Municipal Stormwater Management Plan

Manchester Township, Ocean County, NJ

June 2005

TABLE OF CONTENTS

List of Tables

List of Figures

STORMWATER MANAGEMENT PLAN ELEMENT

As a result of the publication of the United States Environmental Protection Agency (USEPA) Phase II Rules in December 1999, the New Jersey Department of Environmental Protection (NJDEP) promulgated new stormwater regulations to address non-point source pollution entering surface and ground waters of the State of New Jersey. Under these regulations, municipalities were issued a New Jersey Pollutant Discharge Elimination System (NJPDES) Permit that established various statewide basic requirements. One of these requirements is the development and adoption of an amendment to the municipal Master Plan to address stormwater pollution associated with "major development", defined by the NJDEP as a development that causes the disturbance of one acre or more or increases the impervious surface by one-quarter acre or more.

As required by the Municipal Stormwater Regulations (N.J.A.C. 7:14A-25), the Township of Manchester developed this Municipal Stormwater Management Plan (MSWMP) to outline its approach to addressing impacts resulting from stormwater related issues associated with future development and land use changes. The intent of the MSWMP is to provide a Township-wide approach to stormwater management planning. It is not designed to resolve existing flooding or runoff problems, but to identify them for future correction. This MSWMP 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. The design and performance standards will minimize negative or adverse impacts of stormwater runoff such as decreased water quality, increased water quantity and reduction of groundwater recharge providing base flow to receiving bodies of water.

In addition to minimizing these impacts, the Township's MSWMP will provide for long term operation and maintenance measures for existing and proposed stormwater management facilities. This MSWMP will also outline recommendations for revisions to Township ordinances in order to maximize the implementation of stormwater management strategies and include mitigation strategies to allow the Township to grant variances or exemptions from the design and performance standards set forth in this document.

GOALS AND OBJECTIVES

The goals of this MSWMP are to:

1. Reduce flood damage, including damage to life, property and the environment;

2. Minimize, to the extent practical, any increase in stormwater runoff from any new development;

3. Reduce soil erosion from any development, redevelopment or construction project;

4. Assure the adequacy of existing and proposed culverts and bridges, and other in-stream structures;

5. Maintain groundwater recharge;

6. Prevent, to the greatest extent feasible, an increase in non-point source pollution;

7. Maintain the integrity of stream channels for their biological function, as well as for drainage;

8. Minimize pollutants in stormwater runoff from new and existing development to restore, enhance, and maintain the chemical, physical, and biological integrity of the waters of the State, to protect public health, to safeguard fish and aquatic life and scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial, commercial, and other uses of water; and

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

In addition to the State goals for stormwater management, the Township goals in Chapter 6 provide the basis for the protection of environmental features in the Township:

- To protect environmentally sensitive areas, such as wetlands and floodplains, and stream corridors.

- To preserve open space areas within the Pinelands National Reserve and CAFRA Areas.

- To continue to use practical and flexible development criteria, in order to protect existing open spaces, conserve the natural landscape, protect sensitive ecological areas and provide for development on a controlled and comprehensive basis.

- To relate the Master Plan and development policies with the State Development and Redevelopment Plans, the Pinelands Comprehensive Management Plan, and the Coastal Areas Facilities Review Act.

- Protect aquifer recharge areas for existing and future water supply.

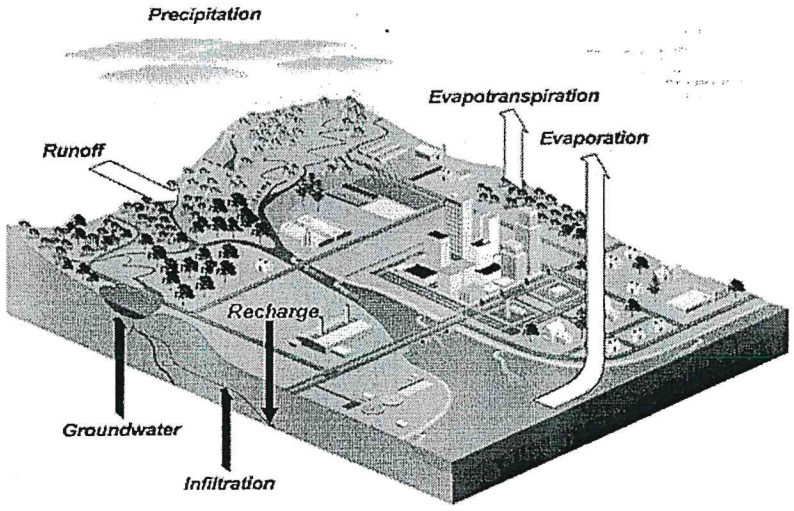
To achieve these goals, the MSWMP outlines specific stormwater design and performance standards for new development and proposes stormwater management controls for addressing impacts from existing developments. Preventive and corrective maintenance strategies are also included to ensure the long-term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

STORMWATER CHARACTERISTICS

HYDROLOGIC CYCLE

The hydrologic cycle or water cycle (Figure 16-1) is the continuous circulation of water between the ocean, atmosphere, and land. The driving force of this natural cycle is the sun. Water, stored in oceans, depressions, streams, rivers, waterbodies, vegetation and even land surface, continuously 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 surface water flows overland. Groundwater and surface water flow to major waterbodies and eventually to the seas and oceans. This constant process of evapo-transpiration, condensation, precipitation, and infiltration comprises the hydrologic cycle.

Figure 16-1: 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

IMPACTS OF STORMWATER

As towns and cities develop from rural agricultural communities, the landscape is altered in dramatic ways. Both residential and non-residential development on former agricultural fields and pastures has 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.

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

Water quantity impacts, combined with land development, often adversely affect 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 16-2). 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 16-2: Connected Impervious Surfaces

Rainwater is intercepted by roofing and collected into gutters. The water then discharges from 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.

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

BACKGROUND

The Township of Manchester, located in the Pine Barrens of Ocean County, New Jersey encompasses approximately 82.5 square miles. Of this 82.5 square miles, there are approximately 0.3 square miles of water area. The Township is a rural/suburban community lying south of New York City and northeast of Philadelphia. It is located in the Outer Coastal Plain Province, which is characterized by gently sandy, droughty soils with gently rolling terrain and few steep slopes.

The Township shares boundaries with seven municipalities and encircles the Borough of Lakehurst. To the north, Manchester is bordered by the Township of Jackson and to the northwest by the Township of Plumsted. The eastern border of the Township is the Toms River, dividing Manchester from Dover Township. The southern border of the Township is shared between Berkeley and Lacey Townships. Woodland and Pemberton Townships in Burlington County, border the Township to the southwest. The Township's boundary is delineated on United States Geological Survey (USGS) quadrangle maps shown in Figure 3.

The Township consists of several developed sections, many of which are senior citizen or retirement communities. Developed sections include Pine Lake Park, Summit Park, Whiting, Crestwood Village, Holly Oaks and Leisure Village and Leisure Village West. The Township is also home to portions of two military installations; Fort Dix Military Reservation, which extends between the Townships of Plumsted and Manchester, and Naval Air Engineering Station Lakehurst (NAES Lakehurst), which lies between the Townships of Manchester and Jackson. Both military installations lie in the northern section of the Township. Additionally, there are several large State forests and wildlife management areas within the Township, comprising over 40 percent of the Township. These include the Lebanon State Forest, the Pasadena Wildlife Management Area, the Manchester Wildlife Management Area, and the Whiting Wildlife Management Area. Harry Wright Park (383 acres) and Pine Lake Park (112.6 acres) are the major parklands within the Township.

Approximately 83 percent of the Township lies within the Federal designated Pinelands National Preserve, and 72 percent is located in the State Regulated Pinelands Area. As a result, the Township has limited development potential in most of the Township due to the effects of the Pinelands Comprehensive Management Plan.

Figure 16-3: Topographic Map

Demographics

Historic population trends for the Township, County and State are shown in Table 1: Historical Population Trends. The Township population began increasing rapidly in 1950, averaging over 161 percent growth over the following three decades. This population growth coincided with the opening of the Garden State Parkway, which attracted homebuyers from northern New Jersey and New York City. The Township experienced its greatest growth between 1970 and 1980 when the population of the Township (Table 16-1) reached 27,987, a 271 percent increase over the previous decade, mostly due to the development of numerous retirement communities. Since then, the Township population has continued to increase throughout the following years, from 27,987 in 1980 to 35,976 in 1990 and 38,928 in 2000. Though the Township has exceeded the County growth rate since the 1950's and growth is anticipated to continue, the future growth rate is expected at a more moderate rate.

Table 16-1: Historical Population Trends

	Manchester		Ocean County		New Jersey	
Year	*Population*	*percent Change*	*Population*	*percent Change*	*Population*	*percent Change*
1930	1,009	--	33,069	--	4,041,334	--
1940	918	- 9.0	37,706	14.0	4,160,165	2.9
1950	1,758	91.5	56,622	50.2	4,835,329	16
1960	3,779	115.0	108,241	91.2	6,066,782	2.6
1970	7,550	99.8	208,470	92.6	7,171,112	1.8
1980	27,987	270.7	346,038	66.0	7,364,823	0.3
1990	35,976	28.5	433,203	25.2	7,730,118	0.5
2000	38,928	8.2	510,916	17.9	8,414,350	0.9

Source: 1990, 2000 US Census

As shown in Table 16-2: General Housing Characteristics, there has been a 9 percent increase in housing units from 1990 to 2000. Future increases in housing construction will be dependent on various factors over which the Township has little control.

Table 16-2: General Housing Characteristics

	1990		2000	
	Number	Percent	Number	Percent
OCCUPANCY STATUS				
Total Housing Units	20,790	100	22,681	100
Occupied Housing Units	18,215	87.6	20,688	91.2
Vacant Housing Units	2,278	11	1,993	8.8
Seasonal	306	1.5	508	2.2
Tenure				
Occupied Housing Units	18,512	100	20,688	100
Owner- Occupied Housing Units	17630	95.2	19,020	91.9
Renter- Occupied Housing Units	882	4.8	1,668	8.1
Vacancy Status				
Vacant Housing Units	2,278	100	1,993	100
Seasonal	306	13.4	508	25.5
Population	35,976	100	38,928	100
Households	18,512	100	20,688	100
Family Household	10,732	58.0	10,814	52.3
Persons/ Household	1.94	--	1.85	--

Source: 1990, 2000 US Census

EXISTING LAND USE

As previously noted, 73 percent of the Township has limited development potential due to its location within the Pinelands Area. As of 1991, the Township was only about 16.5 percent, or approximately 13.6 square miles, developed. The remaining 68.7 square miles, or 83.5 percent, remained undeveloped. Developed lands within the Township include land uses such as Residential, Commercial, Professional Offices, Quasi-Public, Manchester Public/Public Service, Industrial, Utilities/Landfills, Railroads, Roadways, and developed portions of Federal lands.

The primary land use within the Township is Residential, accounting for 6.9 square miles, or 50.6 percent of the developed land. Federal lands, including Fort Dix and Naval Air Engineering Station – Lakehurst, account for 7.3 square miles of Township lands, or 8.8 percent of the Township's land area, and 10.6 percent of the undeveloped area. State owned lands, such as the three wildlife management areas and Lebanon State Forest, account for 41.6 percent of the undeveloped land and 34.7 percent of the Township area with total State holdings of 28.6 square mile. There are also areas of agricultural land. These tracts are greater than one (1) acre in size, and are permitted to be used for livestock, and growing of crops such as blueberries and cranberries. (Table 16-3: Manchester Township Existing Land Use –1991)

Table 16-3: Manchester Township Existing Land Use – 1991

Land Use/ Zone	Area (Ac)	Percent of Developed Land	Percent of Total Area
Residential	**4,403**	**50.6**	**8.4**
Single Family Detached	1,886	21.7	
Mobile Homes	55	0.6	
Apartments	28	0.3	
Age Restricted			
Manufactured Homes	161	1.9	
Co-ops	1,030	11.8	
Fee Simple/Condos	1,180	13.6	
Senior Health Care Facilities	63	0.7	
Commercial	**186**	**2.1**	**0.4**
Retail	121	1.4	
Service	41	0.5	
Retail/Professional Mixed Use	8	0.1	
Campground	16	0.2	
Professional Offices	**21**	**0.2**	**
Quasi-Public	**801**	**9.2**	**1.5**
Churches	48	0.6	
Cemeteries	28	0.3	
Membership Organizations	9	0.1	
Hunting & Gun Clubs	316	3.6	
Medical Centers	26	0.3	
America's Keswick	373	4.3	
Cares inc.	1	**	
Manchester Public/Public Service	**773**	**7.7**	**1.3**
Manchester Municipal Building	10	0.1	
Manchester M.U.A.	4	**	
Manchester Board of Education	190	2.2	
Manchester parks	560	5.3	
Manchester Vol. Fire Co. #1	2	**	
Ridgeway Vol. Fire Co.	1	**	
Whiting Vol. Fire Dept. #1	2	**	
Manchester First Aid	2	**	
Whiting First Aid Squad	2	**	
Industrial	**131**	**1.5**	**0.2**
Federal	**334**	**3.8**	**0.6**
*Lakehurst Naval Warfare Center	334	3.8	
Utilities/Landfills	**711**	**8.2**	**1.3**
JCP&L & AT&T	31	0.4	
Ocean County Landfill	680	7.8	
Railroads	**58**	**0.7**	**0.1**
Roadways	**1,385**	**16.0**	**2.6**
Township	616	7.1	
County	281	3.2	
State	357	4.1	
Private(Retirement Communities)	131	1.5	
DEVELOPED LAND TOTAL	**8,803**	**100**	**16.5**
TOWNSHIP LAND TOTAL	**52,672**		**100**

Notes: * Lakehurst Naval Warfare Center property (1065 Ac.) is listed under developed land (334 Ac.)
** Less than 0.1percent

Source: 1991 Tax map and Assessment Records and field survey of non-residential uses Jul. 1991, Prepared by T&M Associates Oct. 1993

Table 16-4: Manchester Township Existing Undeveloped Land Use – 1991

Land Use/ Zone	Area (Ac)	Percent of Undeveloped Land	Percent of Total Area
Vacant - Private	**19,571**	**44.7**	**37.4**
Vacant – Manchester Township	**916**	**2.1**	**1.7**
Agricultural (Qualified Assessment)	**449**	**2.1**	**1.7**
State of New Jersey	**18,294**	**41.6**	**34.7**
Lebanon State Forest	10,388	23.6	
Pasadena Wildlife Management Area	4,.73	9.5	
Manchester Wildlife Management Area	2,873	5.9	
Whiting Wildlife Management Area	1,160	2.6	
Federal	**4,639**	**10.6**	**8.8**
Fort Dix	3,908	8.9	
*Lakehurst Naval Warfare Center	731	1.7	
UNDEVELOPED LAND TOTAL	**43,869**	**100**	**83.5**
TOWNSHIP LAND TOTAL	**52,672**		**100**

Notes: * Lakehurst Naval Warfare Center property (1065 Ac.) is listed under developed land (334 Ac.)
** Less than 0.1percent

Source: 1991 Tax map and Assessment Records and field survey of non-residential uses Jul. 1991, Prepared by T&M Associates Oct. 1993

WATERWAYS

Increases in development may have resulted in changes to the landscape, and increased the quantity and pollutant loading of stormwater runoff, which may have resulted in the degradation of Township's waterways. Waterways within the Township include the following delineated in Figure 16-4, and listed in Table 16-5.

The majority of the Township is located in Watershed Management Area (WMA) 13, the Barnegat Bay Estuary. WMA 13 drains 660 square miles of the State to the Atlantic Ocean and has four subwatersheds, including the Metedeconk River, Toms River, Forked River, and Cedar Creek. Manchester Township is located within the Toms River subwatershed region. This area drains 124 miles of Ocean and Monmouth Counties and includes waterbodies such as the Davenport Branch, Wrangle Brook and Horicon Lake. The North Branch and Union Branch are two of the three branches of the Toms River.

Figure 16-4: Waterways Map

Table 16-5: Waterbodies in Manchester Township

Waterbody Type	Name	
Stream Corridors	Toms River Union Branch Sunken Branch Green Branch Big Wrangle Brook Michaels Run Irish/ Davenport Branch Grants Brook Pole Bridge Branch Blacks Brook Mount Misery Brook	Deer Park Branch Middle Ruckles Branch South Ruckles Branch Black Branch Old Hurricane Brook Goodwater Brook North Branch Forked Branch Ridgeway Branch Cabin Branch Union Branch
Bodies of Water	Pine Lake Horicon Lake Goose Pond "Blue Lake"	Keswick Lake Harry Wright Lake Cranberry bogs

Source: Ocean County Hagstrom Map, 1999 *Master Plan*

The Township is also located in WMA 19, Rancocas Creek Watershed. WMA 19 drains about 360 square miles of Burlington, Camden, and Ocean Counties west to the Delaware River. Streams west of County Route 539, such as the Deer Park Branch, flow into the Rancocas Creek.

WATER QUALITY

The Barnegat Bay Estuary provides valuable economic resource in its commercial and recreational facilities. WMA 13 provides both fresh and saltwater wetlands and habitats for hard clams, fin fish, shellfish, etc. The federally funded Barnegat Bay Estuary Program's *Comprehensive Management Plan* published in May of 2002 lists the watershed as suffering from issues relating to water quality and water supply including non-point source pollution, nutrient loading, and pathogen contamination. Additionally, habitat loss or alteration, competing uses and fishery decline are listed as issues.

Furthermore, the Ambient Biomonitoring Network (AMNET), which was established by the NJDEP, monitors and documents the health of New Jersey's waterways. AMNET currently has 820 sites in five drainage basins that monitor benthic macroinvertebrates on a five-year cycle. Waterways are scored based on the data to generate the New Jersey Impairment Score (NJIS) and categorized as severely impaired, moderately impaired, and non-impaired. The NJIS is based on biometrics and benthic macroinvertebrate health. (http://www.state.nj.us /dep/wmm/bfbm/)

The Ridgeway Brook at Turn Mill Pond and Route 70, and Blacks Brook at Route 70, are listed in the AMNET report for the Atlantic Region as moderately impaired. The Toms River at County Route 571, the Ridgeway Brook at County Route 571, Blacks Brook at the Naval Air Engineering Station – Lakehurst boundary and Route 70, Old Hurricane Brook at Beckerville

Road, the Wrangle Brook in the Whiting Wildlife Area, and Southampton Road, and the Davenport Branch at Lacey Road are all listed as non-impaired according to the AMNET report. (http://www.state.nj.us/dep/wmm/bfbm/downloads.html#atl) The 2001 AMNET Report for the Lower Delaware Region lists the Pole Bridge Brook as having decreased in water quality from moderately impaired to severely impaired. Mount Misery Brook is listed as non-impaired.

Table 16-6 is an excerpt of the New Jersey's 2004 Integrated List of Waterbodies, Sublists 1 and 5. (http://www.state.nj.us/dep/wmm/sgwqt/wat/ index.html) for waterbodies within Manchester Township. The integrated list ranks waterbodies in terms of water quality, with Sublist 1 having the highest or best water quality, while Sublist 5 has the lowest or poorest water quality.

The NJDEP also provides a list of Category One (C1) waterways. Category One waterways are areas with a special level of protection. Waterways can be designated C1 because of exceptional significance for ecological, water supply, recreational, shellfish or fisheries resources. Presently, the Wrangle Brook is a C1 waterway. (http://www.nj.gov/dep/cleanwater/c1_waters_list.pdf)

Table 16-6: 2004 Integrated List of Waterbodies for Manchester

List #	WMA	Station Name/ Waterbody	Site ID	Impairment Parameters	Data Source
3	19	Pole Bridge Branch at blw Country Lk in Pemberton	AN0144, GPOWISSA	Pineland Biological Community	NJDEP AMNET, Pinelands
1	19	Pole Bridge Branch at Whites Bogs-Pasadena Rd	GPOWHITE	Pineland Biological Community	Pinelands
1	19	Pole Bridge Branch impoundment below Rt 70 (Lake 1417-19)	GPORT70D	Pineland Biological Community	Pinelands
3	19	Pole Bridge Branch near Browns Mills	01466200	Phosphorus, Dissolved Solids, Total Suspended Solids	NJDEP/USGS Data
1	19	Pole Bridge Branch near Browns Mills	01466200	Temperature, pH, Dissolved Oxygen, Nitrate, Unionized Ammonia	NJDEP/USGS Data
1	19	Mount Misery Brook at Upton	01466100	Temperature, Dissolved Oxygen, pH, Nitrate, Phosphorus, Dissolved Solids, Total Suspended Solids, Unionized Ammonia	NJDEP/USGS Data
5	19	Mount Misery Brook at Upton	01466100	Fecal Coliform	NJDEP/USGS Data
1	19	Mount Misery Brook M Br at Mount Misery-Pasadena Rd	GMIMOUNT	Pineland Biological Community	Pinelands
1	19	Mount Misery Brook N Br at unnamed sand rd	GNOSANDR	Pineland Biological Community	Pinelands
1	13	Wrangel Brook at Congasia Rd in Manchester	AN0536	Benthic Macroinvertebrates	NJDEP AMNET
5	13	Ridgeway Branch at Rt 70 in Manchester	AN0528	Benthic Macroinvertebrates	NJDEP AMNET
5	13	Ridgeway Branch of Toms River	Ridgeway Branch of Toms River	Fish-Mercury	NJDEP Fish Tissue Monitoring
5	13	Pine Lake-13	Pine Lake Bathing Beach	Fecal Coliform	Ocean Co HD
3	13	Old Hurricane Branch at Beckerville Rd in Manchester	AN0531	Benthic Macroinvertebrates	NJDEP AMNET
1	13	Harry Wrights Lake-13	Harry Wright Lake High Beach and Low Beach	Fecal Coliform	Ocean Co HD
3	13	Blacks Branch at Naval Air Sta boundary in Manchester	AN0529	Benthic Macroinvertebrates	NJDEP AMNET
3	13	Blacks Branch at Rt 70 in Lakehurst	AN0530	Benthic Macroinvertebrates	NJDEP AMNET

Source: NJ Integrated List http://www.state.nj.us/dep/wmm/sgwqt/wat/integratedlist/integratedlist2004.html August 9, 2004

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

entering the waterbody. TMDLs can be used to prevent further deterioration of a waterbody, or to improve the current water quality.

Currently, there are no TMDLs proposed for Township streams in either WMA. Once TMDLs are established, an implementation plan should be developed to identify how various sources of pollution could be reduced to the levels specified in the proposed TMDL. Some of the strategies that may be implemented include stormwater treatment, restriction of impervious surfaces, retrofitting of stormwater systems, disconnection of impervious surfaces, and other uses of recommended best management practices (BMPs).

WATER QUANTITY

According to the Township Engineer, in addition to water quality issues, the Township has experienced water quantity problems including frequent flooding of the Roosevelt City and Pine Lake Park area during major storm events. This localized flooding is believed to be due to the lack of drainage facilities. The Township is currently performing a drainage study in these areas to determine causes.

HYDROGEOLOGY

According to the *Manchester Township Natural Resources Inventory*, April, 2005, the most important abiotic feature of the Pinelands region is water. The groundwater within the Township supports about 89 percent of the flow in Pinelands streams, easily infiltrating through the highly permeable, though chemically inert, topsoil layers to the aquifers. There are five aquifer systems that produce substantial quantities of water. These systems include the Potomac-Raritan-Magothy Aquifer System, the Englishtown Formation. The Wenonah Formation and Mount Laurel Sand, the Kirkwood Formation, and the Cohansey Sand. Due to its location along the coastal areas, the Kirkwood Formation is prone to saltwater intrusion.

GROUNDWATER RECHARGE

Hydrologic conditions have changed since the design of the stormwater conveyance system. Currently there is greater impervious area then before. This imperviousness allows for a greater volume of water to reach these conveyances faster than the intended design rates. This causes the system to backup and flood. The high amount of impervious area also decreases ground water recharge, and base stream flows. Combined the effects have negative impacts on the stream and river ecosystems of the Township.

As noted earlier, the groundwater within the Township supports about 89 percent of the flow in the Pinelands streams. About 44 percent of the annual precipitation total infiltrates the sandy top layers of soil and recharges the aquifers. Manchester Township receives its drinking water from groundwater drawn from the Cohansey and Raritan aquifers, therefore, recharging groundwater will also recharge the Township's drinking water supply. A map of ground water recharge areas is located in Figure 16-5.

Wellhead Protection Areas (WHPA) for public community water supplies are delineations of the horizontal extent captured by well pumping at a given rate over a two-, five-, and twelve-year

period of time. These areas are the first step in defining the source of a public drinking supply well. The Township WHPAs are delineated on Figure 16-6. There are 35 WHPAs within the boundary of the Township. Ten WPHAs are owned by the Manchester Township Utilities Authority, 8 are owned by Crestwood Village Water Company, 5 are owned by the United States Navy, 3 are owned by Cedar Glen Homes Inc., and the remaining 6 are split amongst the Ridgeway Mobile Home Court, Manchester Village, and Cedar Glen Lakes Water Company. There are ten WPHAs that encroach upon the Township boundary, 9 of which are owned by Lakehurst Water Department and the other is owned by the United States Navy.

Figure 16-5: Groundwater Recharge Areas

Figure16-6: Wellhead Protection Areas

DESIGN AND PERFORMANCE STANDARDS

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

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

Township personnel will observe construction of the project to ensure that the appropriate stormwater management measures are constructed and function as designed. Township personnel will also conduct periodic inspections after significant storms to ensure the system is functioning properly and to identify maintenance needs, if any. For privately owned and operated BMPs, the Owner shall inspect the BMPs as needed. After this, annual checks will be done to identify any additional maintenance needs required. This may include clearing of blockages from inlets and/or outlet structures, removal of unhealthy vegetation or accumulated debris/materials.

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

Plan Consistency

Regional Stormwater Management Plans

Currently, there are no Regional Stormwater Management Plans (RSWMP) developed or in the process of development for waters within the Township. Therefore, this plan does not need to be consistent with any such plans at this time. This plan will be updated to be consistent with any RSWMP that are established in the future. The Township plans to take part in the development of any RSWMP that affects waterbodies with in its bounds.

Total Maximum Daily Loads

Currently there are no stormwater TMDLs for the Township's waterways. The Township will update this MSWMP to be consistent with any stormwater TMDLs as they are established by the NJDEP.

Residential Site Improvement Standards (RSIS)

This Municipal Stormwater Management Plan is consistent with regulations established under the Residential Site Improvement Standards (RSIS) at N.J.A.C. 5:21. This plan acknowledges that RSIS will be updated periodically. The Township shall use the latest update of RSIS during its reviews of residential area development for stormwater management.

Soil Conservation

The Township Stormwater Control Regulations will require that all new development and redevelopment projects comply with the Soil Erosion and Sediment Control Standards of New Jersey. In cooperation with the Ocean County Soil Conservation District, Township personnel will observe on-site soil erosion and sediment control measures as part of the construction site inspections and contact the district for enforcement and follow-up.

Stormwater Management Strategies

The Township Ordinances have been reviewed relative to stormwater management planning. The following list tabulates areas within these existing documents where evaluation/investigation is recommended for compliance with the new stormwater regulations.

Ordinances

- **35-27. Performance Standards**: This section describes the performance standards of the Township. This section should be modified to include the design, performance, and safety standards described in this MSWMP and as outlined in N.J.A.C. 7:8.

- **35-29. Parking, Loading, and Vehicular Access:**

  - **35-29.3. Size of Parking Space**: This section requires parking stalls of 10'x20'. This section could be evaluated to allow for reduced stall lengths or vehicle overhangs, where possible.

  - **35-29.4. Parking Areas**: This section describes set back and other requirements. This section should be evaluated to allow buffer zones with native vegetation or filter strips along parking lots.

  - **35-29.7.h. Access Management:** This section describes curb requirements. This section should be updated to allow for the use of flush curbing or curb cuts.

- **35-30. Landscaping and Buffer Requirements for Non-Residential Zones:** This section should be evaluated to encourage the use of native vegetation and filer strips where practical.

- **35-74. Cluster Development:** This section describes the requirements for cluster development, including the open space requirement. This section should be evaluated to encourage the use of native planting in the open space area.

- **35-33.11. Water Quality:** This section describes water quality, allowable discharges, etc. This section should be updated to include the stormwater quality standards that are described in this MSWMP and as outlined in N.J.A.C. 7:8.

  - **38-34.1.c Allocation Formula – Drainage:** This section should be updated to include the standards described in this MSWMP and as outlined in N.J.A.C. 7:8.

- **35-85.1.b. Streets-Improvement Specifications and 35.85.15 Curbing:** These sections require curbs along all streets. These sections should be evaluated to allow for flush curbing and curb cuts where possible.

- **35-85.6 Topsoil Protection:** This section states the requirements for topsoil protection. This section should be updated to include the standards of this MSWMP including compliance with Ocean County Soil Conservation District requirements and standards outlined in N.J.A.C. 7:8.

- **35-85.7 Watermains, Culverts, Storm Sewers, and Sanitary Sewers:** This section states that these utilities should be of adequate size. This section should be updated to include the design, performance, and safety standards of this MSWMP and as outlined in N.J.A.C. 7:8.

- **35-85.12 Sidewalks:** This section requires concrete sidewalks. This section should be investigated to allow for permeable or pervious paving in areas where practical and safe.

- **35-86.4 Environmental Design Requirements:** This section states the environmental

design criteria required for site design. This section should be updated to comply with the stormwater standards described in this MSWMP and as outlined in N.J.A.C. 7:8.

- **35-87 Stormwater Management:** This chapter describes the requirements for Township stormwater management. This section should be reviewed and updated for compliance with the design, performance, maintenance and safety standards described in this MSWMP. The Township should consider updating this ordinance, or superseding this ordinance with the Township's Stormwater Control Ordinance, required by NJDEP to be adopted within 12 months of adopted of this MSWMP.

NONSTRUCTURAL STRATEGIES

This MSWMP recommends the practical use of the following nonstructural strategies for all major developments in accordance with the NJDEP's 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 discharge into and through stable vegetated areas.
8. Provide preventative source controls.

In addition, the NJDEP's BMP Manual further requires an applicant seeking approval for a major development[1] to specifically identify which and 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. 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 the following:

- **Vegetated Filer Strips**

  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.

- **Deterrence of Geese**

  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. However, if these actions are not sufficient, the Township should investigate other actions.

- **Fertilizers**

  The use of fertilizers to create the "perfect lawn" is an increasingly 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 fertilizer causes nitrate contamination of groundwater. Good fertilizer maintenance practices can help in reducing the amount of nitrates in the soil and thereby lower its content in the water. Initially, the Township should work with the NJDEP to educate homeowners of the impacts of the overuse of fertilizers. This discussion should include other techniques to create a "green lawn" without over fertilizing. Almost as important of the use of fertilizer is the combination of over fertilizing and over watering lawns. In many cases this leads to nutrient rich runoff, which ultimately may terminate into a nearby stream, lake or other water body. If fertilizer is applied correctly, the natural characteristics of the underlying soils will absorb or filter out the nutrients in the fertilizer.

STRUCTURAL STORMWATER MANAGEMENT[3]

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

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

- **Bioretention Systems**

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

- **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 percent.

- **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

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

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

- **Extended Detention Basins**

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

- **Infiltration Basins**

An infiltration basin is a facility constructed within highly permeable soils that provides temporary storage of stormwater runoff. An infiltration basin does not normally have a structural outlet to discharge runoff from the stormwater quality design storm. Instead, outflow from an infiltration basin is through the surrounding soil. An infiltration basin may also be combined with an extended detention basin to provide additional runoff storage for both stormwater quality and quantity management. The adopted TSS removal rate for infiltration basins is 80 percent. It should be noted that a dry well is a specialized infiltration facility intended only for roof runoff.

- **Manufactured Treatment Devices**

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

- **Pervious Paving Systems**

Pervious paving systems are paved areas that produce less stormwater runoff than areas paved with conventional paving. This reduction is achieved primarily through the infiltration of a greater portion of the rain falling on the area than would occur with conventional paving. This increased infiltration occurs either through the paving material itself or through void spaces between individual paving blocks known as pavers.

Pervious paving systems are divided into three general types. Each type depends primarily upon the nature of the pervious paving surface course and the presence or absence of a runoff storage bed beneath the surface course. Porous paving and permeable paver with storage bed systems treat the stormwater quality design storm runoff through storage and infiltration. Therefore, these systems have adopted TSS removal rates similar to infiltration structures.

- **Sand Filters**

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

- **Vegetative Filters**

  Vegetated filter strips are engineered stormwater conveyance systems that treat small drainage areas. Generally, a vegetated filter strip consists of a level spreader and planted vegetation. The level spreader ensures uniform flow over the vegetation that filters out pollutants, and promotes infiltration of the stormwater.

  A vegetative filter is an area designed to remove suspended solids and other pollutants from stormwater runoff flowing through a length of vegetation called a vegetated filter strip. The vegetation in a filter strip can range from turf and native grasses to herbaceous and woody vegetation, all of which can be either 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 percent depending on the permanent pool storage volume in the pond and, where extended detention is also provided, the duration of detention time provided in the pond.

Table 16-7, below, summarizes the approximate TSS removal rates for these structures. Final TSS removal rates should be calculated for each structure based on its final design parameters.

Table 16-7: TSS Removal Rates for BMPs

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

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

LAND USE/ BUILD-OUT ANALYSIS

In accordance with NJDEP regulations, the Township is not required to complete its build-out analysis prior to February 2, 2006. The Township intends on adopting this Stormwater Management Plan with the understanding that it will be amended to contain a build-out analysis that meets NJDEP regulations prior to the February 2, 2006 build-out requirement deadline.

Figures 16-7, 16-8, 16-9 and 16-10 will complement the build-out analysis, once completed, by identifying existing land use (based on the 1995/1997 N.J.D.E.P. GIS data), subwatersheds (Hydrologic Units - HUC 14s), zoning and environmental constraints located within the Township.

Figure 7: Existing Land Use

Figure 8: Hydrologic Units (HUC 14s) within the Township

Figure 9: Zoning Map

Figure 10: Environmental Constraints

MITIGATION PLAN

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

MITIGATION PROJECT CRITERIA

Mitigation for major development as defined by N.J.A.C. 7:8 – 1.2 et seq. must be implemented in the same drainage area as the proposed development and must provide additional groundwater recharge benefits, or protection from stormwater runoff quality and quantity from previously developed property. Performance standards must ensure the long-term maintenance of the project, which include the maintenance requirements under Chapters 8 and 9 of the NJDEP Stormwater BMP Manual. The Township does not anticipate granting variances or exemptions from "major developments" until a detailed mitigation plan is developed and approved. The Township will investigate granting variances or exemptions for "major developments" subject to:

1. Demonstrating that alternate measures proposed by the developer achieve substantially similar benefits to the required measures, or

2. Showing that literal compliance is technically impractical or presents a substantial economic hardship; and

3. Providing mitigation by implementing stormwater management improvements identified by the Township elsewhere within the basin, which achieves substantially similar stormwater management benefits.

DEVELOPER MITIGATION PLAN REQUIREMENTS

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

- Mitigation Project Name, Owner name and address, Developer name and address, Mitigation Project Location, Drainage Area, Cost Estimate;

- Proposed mitigation strategy and impact to sensitive receptor. What is being impacted, mitigated, and how;

- Legal authorization required for construction and maintenance;

- Responsible Party including: required maintenance, who will perform the maintenance, proposed cost of maintenance, and how it will be funded;
- All other permits required for construction of the mitigation project;

- Cost estimate of construction inspection; and
- Reason a waiver or exemption is required and supporting evidence.

RECOMMENDATIONS

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

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

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

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

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

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

  Stormwater facilities require regular maintenance to ensure effective and reliable performance. Failure to perform the necessary maintenance can lead to diminished

performance, deterioration and failure. In addition, a range of health and safety problems, including mosquito breeding and the potential for drowning, can result from improperly maintained facilities. To minimize these risks, the Township should implement a procedure for regular inspection, monitoring, and maintenance of Township owned stormwater facilities.

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

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

- **Recommendation D: Evaluate the need to adopt a Stream Corridor Buffer Ordinance.**

  The NJDEP Stormwater Regulations requires any development with more than 1 acre of disturbance or ¼ acre of impervious coverage to provide a 300-foot Buffer along a Category-1 (C1) stream from the center line of the stream. The Wrangle Brook is a C1 stream located within the Township. The Township should evaluate the need to adopt a 300-foot C1 Stream Corridor Buffer Ordinance or amend any existing buffer ordinance to comply with the NJDEP regulations.

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

- **Recommendation E: 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.

REFERENCES

Kern River Connections. "The Hydrologic Cycle." <http://www.creativille.org/kernriver/watershed.htm>

Linsley, Ray K., Franzini, Joseph B., Freyber, David L, and George Tchobanoglous. *Water resources Engineering.* 4th ed. New York, New York: Irwin McGraw-Hill, 1992.

Manchester Township Environmental Commission and T&M Associates. *Natural Resource Inventory, Township of Manchester*. July 1992.

Manchester Township Planning Board. *Master Plan: Township of Manchester*. Mar. 1999.

New Jersey Administrative Code N.J.A.C. 7:14A-25: NJPDES Stormwater Rules. Jan. 5, 2004.

New Jersey Administrative Code, N.J.A.C. 7:8, Stormwater Management Rules, Feb. 2, 2004.

New Jersey Department of Environmental Protection, Division of Watershed Management *New Jersey Stormwater Best Management Practices Manual* April 2004.

New Jersey Department of Environmental Protection, Division of Watershed Management. *Tier A Municipal Guidance Document: NJPDES General Permit No. NJ0141852*. April 2004.

New Jersey Department of Environmental Protection. *The Ambient Biomonitoring Network Watershed Management Area 12, 13, 14, 15, and 16, Atlantic Region.* <http://www.state.nj.us/dep/wmm/bfbm/>. March 2001.

New Jersey Department of Environmental Protection. *The Ambient Biomonitoring Network Watershed Management Area 17, 18, 19 & 20, Lower Delaware Region.* <http://www.state.nj.us/dep/wmm/bfbm/>. Nov. 2003.

New Jersey Department of Environmental Protection. List of Category One Streams, Lakes and Reservoirs <http://www.nj.gov/dep/cleanwater/c1_waters_list.pdf. >

New Jersey Department of Environmental Protection. Division of Watershed Management. Total Maximum Daily Loads. <http://www.state.nj.us/dep/watershedmgt/tmdl.htm> Mar. 29, 2005.

New Jersey Department of Environmental Protection. Division of Watershed Management. <http://www.state.nj.us/dep/watershedmgt/index.htm> Apr. 5, 2005.

New Jersey Department of Environmental Protection. Stormwater and Non-point Source Pollution, <www.njstormwater.org> Mar. 17, 2005.

New Jersey Department of Environmental Protection. Sub-list 1-5, New Jersey's 2004 Integrated List of Water Bodies <http://www.state.nj.us/dep/wmm/bfbm/> Jan. 31, 2005.