

Goal G: Maintain the integrity of stream channels for their biological function, as well as for drainage;

Goal H: Minimize pollutants and the amount of total suspended solids 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, commercial, industrial, and other uses of water;

Goal I: Protect public safety through the proper design and operation of stormwater basins and Best Management Practices.

In addition to the state mandated requirements described above, the Township has the following additional goals, some of which were goals from the January 2004 *Holmdel Township Master Plan*:

Goal J: Prevent floatables and solids (i.e. bottles and cans) from entering water bodies that receive stormwater;

Goal K: Encourage the use of indigenous vegetation in landscape design;

Goal L: Continue to preserve open space and maintain undisturbed vegetation along streams *(Master Plan Conservation Element Goal 4.E)****;***

Goal M: Protect groundwater and surface water resources from potential contamination as a result of sedimentation and pollutants carried by stormwater through street drains, detention basin overflows, streambed scouring, and wastewater disposal systems *(Master Plan Utility Element Goal 9.E);*

Goal N: Provide a plan for wildlife management, including geese and deer:

Goal O: Limit clearing of trees and forested land *(Master Plan Conservation Element Goal 4.D);*

Goal P: Limit the increase of impervious coverage throughout the Township; and

Goal Q: Increase public awareness of stormwater management through public education.

2.0 STORMWATER DISCUSSION

2.1 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 flows to the Earth's seas and oceans. This constant process of evapo-transpiration, condensation, precipitation, and infiltration comprises the hydrologic cycle.

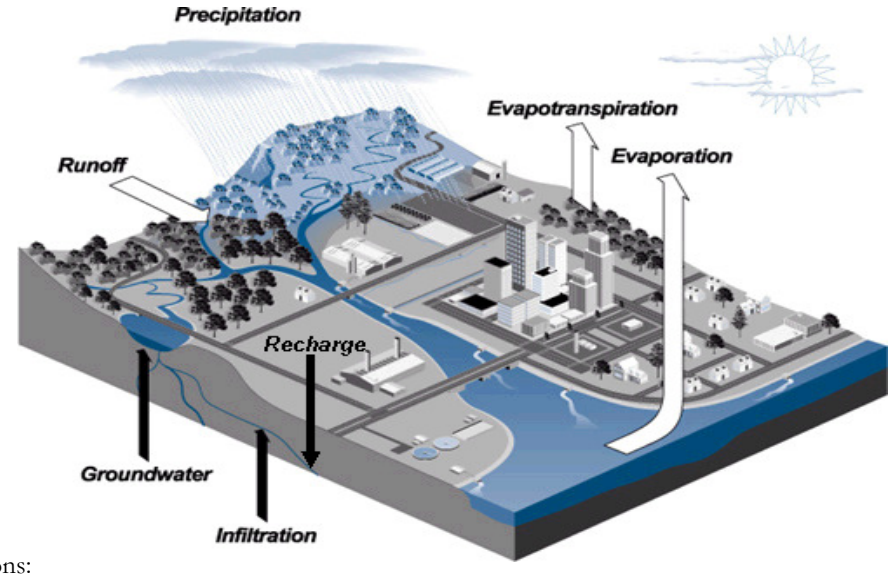
2.2 IMPACTS OF DEVELOPMENT AND STORMWATER

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) allows 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 flows 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 of the watershed, impacting ecological integrity.

Water quantity impacts, combined with land development, often adversely impacts 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, 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. This Plan 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.

3.0 BACKGROUND

Holmdel Township is approximately 18.1 square miles or 11,580 acres in size. It is primarily a residential community located in central Monmouth County New Jersey, several miles south of the Raritan Bay and immediately north of the Swimming River Reservoir. It is located on a ridgeline that separates New Jersey's Bayshore Region from the Interior Coastal Plain. The topography within the Township ranges from near sea level to 400 feet near the ridgeline as shown on Figure 3 (Page 3-2).

Between 2000 and 2004, the Holmdel Township Planning Board updated their master plan. A detailed study of the existing conditions and trends within Holmdel was performed as part of this comprehensive update and includes numerous goals, objectives, and recommendations for the future development of Holmdel Township.

3.1 DEMOGRAPHICS

This Municipal Stormwater Management Plan is a new element of the recently adopted comprehensive Master Plan. It is intended to build on the research, background information, goals, objectives and recommendations included in the Planning Board's *Holmdel Township Master Plan: Background Studies*, dated August 2001 and *Holmdel Township Master Plan*, dated January 2004.

Holmdel, prior to 1950, was a predominantly agricultural community. As noted in Table 1, Holmdel experienced its first population boom between 1950 and 1960. This population boom coincided with the opening of the Garden State Parkway, which attracted homebuyers from northern New Jersey and New York City. Holmdel's population continued to increase by approximately 11 % a year between 1950 and 1970. The Township's population continued

Figure 3: Topography

to grow at an average rate of approximately 4% per year between 1970 and 2000. Holmdel's annual growth rate for the past 50 years has generally exceeded that of Monmouth County and the State. However, according to the recently completed build-out analysis, Holmdel's acreage is approximately 90% developed and its population is expected to grow slowly over the next 20 years.

Table 1: Historical Population Growth 1930 – 2000

Year	*Holmdel Township*		*Monmouth County*		*New Jersey*	
	Total Population	*Average Annual Growth Rate Over the Prior Period*	*Total Population*	*Average Annual Growth Rate Over the Prior 10-year Period*	*Total Population*	*Average Annual Growth Rate Over the Prior 10-year Period*
1930	1,191		147,209	4.0%	4,041,334	2.8%
1940	1,201	0.1%	161,238	0.9%	4,160,165	0.3%
1950	1,380	1.4%	225,327	4.0%	4,835,329	1.6%
1960	2,959	7.9%	334,401	4.8%	6,066,782	2.6%
1970	6,117	7.5%	461,849	3.8%	7,171,112	1.8%
1980	8,447	3.3%	503,173	0.9%	7,364,823	0.3%
1990	11,532	3.2%	553,124	1.0%	7,730,118	0.5%
2000	15,781	3.2%	615,305	1.1%	8,414,350	0.9%
2003	17,487	3.5%*				
Full Build-Out	19,608	0.6%**				

Sources: Holmdel Township Master Plan Background Studies, dated August 2001, Tables 2-1 and Table 2-2; and http://www.wnjpin.net/OneStopCareerCenter/LaborMarketInformation/lmi01/poptrd6.htm

* - Source: Holmdel Township *Build-out Analysis*, June 2003.

**Assuming full build-out occurs over a twenty year period

3.2 LAND USE CHARACTERISTICS

In recent years, available land resources were reduced as a result of development and large-scale property acquisitions for use as farmland in perpetuity and dedicated open space set aside for park and land conservation, thereby limiting future growth. In 2003, a build-out analysis was conducted in an attempt to better define the anticipated population increase. The build-out analysis revealed that at full build-out, Holmdel is projected to have a total population

of 19,608. Please refer to Section 2.4 of the *Holmdel Township Master Plan* dated January 2004 for further information on the build-out analysis.

As noted in the *Holmdel Township Master Plan: Background Studies*, Holmdel experienced a steady growth in the number of housing units over the past thirty years. In 1970, there were 1,410 housing units, which increased to 2,237 in 1980, 3,477 in 1990, and 5,137 in 2000. At full build-out, Holmdel is projected to have approximately 6,194 housing units.

These population and housing trends indicate that the Township has seen an increase in development demand. In fact, according to the Township's *Master Plan*, Holmdel is entering into the full build-out stage of development. Increased development resulted in changes to the landscape, and increased the quantity and pollutant loading from stormwater runoff.

In August 2001, according to the *Holmdel Township Master Plan: Background Studies*, residential development was noted as the single largest land use, comprising 37% of the total Township acreage. The second largest land use is Public and Quasi-public uses, which accounted for 34% of the total Township Land Area. Included in the Public and Quasi-Public uses are approximately 1,660 acres of existing open space, park and recreational facilities, of which over 600 acres are "Dedicated Open Space." Commercial and industrial land uses account for approximately 8% of the Township area. Finally, in 2001, vacant, wooded, water, or agricultural land comprised the remaining 21% of land of, which a small portion included lots set aside as open space and conservation easements.

3.3 WATERWAYS

Holmdel has a number of water resources, as shown in Figure 4 (Page 3-7). The water bodies in the northern part of the Township flow towards the Raritan Bay and include the Mohingson Brook, Monascunk Brook, Luppatatong Creek, Flat Creek, East Creek, Takolusa Brook, Waackaack Creek (Waycake Creek), and Mahoras Brook. Many of these streams have extensive wetlands and flood plains adjacent to the waterways.

Figure 4: Water Resources

The water bodies in the southern part of the town drain into the Swimming River Reservoir. These water bodies include the Willow Brook, Ramanessin Brook/Hop Brook, and Borden's Brook. The Ramanessin Brook/Hop Brook is the largest single stream system in the Township and is listed by the NJDEP as a FW-2, Trout Maintenance Stream. The headwaters of the Willow Brook originate within adjacent Marlboro Township as well as in Holmdel. Portions of the Ramanessin Brook/Hop Brook and portions of the Willow Brook and Borden's Brook, within a certain distance of the Reservoir, are classified by the New Jersey Department of Environmental Protection (NJDEP) as a Category-1 Stream, while other portions of the Ramanessin Brook/Hop Brook, Willow Brook and Borden's Brook are not included in the Category-1 classification. However, the NJDEP indicates that any stream tributary, or feeding into, to a public drinking water supply is considered a Catergory-1 Stream and has listed these streams on their suggested list for Category 1 Streams. Since these streams are major feeder streams for the Swimming River Reservoir which provides potable water to over 200,000 residents of Monmouth County, Holmdel Township has petitioned the NJDEP to have the entire length of Ramanessin Brook/Hop Brook, Willow Brook and Borden's Brook classified as Category-1 streams. The Township has also requested that the Waackaack Creek and Mahoras Brook also be classified as Category 1. To date, the NJDEP has not acted on either of these requests.

In response to increased development, the Township has been working to protect environmentally sensitive areas. In 1994, Holmdel Township adopted the "Resource Management Regulations." As part of these regulations, developers were required to protect stream corridors and stream corridor buffers within a conservation easement. These regulations had required a stream corridor buffer of 50 feet on either side of the stream corridor for all streams except the Ramanessin Brook, which requires a 150-foot buffer of either side. Unlike many other municipalities, the stream corridor buffer is measured from the edge of the 100-year flood plain plus any adjacent steep slopes of 15% or greater. In 2002, Holmdel Township modified this ordinance to increase the stream corridor buffer width to 100 feet on each side for all streams except the Ramanessin Brook which continues to require a 150 foot wide buffer. The Township is also working to acquire open space along the streams to further protect these environmentally sensitive areas.

Holmdel Township also has numerous publicly and privately maintained detention basins and structural stormwater facilities. In addition to these facilities, the Township has an extensive storm drainage collection system. Additional information on the Township's stormwater facilities and storm drainage collection system can be found in the Township's Stormwater Pollution Prevention Plan which is on file at the Township's Administrator's Office.

3.4 WATER QUALITY

The Ambient Biomonitoring Network (AMNET) was established by the New Jersey Department of Environmental Protection (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 macro-invertebrates 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 macro-invertebrate health. (http://www.state.nj.us/dep/wmm/bfbm/).

In addition to monitoring the biological health of waterways, chemical data is gathered by the NJDEP, the Monmouth County Health Department, and other organizations, and used to determine the health of Holmdel's waterways. The impaired waterways are summarized on the New Jersey 2004 Integrated List of Water Bodies. This list is then broken down into five sublists based on priority. The streams on Sublist 5 are classified as being the most severely impaired or threatened, whereas the streams on Sublist 1 are the least threatened or impaired. The NJDEP then prioritizes the most severely impaired stream on the Sublist 5 into three (3) categories (high, medium and low) based on the priority or the need for mitigation of the impairment. A summary of the impaired Township streams is present in Table 2 on Page 3-8.

Table 2: 2004 Holmdel Township Impaired Water Bodies

Stream Location	*ID number*	*Sub List Number*	*Priority for Sub list 5 Water Bodies*	*Impairment (s)*	*Data Source*
Borden's Brook at Route 520	54	1 3 4 5	Medium	Nitrate pH & Total Suspended Solids Fecal Coliform Phosphorous	Monmouth County Health Department
Flat Creek at Middle Road in Hazlet	AN0457	5	Low	Benthic Macro-invertebrates	NJDEP AMNET
Hop Brook at Roberts Road	AN0465	5	Low	Benthic Macro-invertebrates	NJDEP AMNET
Hop Brook at Willow Brook Road	AN0466	5	Low	Benthic Macro-invertebrates	NJDEP AMNET
Mahoras Brook at Holland Road	MB-Park3	3		Benthic Macro-invertebrates	Monmouth County Health Department
Mahoras Brook at Route 35	AN0460 EWQ460 EWQ460	3 1 3		Benthic Macro-invertebrates Temperature, Dissolved Oxygen, pH, Nitrate, Phosphorus, Total Suspended Solids, Unionized Ammonia Dissolved Solids	NJDEP AMNET EWQ EWQ
Ramanessin Brook at Willow Road	53	1 3 4 5	Medium	Nitrate pH & Total Suspended Solids Fecal Coliform Phosphorous	Monmouth County Health Department
Waackaack Creek at Highland Ave in Keansburg	35, R65	5	High	Fecal Coliform Total Coliform	Monmouth County Health Department, NJDEP Coastal Monitoring and NJDEP Shellfish Monitoring
Willow Brook at Schanck Road	AN0468	5	Low	Benthic Macro-invertebrates	NJDEP AMNET
Willow Brook at Willow Brook Road in Colts Neck	AN0468	5	Low	Benthic Macro-invertebrates	NJDEP AMNET
Willow Brook at Willow Brook Road in Holmdel	52	1 3 4 5	Medium	Nitrate pH & Total Suspended Solids Fecal Coliform Phosphorous	Monmouth County Health Department

Sources: <http://www.state.nj.us/dep/wmm/bfbm/> Sub-list 1-5, New Jersey's 2004 Integrated List of Water Bodies, dated June 22, 2004

This water quality data is used by NJDEP to develop Total Daily Maximum 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 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, New Jersey Pollutant Discharge Elimination System (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 water body. TMDLs can be used to prevent further deterioration of a water body, or to improve the current water quality. Currently there are no established stormwater TMDLs in Holmdel.

In 2003, the Monmouth County Planning Board in cooperation with the Watershed Management Area 12, the Freehold Soil Conservation District and the Monmouth County Health Department, received a 319(h) grant from the NJDEP to study the Ramanessin Brook to determine sources of fecal coliform and phosphorus, and to develop a watershed pollutant-loading model and hydrologic model of the stream to assess water quality impacts from erosion, stormwater, and non-point source pollutants. This data can then be used to develop TMDLs for the Ramanessin Brook to remove these impairments. This work is currently underway and the results should be available in the next year or two. In addition, the Township should encourage future monitoring of the Township's streams and mitigation as necessary.

3.5 WATER QUANTITY

Stormwater also often causes water quantity issues. There are several flood prone areas in Holmdel Township including, but not limited to, the following:

- Middle Road, near the Mahoras Brook;
- Palmer Avenue, in several location where tributaries of the Mahoras Brook cross the roadway;
- Crawfords Corner Road, near the High School and the Public Works Facility;
- Mahoras Brook, near the Fox Chase development;

- Route 35, near the Mahoras Brook culvert;
- Willow Brook Road, near the confluence of Willow Brook and Ramanessin Brook; and
- Chestnut Ridge Road, behind the Indian Hill School.

Many of these areas are flood prone due to undersized storm water conveyances, accumulation of silt within streams and conveyance systems and limited opportunities for groundwater recharge. The Township is working with the State and County to undertake short-term strategies to address these problems.

3.6 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. A map showing ground water recharge areas, within the Township is located on Page 3-11 (Figure 5). This map was developed using the New Jersey Department of Environmental Protection Geographic Information System digital data and the New Jersey Geological Survey Data. This data was developed by comparing the localized surface Land Use Land Cover, the underlying soils, the slopes and the wetlands and their ability to absorb and recharge groundwater. This map was prepared in 1995-1997. Since then Holmdel has experienced a significant amount of development. Therefore, this map is somewhat out of date. Since this was the most current information available, the map was included in this Plan. The Township should work with the NJDEP to update their mapping. It should be noted that the municipal boundary shown in this figure differs from the actual Township boundaries. See Section 8.0 for further information.

Figure 5: Groundwater Recharge Areas

In addition to the protection of surface water, maintaining groundwater quality and quantity is important due in part to the presence of private wells for drinking water. Furthermore, the Shorelands Water Company, which serves portions of Holmdel and adjacent communities, draws deep groundwater through five wells located off of Hunters Lane. The Township's wellhead protection areas are delineated in Figure 6 (Page 3-15).

The four aquifers that lie underneath Holmdel are the Red Bank Sands aquifer, the Wenonah-Mount Laurel aquifer, the Englishtown aquifer, and the Potomac-Raritan, Magothy Upper and Middle aquifer. These aquifers exist within the unconsolidated sedimentary Coastal Plain deposits. These aquifers are replenished through groundwater recharge of rainwater that seeps through soil. Large areas of Holmdel are designated recharge areas for the Red Bank Sands, the Wenonah-Mount Laurel and the Englishtown aquifers. Figure 7 (Page 3-16) shows the location of the aquifers within the Township boundaries according to the Environmental Commission's 1990 *Natural Resource Inventory* and Figure 8 (Page 3-17) shows the surficial geology throughout the Township.

As is typical in the New Jersey Coastal Plain, shallow ground water zones eventually discharge to surface water bodies. Shallow ground water tends to flow in a similar direction to the slope of the overlying surfical topography. An exception to this general rule can be found in portions of the in the northwestern portion of the Township, in the area between Line Road and the Garden State Parkway, where the Wenonah-Mt. Laurel aquifer is exposed at the land surface or outcrops.

As shown in Figure 9 (Page 3-18), groundwater recharged into the Wenonah-Mt. Laurel aquifer is directed by the geologic structure and the southeast dip of the formation so that the recharged water flows in a south to southeasterly direction, beneath the ridge, which forms the surface water runoff drainage divide. Tributaries of both of the Willow Brook and the Ramanessin/Hop Brook have eroded streambeds to the point where they intercept the Wenonah-Mt. Laurel aquifer. The water is discharged from the Wenonah-Mt. Laurel aquifer into the tributaries of the Willow Brook and Ramanessin/Hop Brook, and ultimately discharges into the Swimming River Reservoir, which is a potable water source for the region.

This is further illustrated in Figure 10 (Page 3-19), which shows a cross-section of the area and how the groundwater entering the aquifer recharge area in the northern part of Holmdel, or north of the "ridge-line", is directed via the nature of the geologic structure, as well as, the dip of the aquifer to the discharge areas along the Ramanessin/Hop and Willow Brooks in the southern part Holmdel. Additional information on the Wenonah-Mt. Laurel aquifer and hydrology in Holmdel can be found in the October 2002, *Township of Holmdel Wastewater Management Plan.*

The supplemental flow to streams in the groundwater discharge areas is the single most important factor maintaining the stream flow during periods of annual low flow (hot, dry summer and early fall months) and during periods of drought. During these times, base flow of the stream is maintained via discharging groundwater. The maintenance of quantity of flow, the water quality and the survival of the aquatic and wetlands communities are directly dependent upon this groundwater discharge.

It is important to note that Holmdel Township is located in the NJDEP designated "Water Supply Critical Area No. 1," due to saltwater intrusion of saline coastal waters into freshwater aquifers. Two of the aquifers restricted by this "critical" area designation (The Englishtown and the Wenonah-Mt. Laurel aquifers) and have extensive recharge areas in the northern portion of the Township. This designation imposes groundwater withdrawal restrictions, limiting the amount that may be withdrawn by water company wells and the groundwater component of the Townships drinking water supply. Any future potable water allocations will largely rely upon surface water resource, such as the Swimming River Reservoir.

Holmdel is working to preserve and protect the quantity and quality of groundwater. In 1994, Holmdel Township adopted Ordinance 94-22, which requires major subdivisions and major site plans in aquifer recharge areas to be designed to maintain the quality of groundwater resources and to maintain or decrease the ratio of runoff to infiltration. Additionally this ordinance recommends surface water runoff be directed so as to travel over stabilized, vegetative areas as opposed to over potentially contaminated surfaces such as parking lots. This practice will reduce the level of pollutants in stormwater and will allow for vegetative and soil filtration of stormwater contaminants.

Figure 6: Well Locations

Figure 7: Aquifer Recharge Areas

Figure 8: Surficial Geology

Figure 9: Aquifer Recharge & Discharge in Western Holmdel

Figure 10: Geologic Cross Section

4.0 DESIGN AND PERFORMANCE STANDARDS

The Township should adopt applicable design and performance standards for stormwater management measures as presented 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. Section 6.0 of this plan, entitled "Stormwater Management Strategies," indicates actions appropriate for various types of development in Holmdel. Ultimately, design and performance standards should be created to contain the necessary language to maintain stormwater management measures consistent with applicable stormwater management rules at 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. The ordinances must be submitted to the county for review and approval within 12 months of the adoption of this plan.

A number of structural and nonstructural strategies require water to be retained for long periods of time. This has the potential to increase the promulgation of mosquito breeding habitats. New development and redevelopment activities should be coordinated with the Monmouth County Mosquito Extermination Commission so that the facilities can be properly designed and maintained. One way to mitigate against mosquito breeding is through the movement of water.

Proper construction and maintenance are critical to the successful performance of a stormwater management system. During construction, Township inspectors will observe the construction of the project to ensure that the stormwater management measures are constructed and function as designed.

The Township is also preparing a Stormwater Pollution Prevention Plan (SPPP) that includes an inventory of the existing stormwater facilities and establishes a maintenance schedule for all existing stormwater related facilities. Facilities on Township property and in residential developments are generally maintained by the Township and facilities on non-

residential are generally privately maintained. The Township will also initiate a local education program to educate property owners on the control of household waste, pet waste, goose waste, wildlife feeding, fertilizers, solids, floatable controls, pesticides and other methods to reduce stormwater pollutants that may adversely affect the Township's waterways.

For new development and redevelopment projects meeting the stormwater management threshold, the Township will require an operation and maintenance plan in accordance with the DEP *BMP Manual*. Copies of each maintenance plan will be filed with the Township Department of Public Works. Township personnel will perform inspections during the first two years of operation or after significant storms to ensure that the system is functioning properly. After this, annual checks will be done to identify maintenance needs. As part of these inspections, blockages must be cleared from inlets and outlets. The design of stormwater management practices for water quality improvement is based primarily on removal of sediment. Therefore, at some point, accumulated material must be removed and properly disposed of in accordance with the NJDEP regulations. 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.

5.0 PLAN CONSISTENCY

5.1 REGIONAL STORMWATER MANAGEMENT PLANS

Currently, there are no adopted Regional Stormwater Management Plans (Regional Plans) developed for waters "within" the Township. However, Regional Plans for the Swimming River watershed and the Ramanessin Brook watershed are intended to be adopted in the future. This Plan will be updated to be consistent with any Regional Plans that are established in the future, provided that they are equally as protective as those developed for new development or redevelopment within the Township. The Township plans to take part in the development of any Regional Plans that affects waterbodies within or adjacent to the municipality.

5.2 TOTAL MAXIMUM DAILY LOADS

There is an ongoing study on Ramanessin Brook to determine: a) sources of phosphorus and fecal coliform; b) develop a model to assess water quality impacts from erosion, stormwater, and non-point source pollutants; and c) to develop TMDLs for the Ramanessin Brook to reduce impairments. There are no stormwater TMDLs currently developed for the Township. This Plan will be updated to be compliant with any TMDLs issued in the future.

5.3 RESIDENTIAL SITE IMPROVEMENT STANDARDS (RSIS)

This Municipal Stormwater Management Plan 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 version of the RSIS during its reviews of residential developments for stormwater management.

5.4 SOIL CONSERVATION

The Township's Stormwater Management Control Ordinance requires that all new development and redevelopment site plans and subdivisions, including renovations, comply with the Soil Erosion and Sediment Control Standards of New Jersey, including all Technical Bulletins issued by the New Jersey Department of Agriculture State Soil Conservation Committee, (i.e. 2004-2.0, 2004-3.0 and 2004-4.0). In cooperation with the Freehold Soil Conservation District, Township inspectors will observe and help ensure compliance with on-site soil erosion and sediment control measures as part of construction site inspections. In the conservation element of the 2004 *Holmdel Township Master Plan*, the Planning Board also recommended that the Township consider modifying its existing soil conservation ordinances to require smaller construction projects, with less than 5,000 square feet of disturbance, comply with the Soil Erosion and Sediment Control Standards.

6.0 STORMWATER MANAGEMENT STRATEGIES

6.1 MASTER PLAN & ORDINANCE REVIEW

The Township reviewed its master plan and the Township's land use and zoning ordinances, Chapter 30 of the Township's code, entitled "Development Regulations," for consistency with the new stormwater regulations. Based on its review, the Board finds that the following sections must be modified to incorporate nonstructural stormwater management strategies:

Section 30-54: Buffers: requires a buffer zone be planted or a solid fence erected between any non-residential and residential or park zone; and to screen any bulk trash collection areas. The language does not explicitly encourage the use of native vegetation. The ordinance should be amended to include the use of native vegetation, where feasible, that requires less fertilization and watering. Language should be added to allow the use of buffer zones for stormwater management to encourage separation (i.e. disconnection) of impervious surfaces with vegetation areas and treatment of runoff.

Section 30-55 Cluster Development: allows the option of cluster development on tracts greater than 10 acres. This option requires 40% of the land be set aside for agricultural or open space recreational uses. Cluster development allows for the preservation of environmentally sensitive lands and aids in the reduction of impervious surfaces, as well as encourages separation of impervious surfaces with vegetative areas. This option also requires buffers between non-residential uses. There is currently no requirement for planting, except in buffer zones. This language should be modified to promote the use of native vegetation, where feasible, that requires less fertilization and watering than non-native ornamental plantings. This section should also be modified to require the use of Best Management Practices for any farms or active recreation facilities.

Section 30-56 Curbs & Gutters: This section requires the use of either Belgian block curbing, or rolled concrete curbing surrounding all roads, streets and edges of pavement. This section should be amended to allow the use of curb cuts or flush curbing with curb

stops to allow vegetative swales to be used as stormwater conveyances and to allow the separation of impervious areas.

Section 30-79 Off-site & Off-tract Improvements: details the requirements for off-site and off-tract improvement. Language should be added to require stormwater management and drainage improvements to conform to the "Design and Safety Standards" of this plan.

Section 30-80 Off-street Parking and Loading: states the requirements for parking and loading areas. Buffer strips are required, as well as curbing and landscaping between parking areas and the street and buildings. This section should be modified to encourage the use of native vegetation for buffer strips and landscaping, which requires less fertilizer and water than ornamental plantings. Additionally, the use of landscape islands, with flush curb or curb cuts, should be encouraged to separate impervious surfaces. The curbing requirement should also be amended to allow the use of curb cuts or flush curbing with curb stops to allow vegetative swales to be used as stormwater conveyances and to allow the separation of impervious areas. This section should also be amended to permit a portion of the required parking spaces to be "banked" and left as green space unless needed to minimize the amount of impervious coverage.

Section 30-87 Performance Standards: This section should be amended to include the performance standards detailed in this plan for stormwater management.

Section 30-94 Sidewalks: This section requires all streets have sidewalks constructed from poured concrete. This section should be amended to allow the use of porous paving materials in areas with low pedestrian traffic. Language should be added to require new sidewalks to direct stormwater to neighboring lawn and swales, where feasible. This design criterion will allow for the disconnection of impervious surfaces.

Section 30-103 Streets: This section describes minimum street widths, right of ways, shoulders, cul-de-sac radii, the limit of through streets, etc. This section should be updated to encourage the limitation of on-street parking, thereby allowing narrower streets where public safety permits. This should also be revised to encourage the use of landscape islands within cul-de-sacs to minimize large areas of impervious cover. This section should be updated to be consistent with RSIS.

Section 30-116.4 Groundwater Protection and Drainage: describes the requirements of major subdivisions to provide ground water recharge of aquifers, protect natural drainage, and improve stormwater runoff quality. This section should be updated to comply with the standards set forth in this plan, as well as stormwater control ordinances required by N.J.A.C. 7:14A-25 and to maintain 100% of the pre-development groundwater recharge.

Section 30-116.7 Stream Corridors: discusses the requirement for stream corridors, and associated buffers. As stated in Section 3.3 above, Holmdel's stream corridor buffer ordinance is measured from the 100-year floodplain and contiguous steep slopes. Therefore, in many cases the Township's requirement is more stringent than the NJDEP Buffer requirements of 300 feet from the centerline of the stream. This section should be updated to require buffers to comply with the greater of the Township's currently required stream corridor buffers or the required buffers for Category 1 waterways and the NJDEP provision that permits reductions for previously disturbed areas.

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

6.2 NONSTRUCTURAL STRATEGIES

This Plan recommends the practical use of the following nonstructural strategies for all major developments[1] 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 *BMP Manual* further requires an applicant seeking approval for a major development[1] to specifically identify how these nonstructural strategies have been incorporated into the development's design. Finally, for each of those nonstructural strategies that could not be incorporated into the development's design due to engineering, environmental, or safety reasons, the applicant must provide a basis for this contention.

[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".

Recommended Measures

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

Vegetated Filter Strips

Vegetated filter strips are either natural or engineered stormwater conveyance systems that treat small drainage areas. Generally, a vegetated filter strip consists of vegetation, which filters out pollutants, and promotes infiltration of the stormwater. 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.

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 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

Several homeowners in Holmdel have created ponds for aesthetic purposes. Some of these ponds are shallow and suffer from eutrophic[2] conditions. This leads to 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 width of the pond should be minimized 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 maintenance and access to the pond, as well as, the type of vegetation installed, since leaves and other vegetative debris can clog the pond creating other problems.

Deterrence of Geese and Deer

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-resistant vegetation adjacent to waterbodies is a means of deterring deer by minimizing food sources. If

[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

however, these actions are not sufficient, the Township should investigate other means of deterrence. In the past several years the Township has utilized the Geese Police as another means of deterrence.

Fertilizers

The use of fertilizers to create the "perfect lawn" is an increasingly 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 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, as part of the Township's Local Public Education program, 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, which can result in mosquito-breeding habitats. 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.

Minimizing Lawns

Reducing the amount of manicured lawn area and increasing the amount of woods and native vegetation provides several benefits. Native vegetation requires less fertilizer, filters out more pollutants, and promotes groundwater recharge. Initially, the Township should educate homeowners, as part of the Township's Local Public Education program, about the benefits of native vegetation.

[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.

Unpaved Roads and Driveways

While there are no unpaved public roads in the Township, there are a few privately maintained unpaved roads or driveways. There is a need to manage the runoff from these roadways. Poorly maintained roads and driveways may contribute to water quality problems, and erosion from unpaved roads may increase non-point source pollution. This Plan recommends encouraging the use of Best Management Practices (BMPs) to properly manage existing unpaved roads.

6.3 STRUCTURAL STORMWATER MANAGEMENT[3]

In Chapter 9 of its *Stormwater Management Best Management Practices* (BMP) manual, the Department of Environmental Protection identifies several structural stormwater management options. The Township recommends the following structural devices in accordance with the Township's Design and Performance Standards – Policy Implementation Table included in this Plan. Structural methods should be used only after all non-structural strategies are deemed impracticable or unsafe. Specifically, the Township encourages the use of structural stormwater management systems, in accordance with the BMP manual, 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%. Additional attention should be paid to better ways to handle sheet flow in wetlands and areas of seasonal high water table.

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 amount of stormwater runoff that a roof would ordinarily discharge to downstream stormwater management facilities. Care should be taken with the location and size of drywells due to potential adverse impacts on basements and foundations.

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, but may require an emergency overflow for extraordinary storm events. 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%.

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 pavers 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. Care must be taken in the use of pervious systems

to avoid subgrade instability and frost related deterioration. Pervious paving systems also require significant maintenance to maintain their designed porosity.

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. Vegetated filter strips are engineered stormwater conveyance systems that treat small drainage areas. Generally, a vegetated filter strip consists of vegetation that filters out pollutants, and promotes infiltration of the stormwater. 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 also 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 the length of retention time provided by the pond.

Each of these structures has advantages and disadvantages to manage stormwater Table 3 Design and Performance Standards: Policy Implementation Table indicates the appropriateness of these structural stormwater management structures in Holmdel.

TABLE 3: DESIGN AND PERFORMANCE STANDARDS – POLICY IMPLEMENTATION TABLE

	Residential Development Subject to RSIS (i.e. Subdivisions)				Residential Development Not Subject to RSIS (Generally a single lot.)				Non-residential Development			
	Major Development[1]		Other		Major Development[1]		Other		Major Development[1]		Other	
	Well Drained Soils[2]	Poorly Drained Soils[3]	Well Drained Soils[2]	Poorly Drained Soils[3]	Well Drained Soils[2]	Poorly Drained Soils[3]	Well Drained Soils[2]	Poorly Drained Soils[3]	Well Drained Soils[2]	Poorly Drained Soils[3]	Well Drained Soils[2]	Poorly Drained Soils[3]
Non-structural Strategies[4]												
Protect critical / sensitive areas	●	●	●	●	●	●	●	●	●	●	●	●
Minimize Impervious surfaces	●	●	⊗	⊗	●	●	⊗	⊗	●	●	⊗	⊗
Protect Natural Features	●	●	●	●	●	●	●	●	●	●	●	●
Decrease "reduction in time of concentration"	●	●	⊗	⊗	●	●	⊗	⊗	●	●	⊗	⊗
Minimize land disturbance	●	●	●	●	●	●	●	●	●	●	●	●
Open channel conveyance systems (i.e. swales)	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
Structural Strategies (See Section 6.3 for further information on these strategies)												
Bioretention systems	●	●	⊗	○	⊗	⊗	○	○	●	●	⊗	○
Constructed wetlands	⊗	⊗	⊗	⊗	⊗	⊗	○	○	●	●	●	●
Dry wells	●	⊗	●	⊗	●	⊗	●	⊗	⊗	○	●	⊗
Extended detention Basins (i.e. dry detention basins)	●	⊗	⊗	○	○	○	○	○	●	⊗	⊗	⊗
Infiltration basins	●	⊗	⊗	○	⊗	○	○	○	●	⊗	⊗	○
Manufactured treatment devices (i.e. vortonics and stormceptors)	⊗	⊗	⊗	⊗	○	○	○	○	⊗	⊗	⊗	⊗
Pervious paving systems	○	○	○	○	○	○	○	○	○	○	○	○
Sand filters	⊗	○	⊗	○	⊗	○	○	○	●	⊗	⊗	○
Vegetative filters	●	●	●	●	●	●	⊗	⊗	●	●	⊗	⊗
Wet ponds (i.e. retention basins)	⊗	⊗	○	○	○	○	○	○	⊗	⊗	⊗	⊗

Key: Non-structural Strategies

● - Appropriate in most cases
⊗ - May be appropriate, further study necessary
○ - Inappropriate in most cases

Key: Structural Strategies

● - Usually preferred
⊗ - Considered on-site specific basis
○ - Not preferred

[1] Major Development - As defined by the NJDEP Stormwater Management Regulations is more than 1 acre of disturbance or 1/4 acre of new impervious coverage
[2] Well drained soils – Typically A&B Type soils
[3] Poorly drained soils – Typically C&D Type soils
[4]. Additional strategies should be considered within the Wenonah-Mount Laurel Aquifer Recharge area

7.0 LAND USE/BUILD-OUT ANALYSIS

Holmdel Township has more than one square mile of vacant or developable land. As a result the NJDEP requires the Township perform a land use and build-out analysis as part of the Stormwater Management Plan. The purpose of this analysis is to calculate the amount of additional pollutant loading that can be anticipated in each watershed. Please note the New Jersey Highway Authority property and Monmouth County Parks System properties have been excluded from this plan, since separate plans are required for each of these facilities.

Monmouth County is currently performing a land use and build-out analysis as part of the Cross Acceptance process. The County is using the 1995/1997 Geographic Information System (GIS) data which is available from the NJDEP. This data is approximately 10 years old and is outdated, given the amount of development, which occurred over the last 10 years.

In June 2003 the Township preformed a build-out analysis, which is entitled *Build-out Analysis for Holmdel Township*, dated July 8, 2003, with revisions through September 19, 2003. As part of this analysis, an inventory was conducted of all vacant or underutilized land throughout the Township. Figure 11 (Page 7-9) is a map showing the existing land uses throughout the Township. Each lot was then examined to determine the amount of potential development based on the current Township Zoning, as shown on Figure 13 (Page 7-11) and the amount of environmentally constrained land (i.e., wetlands, streams and open waters), as shown on Figure 14 (Page 7-12). Additional information on this build-out analysis is included in Attachment 2a of the Land Use Element of the *Holmdel Township Master Plan*, dated January 2004.

In order to determine the amount of developable land within each of the Township's 8 Hydrologic Unit Code 14s (HUC 14) watersheds, the Township build-out analysis was sorted by watershed. The locations of the HUC 14 watersheds are shown in Figure 12 (Page 7-10). Land areas were then summarized based on expected build-out zoning for each watershed area. These land areas were then adjusted to account for environmentally constrained lands and roadways, since these lands will not be developed further. 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 lot coverage permitted in each zone. Table 4 summarizes the build-out calculations and the anticipated amount of additional impervious coverage for each HUC within the Township. Please note numbers have been rounded to account for scientific shortfalls.

Table 4: Build-Out Calculations

HUC 14 & Zone	Total Area Vacant or Underutilized Land in June 2003 (Acres)	Road (Acres)	Constrained Area (Acres)	Total Future Developable Area (Acres)	Max. Permitted Lot Coverage (%)	Build-out Lot Coverage (Acres)
Borden's Brook HUC 14						
R40A	0.9	0	0	0.9	25	0.2
R40B	109.9	2.8	7.8	102.1	25	25.5
HUC Total	110.8	2.8	7.8	103.0		25.7
Chingarora Creek HUC 14, which includes East Creek and Flat Creek						
M	29.0	0	0	29.0	60	17.4
R15	14.9	1.2	3.7	11.2	20	2.2
R30	0	0	0	0	15	0.0
R40A	30.2	0	4.9	25.3	25	6.3
R40B	11.9	0	1.1	10.8	25	2.7
RO3	27.9	0	0	27.9	50	14.0
TMHO3	29.1	0	0	29.1	50	14.6
HUC Total	143	1.2	9.7	133.3		57.2
Ramanessin Brook/Hop Brook HUC 14						
R4	122.9	8	6.40	116.5	15	17.5
R40A	53.4	0.8	12.7	40.7	25	10.2
R40B	330.4	26.1	45.6	284.8	25	71.2
HUC Total	506.7	34.9	64.7	442		98.9
Matawan Creek (below Ravine Drive) HUC 14, which includes Mohingson Brook, Monascunk Brook and Luppatatong Creek						
R40A	44.6	0	7.2	37.4	25	9.4
R40B	204.8	9.2	25.8	179	25	44.8
HUC Total	249.4	9.2	33.0	216.4		54.2
Nut Swamp Brook HUC 14						
R40A	3.6	0	0.9	2.7	25	0.7
R40B	11.6	1.5	2.0	9.6	25	2.4
HUC Total	15.2	1.5	2.9	12.3		3.1
Willow Brook HUC 14						
OL2	33.3	0	0	33.3	20	6.7
R2H	226	27.3	21.8	204.2	20	40.8
R4	322	35.1	30.5	291.5	15	43.7
R40A	21.6	0	1.4	20.2	25	5.1
R40B	86.3	9.5	14.3	72	25	18
HUC Total	689.2	71.90	68	621.2		114.3

HUC 14 & Zone	Total Area Vacant or Underutilized Land in June 2003 (Acres)	Road (Acres)	Constrained Area (Acres)	Total Future Developable Area (Acres)	Max. Permitted Lot Coverage (%)	Build-out Lot Coverage (Acres)
Waackaack Creek/Mahoras Brook HUC 14, which includes Waackaack Creek, Mahoras Brook and Takolusa Brook						
B2	5.8	0	0	5.8	60	3.5
LIH-PUD	77.5	0	0	77.5	45	34.9
O30	17.4	0	0	17.4	50	8.7
R30	56.8	2	5.1	51.7	15	7.8
R40A	58.6	2.3	9.8	48.8	25	12.2
R40B	137.4	0	0	137.4	25	34.4
RTH	16.2	1.3	2.5	13.7	20	2.7
TMHO3	21.5	0	0	21.5	50	10.8
HUC Total	391.2	5.6	17.4	373.8		115

In order to calculate the amount of additional pollutants that can be expected to 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 5 below represent the anticipated amount of pollutant per acre per year which can be anticipated as a result of future development.

Table 5: 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

The total pollutant loading for the Township as a result of future development for each watershed or HUC 14 area summarized in Table 6.

Table 6: Township Pollutant Loads by HUC-14 Area

HUC 14 & Zone	Build-out Zoning	Total Developable Area (Ac)	TP (lbs/Ac/yr)	TP (lbs/yr)	TN Load (lbs/Ac/yr)	TN (lbs/yr)	TSS Load (lbs/Ac/yr)	TSS (lbs/yr)
Borden's Brook HUC 14								
R40A	Low Density, Rural Residential	0.9	0.6	0.5	5	4.5	100	90
R40B	Low Density, Rural Residential	102.1	0.6	61.3	5	510.5	100	10210
HUC Total		103.0		61.8		515		10300
Chingarora Creek HUC 14, which includes East Creek and Flat Creek								
M	Commercial	29.0	2.1	60.9	22	638	200	5800
R15	Low Density, Rural Residential	11.2	0.6	6.7	5	56	100	1120
R30	Low Density, Rural Residential	0	0.6	0	5	0	100	0
R40A	Low Density, Rural Residential	25.3	0.6	15.2	5	126.5	100	2530
R40B	Low Density, Rural Residential	10.8	0.6	6.5	5	54	100	1080
RO3	Commercial	27.9	2.1	58.6	22	613.8	200	5580
TMH03	Commercial	29.1	2.1	61.1	22	640	200	5820
HUC Total		133.3		209		2128.3		21930

HUC 14 & Zone	Build-out Zoning	Total Developable Area (Ac)	TP (lbs/Ac/yr)	TP (lbs/yr)	TN Load (lbs/Ac/yr)	TN (lbs/yr)	TSS Load (lbs/Ac/yr)	TSS (lbs/yr)
Ramanessin Brook/Hop Brook HUC 14								
R4	Low Density, Rural Residential	116.5	0.6	69.9	5	582.5	100	11650
R40A	Low Density, Rural Residential	40.7	0.6	24.4	5	203.5	100	4070
R40B	Low Density, Rural Residential	284.8	0.6	170.9	5	1424	100	28480
HUC Total		442.0		265.2		2210		44200
Matawan Creek (below Ravine Drive) HUC 14, which includes Mohingson Brook, Monascunk Brook and Luppatatong Creek								
R40A	Low Density, Rural Residential	37.4	0.6	22.4	5	187	100	3740
R40B	Low Density, Rural Residential	179	0.6	107.4	5	895	100	17900
HUC Total		216.4		129.8		1082		21640
Nut Swamp Brook HUC 14								
R40A	Low Density, Rural Residential	2.7	0.6	1.6	5	13.5	100	270
R40B	Low Density, Rural Residential	9.6	0.6	5.8	5	48	100	960
HUC Total		12.3		7.4		61.5		1230

HUC 14 & Zone	Build-out Zoning	Total Developable Area (Ac)	TP (lbs/Ac/yr)	TP (lbs/yr)	TN Load (lbs/Ac/yr)	TN (lbs/yr)	TSS Load (lbs/Ac/yr)	TSS (lbs/yr)
Willow Brook HUC 14								
OL2	Commercial	33.3	2.1	69.9	22	732.6	200	6660
R2H	Low Density, Rural Residential	204.2	0.6	122.5	5	1021	100	20420
R4	Low Density, Rural Residential	291.5	0.6	174.9	5	1457.5	100	29150
R40A	Low Density, Rural Residential	20.2	0.6	12.1	5	101	100	2020
R40B	Low Density, Rural Residential	72.0	0.6	43.2	5	360	100	7200
HUC Total		621.2		422.6		3672.1		65450
Waackaack Creek/Mahoras Brook HUC 14, which includes Waackaack Creek, Mahoras Brook and Takolusa Brook								
B2	Commercial	5.8	2.1	12.2	22	127.6	200	1160
LIH-PUD	Low Density, Rural Residential	77.5	0.6	46.5	5	387.5	100	7750
O30	Commercial	17.4	2.1	36.5	22	382.8	200	3480
R30	Low Density, Rural Residential	51.7	0.6	31.0	5	258.5	100	5170
R40A	Low Density, Rural Residential	48.8	0.6	29.3	5	244	100	4880
R40B	Low Density, Rural Residential	137.4	0.6	82.4	5	687	100	13740
RTH	Low Density, Rural Residential	13.7	0.6	8.2	5	68.5	100	1370
TMHO3	Commercial	21.5	2.1	45.2	22	473	200	4300
HUC Total		373.8		291.3		2628.9		41850

As shown in the above table, the Borden's Brook watershed has 103 acres of available land for low-density residential development, which is defined by the Residential Site Improvement Standards as a development with a density of less than or equal to 4 units per acre. Based on the current zoning it is anticipated that this watershed will have 25.7 acres of impervious coverage, as a result of future development, which will produce 61.8 pounds per year (lbs/yr) of Total Phosphorous, 515 lbs/yr of Total Nitrogen, and 10,300 lbs/yr of Total Suspended Solids.

The Chingarora Creek watershed, which permits a mixture of both low-density residential uses and commercial uses, has approximately 133 acres available for development. This watershed is expected to produce approximately 209 lbs/yr of Total Phosphorous, 2,128.3 lbs/yr of Total Nitrogen, and over 21,900 lbs/yr of Total Suspended Solids from 57.2 acres of new impervious coverage at full build-out.

The Ramanessin Brook/Hop Brook watershed, based on the current zoning, will generate approximately 98.9 acres of new lot coverage as a result of the 442 acres, which are available for future low-density residential development. This coverage is expected to produce 265.2 lbs/yr of Total Phosphorous, 2,210 lbs/yr of Total Nitrogen and over 44,000 lbs/yr of Total Suspended Solids. It should be noted that this stream is a tributary to the Swimming River Reservoir, which provided potable water for a significant portion of the residents of Monmouth County.

The Matawan Creek HUC-14 area, which is located in the northwestern portion of the Township, will produce approximately 130 lbs/yr Total Phosphorous, 1,082 lbs/yr Total Nitrogen, and 21,640 lbs/yr Total Suspended Solids from the projected 54.2 acres of expected additional lot coverage. This HUC-14 is expected to have 216 acres available for low-density residential development.

The Nut Swamp Brook HUC-14 is a small area near the Parkway with approximately 12 acres available for residential development. This watershed is expected to have approximately 3.1 acres of additional lot coverage, which will result in pollutant loadings including 7.4 lbs/yr of Total Phosphorous, 61.5 lbs/yr of Total Nitrogen and 1,230 lbs/yr of Total Suspended Solids.

The Willow Brook watershed has 621 acres available and permits a mix of rural residential uses and commercial uses. This watershed is expected to produce 422.6 lbs/yr of Total Phosphorous, 3,672.1 lbs/yr of Total Nitrogen, and 65,450 lbs/yr of Total Suspended Solids as a result of the 114.3 acres of additional lot coverage at full build-out. Similar to the Ramanessin Brook/Hop Brook this stream is also a tributary to the Swimming River Reservoir, which provides potable water for a significant portion of the residents of Monmouth County.

The final watershed area in the Township is the Waackaack Creek/Mahoras Brook watershed, which is located in the northeastern portion of the Township. This watershed has approximately 374 acres available for future residential and commercial developments, which are expected to generate over 115 acres of additional lot coverage. This lot coverage will likely produce 291.3 lbs/yr of Total Phosphorous, 2,628.9 lbs/yr of Total Nitrogen and 41,850 lbs/yr of Total Suspended Solids.

In summary, at ultimate build-out Holmdel Township will generate as much as 500 acres of additional lot coverage. The Township should implement measures to minimize additional pollution to the Township waterbodies.

Figure 11: Existing Land Use

Figure 12: Hydrologic Units (HUC 14s) within Holmdel

Figure 13: Current Zoning Map

Figure 14: Wetlands

8.0 NJDEP MAPPING

In order to facilitate the preparation of this stormwater plan, the NJDEP provided certain mapping. This mapping was developed using the NJDEP Geographic Information System (GIS) digital data. This mapping is approximately 10 years old and is out of date. In addition, the NJDEP mapping does not show the current accepted Township Boundary. The Township through the State Plan Cross Acceptance process has identified the discrepancies and has requested the NJDEP update this GIS digital data to reflect the accepted Township Boundary. Since the Township has mapping, which more accurately reflects the current conditions, the Township's mapping was used in the preparation of this Plan. For informational purposes only, copies of the NJDEP mapping are located in Appendix A of this document.

9.0 MITIGATION PLAN

This mitigation plan is provided for proposed development that is granted a variance or exemption from stormwater management design and performance standards set forth in this plan and N.J.A.C. 7:8-5.

9.1 MITIGATION PROJECT CRITERIA

To grant a variance or exemption from the stormwater regulations, new development and redevelopment plan the developer must propose a mitigation project located in the same drainage basin as the proposed development or redevelopment. The proposed mitigation project must provide additional groundwater recharge benefits, or protection from stormwater runoff quantity or quality from previously developed property that does not currently meet the design and performance standards outlined in this plan. Mitigation projects should also be as close in terms of hydrology and hydraulics to the proposed development/redevelopment as possible. The developer must ensure the long-term maintenance of the project including all maintenance required in Chapters 8 and 9 of the *NJDEP Stormwater BMP Manual*.

Projects must be proposed on an equivalent basis. Developers must propose a mitigation project that is equivalent to the type requested in the variance. This means a "stormwater quality" variance can only be mitigated by a "stormwater quality" mitigation project. Proposed mitigation projects cannot adversely impact the existing environment.

9.2 DEVELOPER MITIGATION PLAN REQUIREMENTS

It is the developer's responsibility to provide a detailed study of any proposed mitigation project, and must provide the Township with a proposed mitigation plan 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 requested and supporting evidence.

10.0 RECOMMENDATIONS

The Conservation Plan Element and the Utility Service Plan Element of the *Holmdel Township Master Plan*, dated January 2004 includes recommendations with respect to stormwater management and conserving natural resources of Holmdel. The following are additional recommendations associated with this Stormwater Management Plan Element of the *Master Plan*:

Recommendation A: Review and update the existing Development Regulations and the Holmdel Development Design Manual to implement the principals of non-structural and structural stormwater management strategies to reduce stormwater quantity, improve stormwater quality and to maintain or increase groundwater recharge for both residential and non-residential developments.

Portions of the existing Development Regulations and the *Holmdel Development Design Manual* are inconsistent with recently adopted New Jersey Department of Environmental Protection (NJDEP) Stormwater Management Regulations and the NJDEP *Best Management Practices for the Control of Non-Point Source Pollution from Stormwater Manual*. Some of these inconsistencies are identified in Section 6.1 above. The Township should update their existing regulations to be in conformance with these regulations and to minimize inconsistencies or conflicts.

The Residential Site Improvement Standards (RSIS) require all residential developments with more than 1 acre of impervious coverage or ¼ acre of additional impervious coverage to comply with the NJDEP Stormwater Regulations. However, non-residential developments are currently exempt from the Stormwater Regulations. The Township should consider implementing regulations to require major development not regulated by the RSIS, such as non-residential development and building permit applications not regulated by site plan and/or subdivision, to comply with portions of the stormwater rules and regulations. These regulations should seek to achieve a balance between minimizing impact on stormwater quality, stormwater quantity and ground water recharge, while protecting private property rights.

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. The design manual should be revised to reflect the revised rainfall amounts.

Table 7: 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

Recommendation B: To improve stormwater management, water quantity and groundwater recharge, consider investigating reducing the permitted amount of building, parking lots and impervious coverage throughout the Township.

Holmdel typically permits less coverage than adjacent municipalities. Also, the existing Resource Management Regulations strive to protect environmentally sensitive areas. Recent development trends show an increasing number of larger homes that typically include large circular driveways and accessory structures such as tennis courts and sports courts. The Township should revisit the current Development Regulations to determine if additional safeguards can be implemented to improve stormwater management and water quality relating to these trends.

The Township should also reevaluate its parking lot design standards. As stated in Recommendation 9.L from the *Utility Service Element* of the *Master Plan*, parking lots generate large volumes of stormwater. The Township should evaluate the existing parking requirement and design standards to prevent over-development of parking lots and to encourage the separation ("disconnection") of impervious areas with landscaping areas to collect stormwater and encourage groundwater recharge. The Monmouth County Planning Board in its January

1998 report, entitled *Not For Cars Only A Guide to Innovative Parking Lot Design*, recommends additional alternatives to creative parking lot design.

There are several vacant sites throughout the Township, which have impervious coverage, which are no longer in use, such as abandoned parking lots and tennis courts. This additional impervious coverage contributes additional stormwater runoff. The Township should investigate methods to remove abandoned impervious coverage and to replace it with vegetation to receive stormwater runoff.

Recommendation C: Explore and consider improving the Township's existing Stream Corridor Buffer Ordinances.

The *Holmdel Resource Management Regulations* currently require a 100-foot stream corridor buffer along both sides of all Township streams except the Ramanessin/Hop Brook, which require a 150-foot stream corridor buffer. For example 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. The Township's current Resource Management Regulations should be updated to require the greater of either 300-foot Category-1 Buffer or the current *Resource Management Regulations* stream corridor buffers.

Priority attention should be given to the Willow Brook and Borden's Brook since they, like the Ramanessin/Hop Brook, drain to the Swimming River Reservoir, as well as any stream contributing to the base flow of the Swimming River Reservoir, including streams crossing the Wenonah-Mt. Laurel aquifer out cropping in north-west Holmdel. Also priority should be given in areas of Glauconite soils.

The Township should also modify the existing stream corridor buffers to make these buffers more effective. The Township should encourage the use of Best Management Practices to encourage 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: Work with residents, property owners and businesses to encourage the installation of vegetation along stream corridors and within existing stormwater detention facilities.

Landscaping with native vegetation along stream corridors and within detention basins improves the quality of stormwater. As such, Holmdel has recently been requiring revegetation of stream corridor buffers and detention basins. Although this is now a requirement, many older developments have manicured lawns abutting the streams or detention basins, which provide less filtering and introduce fertilizers, pesticides, and herbicides to adjacent surface water and stormwater facilities.

Recommendation E: Seek to limit encroachments into existing conservation easements.

A significant number of properties throughout the Township have existing conservation easements. Holmdel's Conservation Easement Ordinance prohibits the removal of trees and ground cover within a conservation easement. The Conservation Easement Ordinance also prohibits the building of any structures, walls, or fences within the easement. Despite the existing regulations, a number of residents have encroached into conservation easements. The Township has implemented a procedure to identify new residents with properties having conservation easement restrictions. The Township should also evaluate their existing enforcement program, implement an education program on the use of easements, work with property owners to mark existing easements more conspicuously, and seek to ensure revegetation of disturbed easements.

Recommendation F: Educate residents, commercial entities, farmers and Township employees on the impacts of the overuse of lawn chemicals and good lawn chemical maintenance practices.

As stated in Section 6.2, the overuse of lawn chemicals, such as fertilizers, pesticides and herbicides have a significant detrimental impact on surface water bodies and groundwater. As part of their annual Local Public Education program, the Township should work with the NJDEP

to educate residents, commercial entities, farmers and Township employees on these impacts and encourage residents to use techniques to create a "green lawn" without over- application of chemicals and/or to convert lawn areas to other kinds of vegetation that do not require fertilization and other chemical treatments. Lawn services and residents also "overspray" chemicals onto roadways and adjacent properties. The Township should investigate methods to minimize the application of chemicals within rights-of-way.

Recommendation G: Educate residents on techniques to deter geese, deer, and other wildlife.

Geese population can take over and contaminate local water bodies. The planting of vegetation around the perimeter of a waterbody is an effective means of deterring geese. Also the planting of deer-intolerant vegetation adjacent to waterbodies is a means of deterring deer by minimizing food sources.

Recommendation H: Consider implementing restrictions that limit the allowable disturbance of existing vegetated areas and removal of vegetation and woodlands.

The Holmdel Shade Tree Committee and the Holmdel Environmental Commission are currently in the process of drafting tree and woodlands protection ordinances. The ordinances may include regulations prohibiting clear-cutting, removal of trees on or adjacent to environmentally sensitive areas and/or the protection of specimen trees.

Recommendation I: Seek to ensure the proper 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.

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

Recommendation J: Work with the Monmouth County Mosquito Commission to monitor existing and proposed BMP's.

Many of the recommended non-structural and structural strategies are designed to retain water for a period of time to promote groundwater recharge. These conditions could be favorable to mosquito breeding habitats. To date there is no data relating mosquito breeding and best management practices. The Township should coordinate new development and redevelopment project using non-structural and structural strategies with the Monmouth County Mosquito Extermination Commission so that these facilities can be periodically monitored, inspected and maintained. Developers and the Township should also solicit input from the Monmouth County Mosquito Extermination Commission early in the design process for new facilities to obtain additional guidance and recommendations.

Recommendation K: Encourage existing storm drains to be replaced with bicycle safe grates and Campbell Foundry Model #N-2-ECO inlet heads (or approved equal) to prevent floatable and solid debris from entering the storm water conveyance system.

Typical roadway debris, such as bottles and cans, can easily enter stormwater conveyance systems through typical inlet openings. This debris is then transported downstream into the receiving water bodies. By replacing existing storm drain inlets with new inlet grates and inlet

heads, which have a maximum opening size of 2-inches by 4-inches, the amount of debris entering the stream can be reduced, improving water quality.

Recommendation L: Encourage regular street sweeping for public and private roads and parking lots.

Salt and sand are applied to roadways and paved areas in the winter months. This salt and sand is then washed into the storm drain conveyance system and then is transported to the receiving water body. This material silts and pollutes the Township streams. Frequent sweeping of streets and parking lots, particularly after winter storms, can minimize the impacts on water bodies. The Township should also implement a program to encourage the remove any silt deposits in storm sewer systems and outfalls.

Recommendation M: Encourage groundwater recharge of all aquifer outcroppings that directly supply the Swimming River Reservoir.

Northern Holmdel is located in NJDEP's "Critical Water Supply Area 1" due to saltwater intrusion from the Raritan Bay. As a result, Holmdel depends on surface water from the Swimming River Reservoir as a source of potable drinking water for up to 6 month annually. The drinking water supply for both northern and southern Holmdel is closely linked to recharge capacity.

Recommendation N: To reduce erosion and sedimentation in streams; encourage residents and property owners to minimize the amount of regrading.

During construction large amounts of disturbance can cause soil erosion. This can result in accumulation and/or sedimentation in streams and elevated amounts of Total Suspended Solids, which can impact the existing vegetation and wildlife. As part of their annual public education program, the Township should educate residents on the impacts of silt on streams. The Township should also consider providing educational materials when building permits are issued.

Recommendation O: Seek to limit erosion of Glauconite soils, which can occur along stream corridors.

Glauconite soils or green sand is generally found along stream corridors. During stream bank erosion it will break apart becoming suspended in the water longer and prolong the turbidity in the stream. Because of high cation exchange, they can act as flocculants and coagulants and attract and concentrate pollutants in water and sediments. The Township should monitor all existing outfalls in Glauconite soils on a regular basis to identify areas of erosion and should implement program to mitigate any erosion. The Township should also implement Best Management Practices for all future stormwater outfalls to limit erosion in these areas.

Recommendation P: Work with the NJDEP to update their existing Geographic Information System digital data to reflect current conditions.

As stated in Section 8.0 of this Plan, the NJDEP Geographic Information System (GIS) digital data is approximately 10 years old and is out of date. In addition, the NJDEP mapping does not show the current accepted Township Boundary. The Township through the State Plan Cross Acceptance process has identified the discrepancies and has requested the NJDEP update this GIS digital data to reflect the accepted Township Boundary.

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APPENDIX A: NJDEP MAPPING

Figure A-1: USGS Base Map

Figure A-2: NJDEP Waterways Map

Figure A-3: NJDEP Wellhead Protection Areas Map

Figure A-4: Existing Land Use Map

Figure A-5: NJDEP Hydraulic Unit (HUC-14s) within the Township

Figure A-6: NJDEP Constrained Wetlands, Streams and Open Waters