Watershed Based
Municipal Stormwater Management Plan

East Greenwich Township

prepared for

Gloucester County Improvement Authority

on behalf of

Gloucester County Board of Chosen Freeholders
and
East Greenwich Township

February 2006

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Section 1. Introduction

All New Jersey municipalities were required in early 2004 to obtain a NJPDES Municipal Stormwater General Permit for control of their stormwater discharges. The Gloucester County Board of Chosen Freeholders, through the Gloucester County Improvement Authority (GCIA), is committed to working with all of the municipalities in Gloucester County to cost-effectively accomplish the new stormwater management permit program's goals.

To that end, the GCIA has undertaken watershed-based municipal stormwater management planning throughout the County, and has prepared a Watershed Based Municipal Stormwater Management Plan (MSWMP) for East Greenwich Township that includes both municipal and watershed stormwater management information and evaluations. The location of East Greenwich Township, in relationship to the eight major watersheds in Gloucester County, is shown on Figure 1.

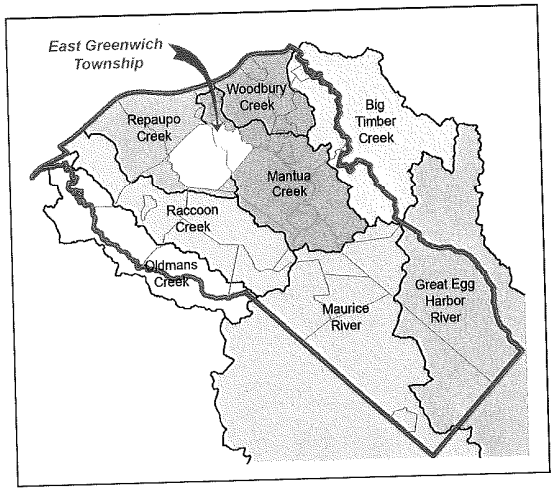
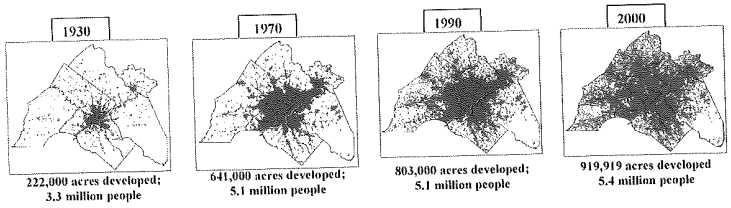


Figure 1. East Greenwich Township and Gloucester County Watersheds

The NJDEP's new Stormwater Management Rules in N.J.A.C. 7:8 have been developed to address the adverse impacts that unmanaged land development can have on groundwater recharge and stormwater runoff quality and quantity. Figure 2 shows the expansion of development within the Delaware Valley during the 70 year period from

1930 through 2000. Along with this development has come a corresponding increase in stormwater runoff, and increased impacts associated with non-point source pollution.



Source: DVRPC

Figure 2. Delaware Valley Development Patterns (1930 – 2000)

The East Greenwich Township MSWMP was prepared as part of Gloucester County's Stormwater Management Program. The Sample Municipal Stormwater Management Plan included in Appendix C of the New Jersey Stormwater Best Management Practices Manual, dated February 2004, was utilized as a template for preparation of the plan.

The MSWMP provides strategies for East Greenwich Township to follow in addressing stormwater management. The plan is required by N.J.A.C. 7:14A-25, the Municipal Stormwater Regulations, and contains the elements required by N.J.A.C. 7:8, the Stormwater Management Rules.

The MSWMP addresses groundwater recharge and stormwater quantity and quality, by incorporating the stormwater design and performance standards for new major development (defined as projects that disturb one or more acres of land or increase the amount of impervious surface by one-quarter acre or more). These standards are intended to minimize the adverse impact of stormwater runoff on water quality, and to address water quantity and the loss of groundwater recharge that provides base flow in receiving water bodies.

The MSWMP also includes:

- Long-term operation and maintenance measures for stormwater facilities associated with new major development projects.
- A "build-out" analysis that is based upon existing zoning and the land available for development.
- Changes that should be made to existing ordinances, the Master Plan, and other municipal land use planning documents, in order to allow various low impact development techniques.
- Mitigation strategies for variances or exemptions from the design and performance standards, including the implementation of specific mitigation projects to offset the effects of such variances or exemptions.

Section 2. Goals

The East Greenwich Township MSWMP goals are:

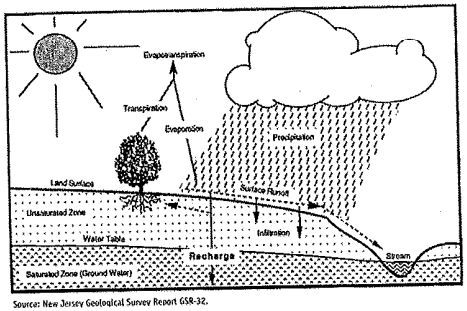
1. The reduction of flood damage, including damage to life and property.
2. The minimization, to the extent practical, of increases in stormwater runoff from new development.
3. The reduction of soil erosion from construction activities.
4. The insurance of adequate stormwater facilities, including culverts, bridges, and other in-stream structures.
5. The maintenance of groundwater recharge.
6. The prevention, to the extent feasible, of non-point stormwater pollution.
7. The maintenance of surface waters to ensure their biological and stormwater management functions, including the restoration, enhancement, and maintenance of their chemical, physical, and biological integrity, in order to protect public health and safeguard aquatic life; the preservation of their scenic and ecological values; and the enhancement of their domestic, municipal, recreational, industrial, and other uses.
8. The protection of public health and welfare, through the planning, engineering, operation and maintenance of stormwater systems.

The MSWMP outlines specific stormwater standards for new development and proposes stormwater management controls that address impacts from existing development. Preventative and corrective maintenance strategies are included to ensure the long-term effectiveness of stormwater management facilities. The MSWMP provides recommendations for stormwater systems to protect the public health and welfare.

This watershed-based MSWMP includes a discussion of both East Greenwich Township and its watershed(s). Land use, zoning, impervious surfaces, and pollutant loadings were evaluated using a Geographic Information System. These efforts provide an initial understanding of surface water quality in the County's watersheds, and establish a basis for evaluating the impacts of future land use and zoning decisions.

Section 3. Stormwater and Development

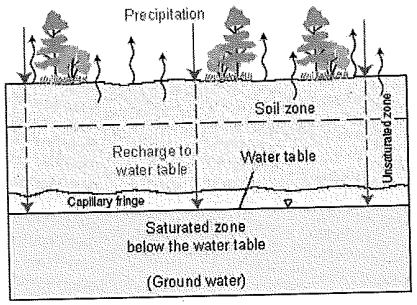
Water moves continuously through the hydrologic or water cycle (see Figure 3). Water evaporates from water bodies and the earth's surface and transpires from vegetation into the atmosphere (these components of the water cycle are jointly referred to as



Source: New Jersey Geological Survey Report 65R-32.

Figure 3. Groundwater Recharge in the Hydrologic Cycle

evapotranspiration). Water vapor in the atmosphere condenses to form clouds which produce precipitation that falls to the earth's surface. A small percentage of this precipitation falls over the land and runs off into streams and lakes flowing to the oceans.

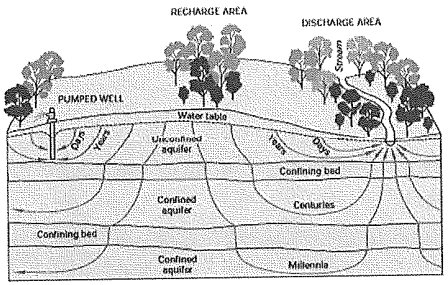


Source: US Geological Survey

Figure 4. Subsurface Water

However, most of the precipitation that falls on land surfaces infiltrates into the ground (see Figure 4), where it either recharges shallow groundwater table aquifers and discharges to streams and springs, sustaining their base flow, or seeps into deeper

confined aquifers, where it is stored for long periods and discharges regionally (see Figure 5). Human activities and development of the land can interfere with the natural water cycle, and in doing so, impact a watershed in many ways.



Source: US Geological Survey

Figure 5. Groundwater Flow Paths

Development can remove beneficial vegetation; replacing it with lawns or impervious cover, thus reducing evapotranspiration and infiltration. Clearing and grading removes depressions that store rainfall and encourage infiltration. Construction activities can also compact the soil and diminish infiltration, resulting in increased volumes and rates of stormwater runoff.

Conversely, increased impervious areas that are connected to each other through gutters, channels, and storm sewers transport runoff more quickly than natural areas. Shortening runoff travel time increases the rainfall-runoff response in the watershed, causing flow in downstream waterways to reach peak rates faster and water levels to increase above natural conditions. These conditions aggravate downstream flooding and erosion and increase the quantity of sediment in stream flow and deposited in stream channels. Impervious areas and storm sewers reduce the potential for surface vegetation to filter and remove pollutants from runoff.

Increased impervious area from land development can also decrease infiltration, and in turn, reduce stream base flow and groundwater recharge. Reductions in stream base flow can dry up habitat in stream channels and adjacent wetlands, and in so doing, adversely impact the health of important biological communities that reside in or depend upon these stream channels and wetlands. Increased impervious area can also increase peak stream flow, channel erosion, and sedimentation and thus can destroy aquatic habitat.

Land development can result in the addition and accumulation of pollutants on the land surface. Runoff and infiltration can mobilize and transport these pollutants to groundwater and streams. Surfaces and cleared areas within a development can receive a variety of pollutants from the atmosphere and from runoff over land surfaces that mobilizes fertilizers, animal wastes, and leakage and corrosion from vehicles. The

pollutants may include suspended and dissolved solids containing metals, nutrients and other inorganic compounds; hydrocarbons, pesticides, herbicides and other organic compounds; and pathogens--all of which can become mobilized by precipitation falling on the land.

Land development can also adversely affect water quality and stream biota in subtle ways. Runoff stored in detention or retention basins can become heated, raising the temperature of the downstream waterway and adversely affecting cold water aquatic species, such as trout, and by providing conditions that support unwanted aquatic species. Additionally, development may remove trees along streams or cause stream bank instability that undermines nearby trees. These trees are valuable because they provide shade that maintains cooler water temperatures and increased dissolved oxygen levels during critical summer periods. Trees also help stabilize stream banks, preventing bank erosion, and their leaf litter provides habitat and food for aquatic communities.

Section 4. Background

EAST GREENWICH TOWNSHIP

East Greenwich Township is located in central-western Gloucester County (see Figure 1). The Township's characteristics, as they relate to the stormwater management planning goals described in Section 2, are discussed in this background section of the MSWMP.

Zoning and Existing Land Use

East Greenwich Township is unique among the 24 municipalities in Gloucester County, for several reasons. In terms of both total area and land area (see Table 1), it is one of the larger municipalities in Gloucester County.

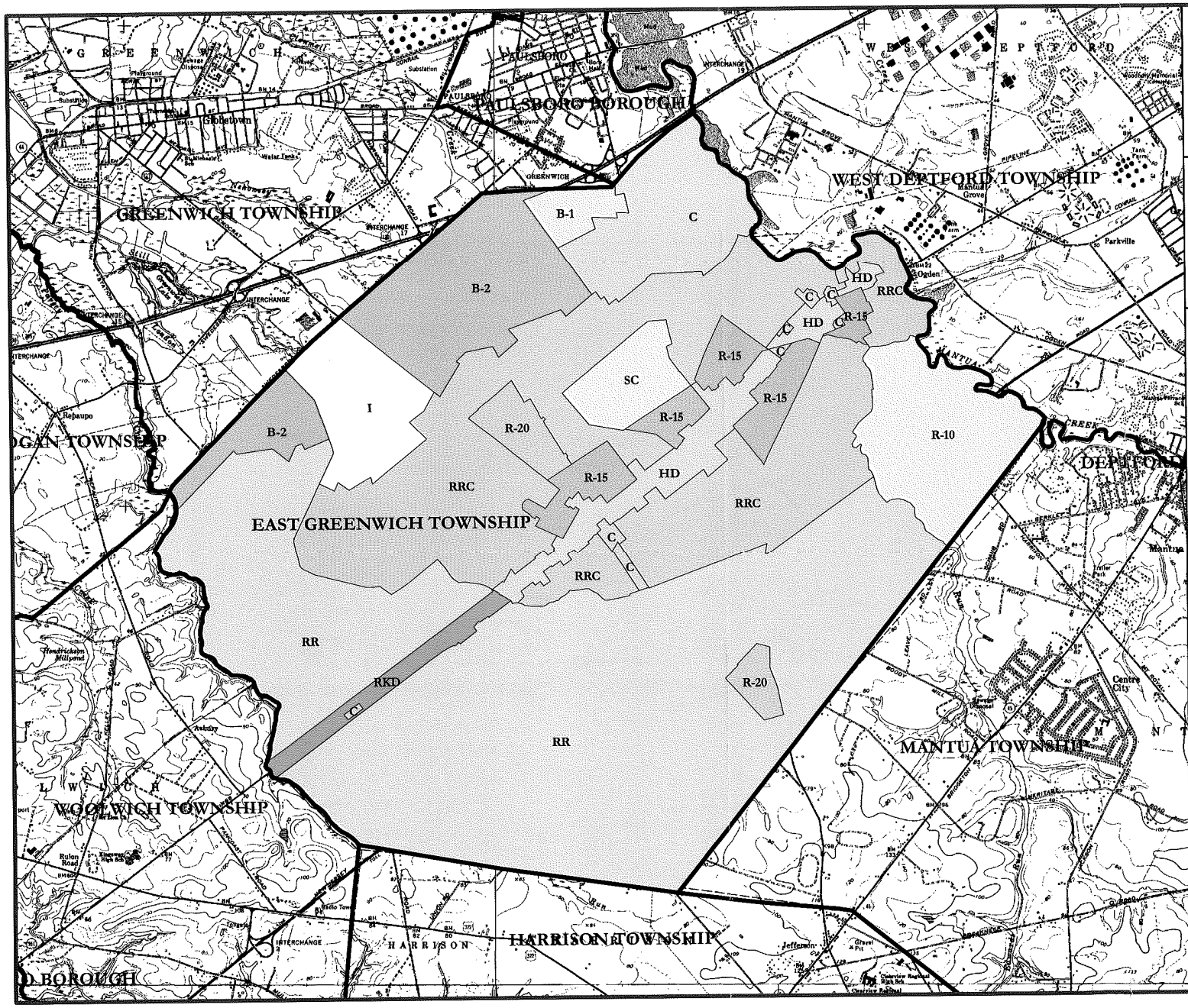
Table 1. East Greenwich Township Area

	Area (sq. mi.)
Total Area	14.97
Land Area	14.75
Water Area	0.22

With its substantial land area, its location between Philadelphia and the New Jersey Shore, and its major highway access (in particular, I-295), it is logical that East Greenwich Township will someday experience significant development pressure. However, the dominant existing land use is agriculture and privately held vacant land, accounts for approximately 44% of the Township's total land area. Areas of residential development account for 18% and are scattered throughout the Township, with existing development fanning out from the three historic villages of Mickleton, Clarksboro, and Mount Royal.

The existing zoning within the Township is shown on Figure 6, and the existing land use, based on the DVRPC aerial photographic land use analysis is shown on Figure 7. Areas of rural residential, along with low and high density residential zoning outweigh the industrial and commercial zones. Residential development that has occurred follows the traditional patterns of suburban development centered along the major road corridors. Single family development has created a demand for strip commercial centers that are located along I-295.

The current rate of development in East Greenwich Township is increasing, yet the projected build-out development in the Township is still many years away, given its geographic location, its size, and the amount of undeveloped land in the Township.



Stormwater Management Plan

Figure 6

ZONING

Legend

Municipal Boundary

East Greenwich Zoning

ZONING, DESCRIPTION

- B-1, INTERSTATE BUSINESS
- B-2, INTERSTATE BUSINESS
- C, COMMERCIAL
- HD, HISTORIC DISTRICT
- I, INDUSTRIAL
- R-10, RESIDENTIAL
- R-15, RESIDENTIAL
- R-20, RESIDENTIAL
- RKD, RURAL KINGS HWY DISTRICT
- RR, RURAL RESIDENTIAL
- RRC, RURAL RESIDENTIAL CLUSTER
- SC , SENIOR CITIZENS

3,000 1,500 0 3,000 Feet

County - Gloucester
Township - East Greenwich

Dated: 02/23/06
Drawn by: SEB

Quadrangles
Bridgeport, NJ #113
Woodbury, NJ #114

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

Population and Housing

The population of East Greenwich Township (see Table 2) is the 14th largest total population in Gloucester County. Table 2 provides the urban population and rural population (if any) breakdown. With respect to housing, the Township also has the 14th largest number of total housing units in Gloucester County and the number of urban and rural housing units (if any) are shown (see Table 2).

East Greenwich Township is one of 13 municipalities in the County with housing units classified as rural.

Table 2. East Greenwich Township Population and Housing (Year 2000)

	Population	Housing Units
Total	5,430	1,971
Urban	4,525	1,657
Rural	905	314

Source: U.S. Census Bureau

East Greenwich Township is 19th of 24 municipalities in Gloucester County in terms of population density.

Table 3. East Greenwich Township Population Density (1990 – 2003)

	Population	Population Density (persons/sq. mi.)
1990	5,259	357
2000	5,430	368
2003	5,876	398

Source: U.S. Census Bureau and N.J. Department of Labor

East Greenwich Township has been one of the fastest growing municipalities in Gloucester County in recent years. Between 1990 and 2000, East Greenwich Township experienced a 3 percent growth, although the estimated growth from 2000 to 2003 is 446 or 8 percent (see Table 4).

Table 4. East Greenwich Township Population Growth (1990 – 2003)

	Population	Population Change	Percent Growth
1990	5,259		
2000	5,430	171	3
2003	5,876	446	8

Source: U.S. Census Bureau and N.J. Department of Labor

The Delaware Valley Regional Planning Commission (DVRPC) projects East Greenwich Township to grow by 1,860 people over the 30-year period from 2000 to 2030 (see Table 5), with an overall growth of 34.3 percent during those three decades.

Table 5. East Greenwich Township Projected Population Growth (2000 – 2030)

	Population	Population Change	Percent Growth
2000	5,430		
2010	5,840	410	7.6
2020	6,580	740	12.7
2030	7,290	710	10.8

Source: DVRPC

Surface Water

(a) Watersheds and Hydrologic Unit Codes (HUCs)

There are eight major Watersheds within Gloucester County. Each of these Watersheds and their land areas within the County are shown in Table 6. Also shown in Table 6 is a two character identification code used in this report to identify data tables and figures related to the individual watersheds.

Table 6. Watersheds Within Gloucester County

ID	Watershed	Area (acres)
BT	Big Timber Creek	12,925
GE	Great Egg Harbor River	36,997
MC	Mantua Creek	32,099
MR	Maurice River	47,177
OC	Oldman's Creek	14,558
RA	Raccoon Creek	31,822
RE	Repaupo Creek	26,222
WC	Woodbury Creek	13,787
		215,587

East Greenwich Township is within two of these major watersheds, as shown in Table 7.

Table 7. East Greenwich Township Watersheds

ID	Watershed	Area (acres)
RE	Repaupo Creek	6,973.39
MC	Mantua Creek	2,565.13
	Total	9,538.52

The NJDEP requires that municipalities evaluate the impacts of their small municipal separate storm sewer systems (small MS4s) on surface waters at the HUC14 sub-watershed level (these watershed and sub-watershed divisions were developed by the United States Geological Survey (USGS) using a coding system called Hydrological Unit Codes, or HUCs).

Figure 8 shows the HUC14s located partially or entirely within the municipal boundaries of East Greenwich Township. The names of the HUC14s are shown in Table 8.

(b) New Jersey Surface Water Quality Standards

The Federal Clean Water Act requires that states maintain surface water quality in high quality waters and restore water quality in impaired waters. Surface Water Quality Standards (SWQS) have been developed by the NJDEP (and Delaware River Basin Commission (DRBC) for the Delaware River) to accomplish this goal. These standards establish "designated uses" to be achieved for surface water bodies and specify the water quality criteria necessary to achieve these uses.

Designated uses established by the NJDEP for New Jersey water bodies include potable water supply (drinking water use), propagation of fish and wildlife (aquatic life use), recreation in and on the water (primary and secondary contact), agricultural and industrial supplies, and navigation. The NJDEP has established stream classifications and antidegradation designations for all of the state's surface water bodies. New Jersey's Water Quality and Monitoring Standards homepage can be found at the following link:

http://www.state.nj.us/dep/wmm/

The Surface Water Quality Standards can be found in N.J.A.C. 7:9B at these links:

http://www.state.nj.us/dep/wmm/sgwqt/swqsdocs.html
http://www.state.nj.us/dep/wmm/sgwqt/sgwqt.html.

In addition, because the Delaware River is an interstate water body, the Delaware River Basin Commission (DRBC) has established interstate zones, designated uses for each zone, and water quality standards to achieve the designated uses along the entire length of the river. Gloucester County adjoins the very lowest end of Zone 3, Zone 4 and the upper most portion of Zone 5. The DRBC's 2004 Delaware River and Bay Integrated List Water Quality Assessment Report, which contains the water quality standards for each

Table 8. East Greenwich Township Watersheds and HUC14s

Watersheds	HUC14 Sub-Watersheds	
	No.	Name
Repaupo Creek	02040202140010	Nehonsey Bk/Clonmell Creek (Lower Delaware River to Mantua Creek)
	02040202140020	Still Run/London Br (above Tomlin Station Rd)
	02040202140030	Pargey Creek
Mantua Creek	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
	02040202130050	Edwards Run
	02040202130060	Mantua Creek (below Edwards Run)

zone (see Section 2.2), and the results of their 2004 Delaware River and Bay Water Quality Assessment, can be found at the following link:

http://www.state.nj.us/drbc/04IntegratedList/index.htm.

The Surface Water Quality Criteria for all classified waterways in the State depend on their designated uses and reflected Surface Water Classification. The Surface Water Quality Criteria are detailed in N.J.A.C. 7:9B-1.14 and are too voluminous to include in this report.

(c) Impaired Waters

States are required to prepare and submit to the USEPA a report that identifies waters that do not meet or are not expected to meet surface water quality standards (SWQS). This report is commonly referred to as the 303(d) list. In accordance with Section 305(b) of the CWA, the States are also required biennially to prepare and submit to the USEPA a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report. Those water bodies, which are listed on the 303(d) list, are referred to as "water quality limited" water bodies and a total maximum daily load (TMDL) must be developed for each individual pollutant in these impaired water bodies.

In November 2001, the USEPA issued guidance that encouraged states to integrate 305(b) Report and the 303(d) List into one report. The New Jersey Department of Environmental Protection (NJDEP) chose to develop an Integrated Report for New Jersey starting in 2002. The 2004 Integrated List of Waterbodies combines these two assessments and assigns water bodies to one of five sublists. Sublists 1 through 4 include water bodies that are generally unimpaired. Sublist 5 of the 2004 Report supersedes Sublist 5 of the 2002 Integrated List and the new sublist presents all water quality limited waters and includes waters for which TMDL development is occurring or will occur within two years. The Sublists of water bodies in New Jersey are categorized as follows.

Sublist 1 - water bodies that are attaining the water quality standards and no use is threatened.

Sublist 2 - water bodies that are attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened.

Sublist 3 - water bodies where there is insufficient or no data and information to determine if any designated use is attained.

Sublist 4 - water bodies that are impaired or threatened for one or more designated uses but do not require the development of a TMDL [for the reasons described in Sublists 4A, 4B and 4C below].

Sublist 4A. - TMDL has been completed.

Sublist 4B - other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.

Sublist 4C - impairment is not caused by a pollutant.

Sublist 5 - the water quality standard is not attained. The waterway is impaired or threatened for one or more designated uses by a pollutant(s) and requires a TMDL.

The link to the most recent 2004 NJDEP Integrated Water Quality and Assessment Report is:

http://www.state.nj.us/dep/wmm/sgwqt/wat/integratedlist/integratedlist2004.html

For the purposes of evaluating surface water quality in Gloucester County, the Integrated Lists (Sublists 1-5) were abridged and sorted to include only those locations within the County. (See Watershed Surface Water Quality discussion(s) that follow)

(d) Total Maximum Daily Loads (TMDLs)

TMDLs are required, under Section 303(d) of the federal Clean Water Act, for water bodies that cannot meet surface water quality standards after the implementation of "technology-based" effluent limitations. TMDLs may also be established to help maintain or improve water quality in waters that are not impaired. Based on the 2002 and 2004 integrated list, the NJDEP entered into a Memorandum of Agreement with USEPA that sets out a schedule for completion of TMDLs.

A TMDL allocates the load capacity to point sources in the form of waste load allocations (WLAs) and to non-point sources in the form of load allocations (LAs), and may also identify reserve capacity and a margin of safety. WLAs result in Water Quality Based Effluent Limits for point source Wastewater Treatment Plants and requirements based on Best Management Practices (BMPs) for regulated stormwater point sources, such as Combined Sewer Overflows (CSOs). Because non-point source pollution does not come from discrete sources, LAs generally identify broad categories of non-point sources that contribute to the parameters of concern. The LA then includes specific load reduction measures, through Best Management Practices (BMPs), that may include local ordinances for stormwater management and non-point source pollution control, headwaters protection practices, or other mechanisms for addressing the parameters of concern.

A separate TMDL calculation must be prepared for each pollutant listed for each impaired stream segment or lake. A TMDL is considered "proposed" when the NJDEP publishes the TMDL Report as a proposed Water Quality Management Plan Amendment in the New Jersey Register (NJR) for public review and comment. A TMDL is considered "established" when the NJDEP finalizes the TMDL Report and formally submits it to EPA Region 2 for a thirty (30)-day review and approval. The TMDL is

considered "approved" when the NJDEP-established TMDL is approved by EPA Region 2. The TMDL is considered "adopted" when the EPA-approved TMDL is adopted by the NJDEP as a water quality management plan amendment and the adoption notice is published in the NJR. The link to New Jersey's TMDLs and their status is:

http://www.nj.gov/dep/watershedmgt/tmdl.htm#intro

In the process of establishing a TMDL, an implementation plan is developed to identify how the various sources will be reduced to their designated allocations. Implementation strategies for non-point sources may include: improved stormwater management, the adoption of ordinances, reforestation of stream corridors, retrofitting stormwater systems, and other Best Management Practices to control stormwater runoff loadings.

(e) Gloucester County's Impaired Waters

There are about 27 different water bodies within Gloucester County that are considered impaired for their designated use, because they do not meet their respective water quality standards for one or more pollutant parameters. The impaired parameters include phosphorus, mercury, copper, silver, PCBs, dioxin, benthic macroinvertebrates, pH, fecal coliform, total coliform, and total suspended solids. The NJDEP has prepared or will prepare TMDLs for each water body and impaired parameter. . (See Watershed Surface Water Quality discussion(s) that follow)

(f) Gloucester County's TMDLs

At this time, the NJDEP has proposed 17 TMDLs that address impaired water bodies in Gloucester County. The full text of these proposals can be found and downloaded at the following link:

http://www.nj.gov/dep/watershedmgt/tmdl.htm#intro .

Fourteen of the 17 TMDL proposals were proposed by the NJDEP in April 2003 and were based on the 2002 Integrated Report. These TMDLs were approved in September 2003, but have not yet been adopted. Three of the 17 TMDL proposals were proposed by the NJDEP in May and July 2005, and these TMDLs have not yet established.

Ground Water

Gloucester County is located in the Atlantic Coastal Plain Physiographic Province. Beneath Gloucester County are a series of geologic units that form aquifers or aquifer systems and confining units (aquitards). The geologic units consist largely of layers of unconsolidated sediments of clays, silts, sands and gravels, deposited over many millions of years, and extending from the land surface, hundreds or thousands of feet to bedrock. These sand and gravel layers and units when grouped together form the aquifers or aquifer systems and the layers and units containing higher amounts of silts and clays when grouped together form the confining units.

The geologic units in the County dip gently to the south-east, and they outcrop (and are exposed) in broad, irregular, northeast-southwest trending bands on the land surface. The oldest formations outcrop along and under the Delaware River, and progressively younger units outcrop in sequence, moving southeasterly towards the Atlantic Coast.

There are several major coastal plain aquifers or aquifer systems which outcrop and are exposed in Gloucester County. Starting with the oldest and most westerly, they are: the Potomac-Raritan-Magothy (PRM) aquifer system, which outcrops along and under the Delaware River; the Englishtown aquifer system; the Wenonah-Mount Laurel aquifer; and the Kirkwood-Cohansey aquifer system.

The Wenonah-Mount Laurel, Englishtown, and PRM aquifers are exposed in their respective outcrops, but dip into the subsurface, becoming semi-confined or confined at depth in a southeasterly direction. The Kirkwood-Cohansey aquifer system remains exposed throughout its outcrop and is exposed and unconfined within Gloucester County.

There are a few other minor geologic units outcropping in the County that may yield very small amounts of water, including the Merchantville, Marshalltown and Vincentown Formations. However, because of their low permeability's, these formations are more often regarded as confining units. In addition to these minor geologic units, small, shallow, deposits of more recent sands with gravel from the Bridgeton, Pennsauken and Cape May Formations can be found on the surface in the County, particularly capping hills and along stream banks.

The aquifers or aquifer systems in Gloucester County are separated by relatively impermeable geologic confining units that vary in thickness and in their confining ability, ranging from semi-confining to confining. These confining units also outcrop in broad, highly irregular, northeast-southwest trending bands on the land surface and are located between the aquifers' outcrops.

Confining geologic units in the County, starting with the oldest and most westerly outcropping, are: the Woodbury-Merchantville (between the PRM and the Englishtown); the Marshalltown (between the Englishtown and the Wenonah-Mount Laurel); and the Hornerstown-Navesink-Vincentown (between the Wenonah-Mount Laurel and the Kirkwood-Cohansey). Water in the subsurface tends to move very slowly, if at all, from one aquifer system to another, because of the confining units between the aquifers.

Minimizing the impacts of stormwater runoff on the ground water of East Greenwich Township is a primary goal of this MSWMP, as is protecting East Greenwich Township's surface waters.

(a) Stormwater Runoff and Ground Water Recharge

In New Jersey's Atlantic Coastal Plain, precipitation averages about 43.75 inches per year. On average, about 45 percent of the annual precipitation results in runoff (or about 19.75 inches per year), and about 55 percent of the precipitation is lost into the

atmosphere as evapotranspiration. The infiltration, or groundwater recharge, component of runoff provides the base stream flow in the Atlantic Coastal Plain. At an average runoff rate of 19.75 inches per year, the maximum recharge rate of 15 inches per year indicates that as much as 75 percent of the runoff will recharge the ground water.

The northwestern portion of East Greenwich Township is located on the outcrop of the Woodbury Formation confining unit. East of the Woodbury Formation, the Englishtown aquifer outcrops in a strip through the western-central portion of the Township. A narrow band of the Marshalltown Formation confining unit outcrops just east of the Englishtown aquifer outcrop. The eastern portion of the Township is located on the outcrop of the Wenonah-Mount Laurel aquifer. The Englishtown and the Wenonah-Mount Laurel aquifers are susceptible to ground water contamination and their protection is important.

Because the Englishtown and Wenonah-Mount Laurel aquifers have the ability to transmit large quantities of water downward, store the precipitation from individual storm events, and discharge the stored water as base flow to streams in a more uniform manner than would result from direct runoff, the streams in the Township can benefit from groundwater recharge and stream base flow maintenance. For this reason, groundwater recharge in the Township is a significant stormwater management strategy and new major development and redevelopment should incorporate measures that maximize potential groundwater recharge. Groundwater recharge on the outcrops of the confining units may not be possible.

(b) Well head Protection Areas (WHPAs)

Water supply wells in exposed unconfined aquifers depend on surface recharge to maintain groundwater levels and groundwater quality, thereby directly linking stormwater management and recharge with water supply. Largely because of this linkage, unconfined public community water supply (PCWS) wells and public non-community water supply (PNCWS) wells have designated "wellhead protection areas" (WHPAs). Water supply wells in the confined portions of aquifers, away from the exposed outcrop area, are not directly linked to surface recharge, and have no WHPAs.

WHPAs establish the approximate area within which contamination, released on the surface, will travel to the well head, over the prescribed period of time. WHPAs include three tiers; the inner boundary, Tier 1, includes an area with a 2 year travel time, the middle boundary, Tier 2, includes an area with a 5 year travel time and the outer boundary, Tier 3, includes an area with a 12 year travel time. WHPAs serve as warning zones, within which high risk activities should be avoided, and further provide a prioritization for clean-up of surface and groundwater contamination that occurs within a WHPA.

Geology (surficial) and Wellhead Protection Areas in East Greenwich Township are shown in Figure 9. East Greenwich has two confined PCWS wells that are not associated with wellhead protection areas.

Greenwich Township

020402021400 50
RepaupoCk(belowTomlin Sta Rd)/CedarSwamp

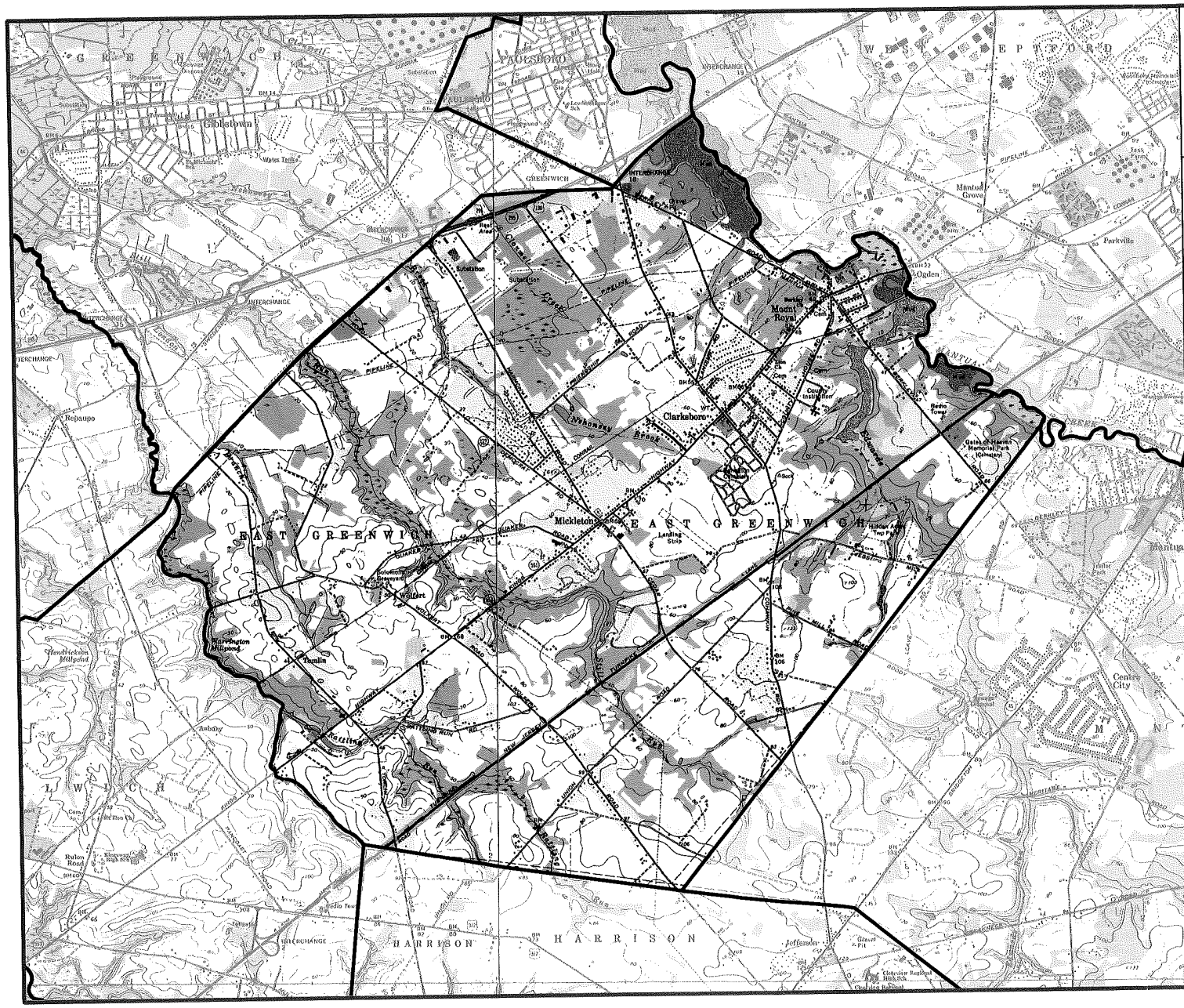
Logan Township

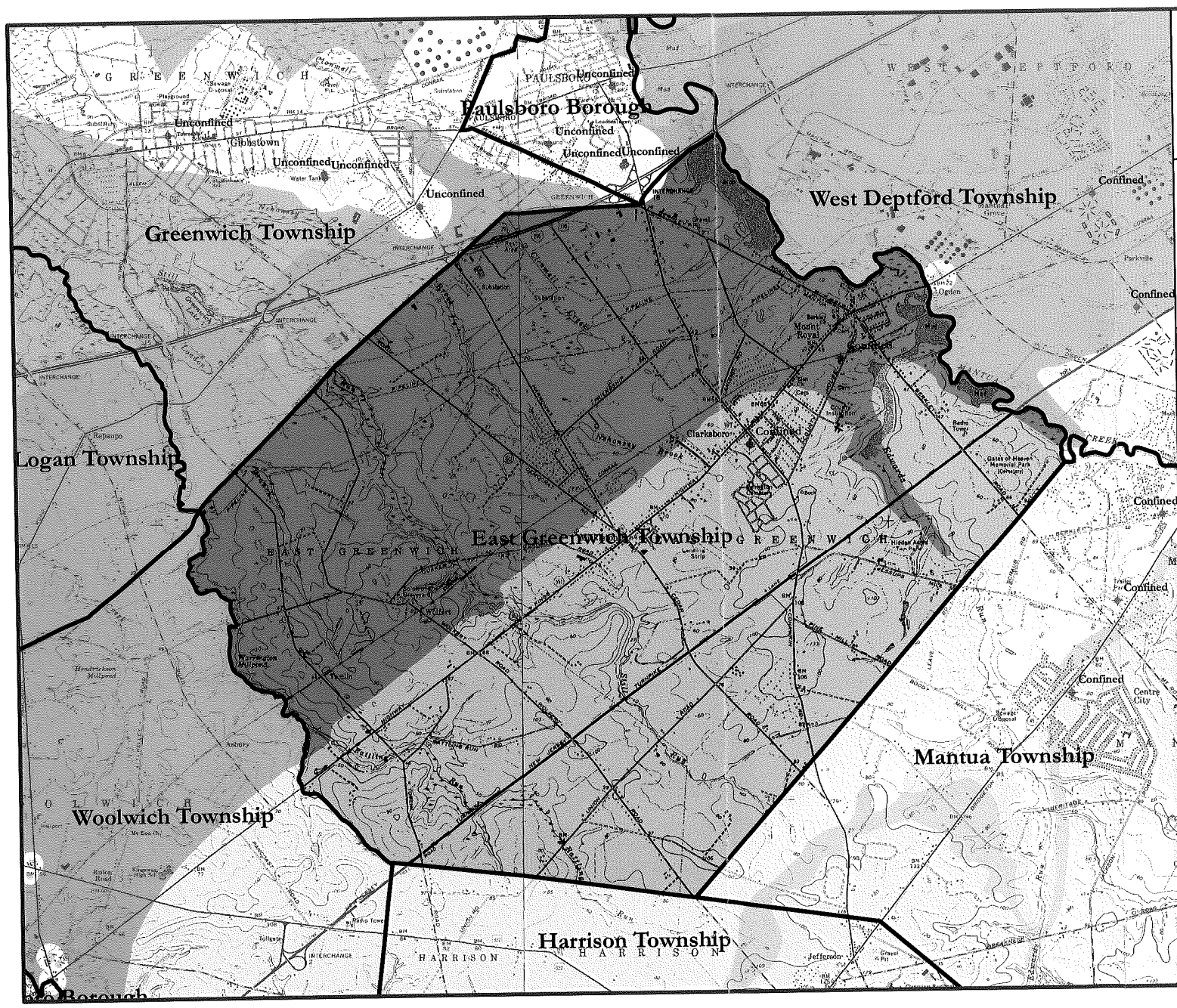
020402021400 40
Moss Branch / Little Timber Ck (Repaupo)

Woolwich Township

020402021500 50
Raccoon Ck (Swedesboro rd-RussellMillRd)

Raccoon Creek Waters





Stormwater Management Plan

Figure 9

GEOLOGY & WELLHEAD PROTECTION AREAS

Legend

- Municipal Boundary
- Public Community Water Supply Wells

Public Community Wellhead Protection Areas

TIER

- Tier 1 (2 years)
- Tier 2 (5 years)
- Tier 3 (12 years)

Public Non-Community Wellhead Protection Areas

TIER

- Tier 1 (2 years)
- Tier 2 (5 years)
- Tier 3 (12 years)

Gloucester County Geology

GEONAME

- Englishtown Formation
- Hornerstown Formation
- Lower Member
- Magothy Formation
- Marshalltown Formation
- Merchantville Formation
- Mt. Laurel Formation
- Navesink Formation
- Wenonah Formation
- Woodbury Formation

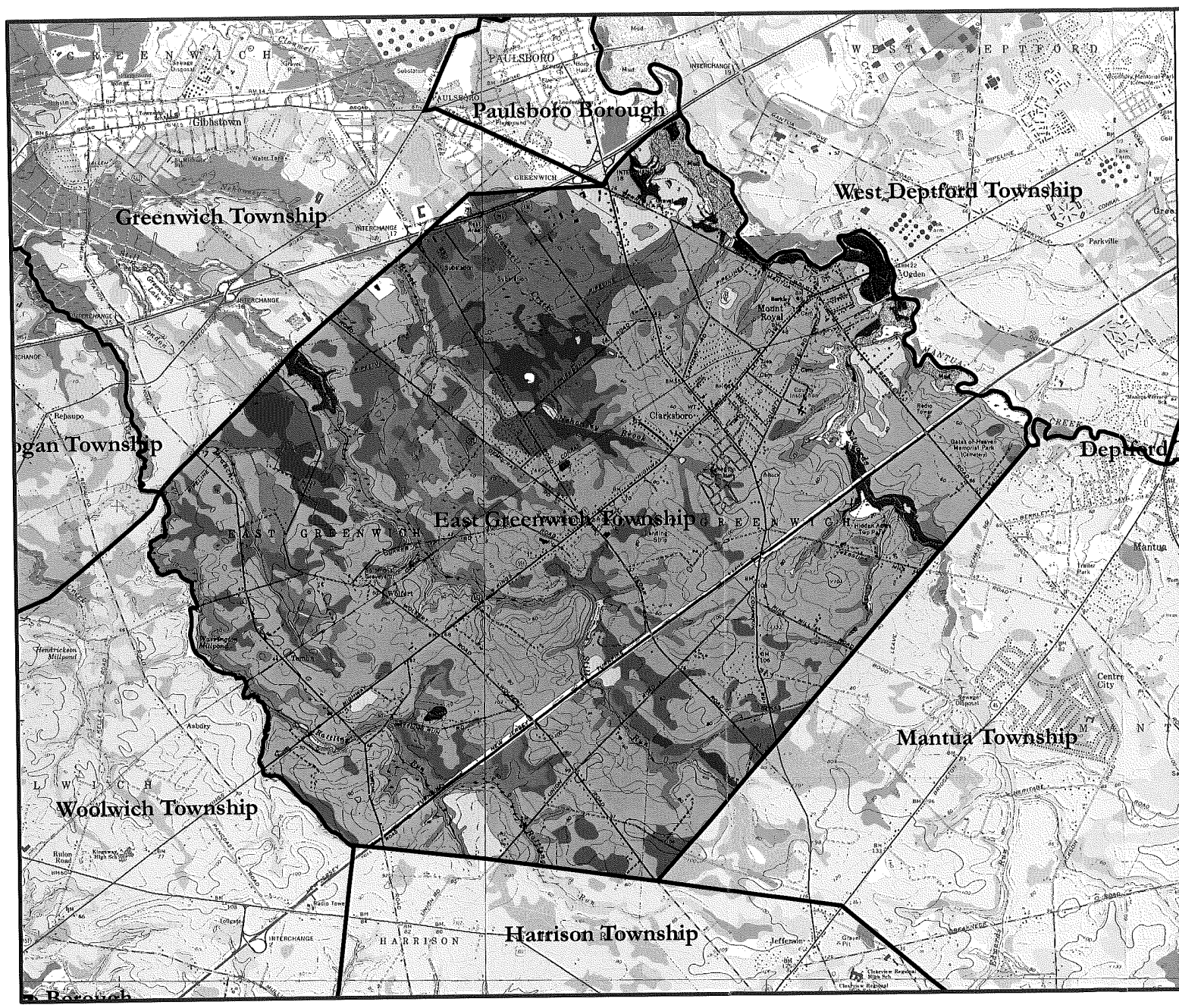
3,000 1,500 0 3,000 Feet

County - Gloucester
Township - East Greenwich

Dated: 02/23/06
Drawn by: SEB

Quadrangles
Bridgeport, NJ #113
Woodbury, NJ #114

Note:
This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.
Additional Information for Wells data:
New Jersey Department of Environmental Protection NJDEP, New Jersey Geological Survey NJGS, Publication Date: April 5th, 2004.
Additional Information for Geologic data:
Originator: New Jersey Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS), Publication Data: June 30th, 1999.



Stormwater Management Plan

Figure 10

SOILS

County - Gloucester
Township - East Greenwich

Dated: 02/23/06
Drawn by: SEB

Quadrangles
Bridgeport, NJ #113
Woodbury, NJ #114

Note:
This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized. Additional Information for Soils data: U.S. Department of Agriculture, Natural Resources Conservation Service. Photographic or digital enlargement of these maps to scales greater than at which they were originally mapped can cause misinterpretation of the data. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale. The depicted soil boundaries, interpretations, and analysis derived from them do not eliminate the need for onsite sampling, testing, and detailed study of specific sites for intensive uses. Thus, these data and their interpretations are intended for planning purposes only. Digital data files are periodically updated. Files are dated, and users are responsible for obtaining the latest version of the data.
Publication Data: April 7th, 2005.

(c) New Jersey Groundwater Quality Standards

The NJDEP's has established Ground Water Quality Standards (GWQSs) for all of the ground waters in the State of New Jersey (N.J.A.C. 7:9-6). Like the SWQSs, the GWQSs establish the designated uses for the State's ground water, and specify the ground water quality criteria for specific constituents, including toxic pollutants, consistent with those designated uses.

The GWQSs establish classification areas according to the geographic extent (both vertical and horizontal) of geologic formations, or units, within which ground water is classified for the designated uses. Designated uses may include any human withdrawal of ground water (for example, for potable, agricultural or industrial water), the discharge of ground water to surface waters of the State which support human use or ecological systems, or the direct support of ecological systems.

The GWQSs include three major classes of ground water:

Class I	Ground Water of Special Ecological Significance
Class II	Ground Water for Potable Water Supply
Class III	Ground Water With Uses Other Than Potable Water Supply

Under the NJDEP GWQSs, the primary designated use for Class I ground waters is the maintenance of special ecological resources supported by the ground water within the classification area; secondary designated uses of Class I waters is use for potable water, agricultural water and industrial water, if these uses are viable using water of natural quality and do not impair the primary use (for example, by altering ground water quality).

Class I ground water is further designated as either Class I-A (Exceptional Ecological Areas) or Class I-PL (Pinelands). Ground water within watersheds of FW-1 surface waters (a Category One surface water classification), and certain "Natural Areas" designated by the NJDEP in the GWQSs, are designated as Class I-A ground waters.

Class III ground waters are ground waters that are not suitable for potable use due to their natural hydrogeologic characteristics, such as aquitards - Class III-A ground water, or due to their natural water quality that is unsuitable for conversion to potable water, such as saline ground water (Class III-B).

All ground waters in New Jersey not designated as Class I or Class III are designated as Class II ground waters. Class II ground waters are further classified as either Class II-A or Class II-B. The designated uses of Class II-B waters are any reasonable use other than potable use; however, the NJDEP has not designated any ground waters as Class II-B.

Because of the different ground water quality criteria, the necessary stormwater management measures may vary among these areas. However, the three contaminants for which the NJDEP has required a projection of build-out stormwater pollutant loading are nitrogen, phosphorus and total suspended solids (see Section 5). These three

pollutants are of particular significance with regard to surface water quality, but are not included in the list of constituent criteria for ground water. It is anticipated that ground water quality issues will not be a significant concern for new major development projects, if the projects comply with the new design and performance standards in N.J.A.C. 7:8.

Soils

One of the main objectives of the new NJDEP Stormwater Management Rules is to promote ground water recharge in order to replenish aquifers, maintain base flow in streams and assist in maintaining the groundwater supply. Ground water recharge is significantly affected by land use (e.g., commercial vs. agricultural uses), as well by the type of natural soil present on the ground surface. The National Resource Conservation Service (NRCS) has grouped soil types throughout the United States into four different Hydrologic Soil Groups (HSGs): A, B, C and D, depending on their infiltration ability and the potential rate of ground water recharge.

Group A soils have high infiltration rates and recharge potential and provide little direct runoff. They generally include well-drained and sorted sands and gravels. Group B soils have moderately high recharge potential, while Group C soils have lower infiltration rates and generally include more silt and clay particles with higher direct runoff potential. Group D soils have very low recharge rates and a high direct runoff potential. Some soils may have two classifications depending on whether or not they contain soil layers with different infiltration characteristics. For example, a soil classified as A/D has both a Group A soil layer that is well-drained and a Group D soil layer that is poorly drained.

The NJDEP's new stormwater regulations encourage new development in areas with soils that do not recharge significant amounts of water to aquifers; that is, in Group C and D soil areas. The regulations encourage the protection of the natural condition, infiltration and recharge rates in Group A or B soil areas. However, many Group D soil areas are located in wetlands or adjacent to wetlands and water bodies and these areas are not developable. It may not be possible to completely avoid disturbance and new development in Group A and B soil areas. But, the NJDEP's new stormwater regulations require equal amounts of ground water recharge before and after new development.

Figure 10 depicts the hydrologic soil groupings in East Greenwich Township. East Greenwich Township soils are primarily moderately well draining Group B soils, with lesser quality soils being associated with wetlands and along waterways throughout the Township.

REPAUPO CREEK WATERSHED

Topography

Figure RE-1 (see Appendix A) provides an aerial photograph (2000) of the Repaupo Creek Watershed and depicts general land use and other planimetric relationships within the watershed. It is a "birds-eye" view of the watershed that allows a quick assessment of watershed conditions as they existed at that time. This watershed appears generally to be a rural watershed.

Figure RE-2 (see Appendix A) provides the USGS Quadrangle (topographic map) for this watershed. Relief (elevation difference) within the Repaupo Creek Watershed is about 128 feet, with elevations ranging from a low of 3.3 to a high of 131 feet above mean sea level. Lower elevations occur along the waterways and wetlands and higher elevations occur along the watershed's boundaries. The land surface elevations and relief in this watershed have been sculpted by surface runoff and erosion of the unconsolidated coastal plain sediments at the land surface. But, the relief in this watershed is generally small, although there are (few/some/many) localized land areas with steeper slopes. Hills with steeper slopes, often capped by more erosion resistant sediments (gravels), can generally be found within the watershed, providing some structural control and forming drainage boundaries

The creek is about 7 miles long, and the average stream gradient (slope) along the length of the watershed's stream channel (the long profile) is 0.0017 (excluding any estuarine portions). In general, stream slopes within the watershed are extremely flat.

In this watershed, surface drainage has eroded the land surface in dendritic drainage patterns that exhibit little structural control because of the relatively uniform resistance to erosion from the underlying sediments. Generally, the streams in the watershed consist of short straight sections connected by bends and kinks. For the most part, there is little or no stream braiding or meandering and stream channels are not heavily incised. The streams in the watershed appear to be "graded." Stream base level, gradient, channel section, sediment load and flow are in relative dynamic equilibrium. Uncontrolled development within the watershed could, however, upset this equilibrium.

Hydrology

The Repaupo Creek Watershed has a drainage area of approximately 41 square miles, all of which is contained within Gloucester County. The watershed includes Clonmell Creek, Nehonsey Brook and Little Timber Creek that drain directly into the Delaware Estuary. Repaupo Creek contains two main branches, Still Run and its tributary London Branch to the north and Pargey Creek and its tributary Rattling Run to the south. The Creek and its tributaries are shown on Figure RE-3. This watershed contains 5 HUC14 sub-watersheds and these are listed in Table RE-1.

Table RE-1. Repaupo Creek Watershed HUC14s

Municipality	HUC14 Sub-Watershed	
	No.	Name
East Greenwich Township	02040202140010	Nehonsey Bk/Clonmell Creek (Lower Delaware River to Mantua Creek)
	02040202140020	Still Run/London Br (above Tomlin Station Rd)
	02040202140030	Pargey Creek
Logan Township	02040202140030	Pargey Creek
	02040202140040	Moss Branch / Little Timber Creek (Repaupo Creek)
	02040202140050	Repaupo Creek (below Tomlin Station Rd)/Cedar Swamp
Greenwich Township	02040202140010	Nehonsey Bk/Clonmell Creek (Lower Delaware River to Mantua Creek)
	02040202140020	Still Run/London Br (above Tomlin Station Rd)
	02040202140030	Pargey Creek
	02040202140050	Repaupo Creek (below Tomlin Station Rd)/Cedar Swamp
Woolwich Township	02040202140030	Pargay Creek
	02040202140040	Moss Branch/Little Timber Creek (Repaupo Creek)
Harrison Township	02040202140020	Still Run/London Br (above Tomlin Sta Rd)
	02040202140030	Pargey Creek
Mantua Township	02040202140020	Still Run/London Br (above Tomlin Station Rd)
	02040202140030	Pargey Creek
Paulsboro Borough	02040202140010	Nehonsey Brook / Clonmell Creek (Lower Delaware River to Mantua Creek)

Surface Water Quality

(a) Surface Water Classifications

The surface waters in the Repaupo Creek Watershed are classified FW2-NT/SE2 or FW2-NTC1/SE2.

The designated uses for surface water classification FW2-NT (non-trout fresh surface waters not designated as FW1 or PL) as described by the N.J.A.C. 7:9B-1.12(c) are:

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

The designated uses for surface water classification SE2 (saline waters of estuaries not designated as SE1 or SE3) as described by N.J.A.C. 7:9B-1.12(e) are:

1. Maintenance, migration and propagation of the natural and established biota;
2. Migration of diadromous fish;
3. Maintenance of wildlife;
4. Secondary contact recreation; and
5. Any other reasonable uses.

The designated uses for surface water classification FW2-NT/SE2 are a combination of two classifications due to a salt water/fresh water interface. The location of the interface is determined by the salinity measurements. It is located where the salinity is equal to 3.5 parts per thousand (ppt) at mean high tide. This location can change dependent on a number of factors, such as tidal effects, rainfall amounts, evapotranspiration and freshwater input. The fresh water portions or where the salinity is below or equal to 3.5 ppt at mean high tide, are classified as FW2-NT and take on the designate uses as described above. The saline portions or where the salinity is above 3.5 ppt at mean high tide, are classified as SE-2 and take on the designated uses as described above.

FW2-NTC1/SE2 waterways are classified as SE-2 in their saline portions, but they are classified as FW2-NTC1 in their fresh water portions of the waterways. They are still non-trout fresh water surface waters but they are also Category One waters. There are special anti-degradation policies applied to Category One waters in order to protect against "measurable changes in water quality characteristics because of their clarity, color, scenic setting, other characteristics of aesthetic value, exceptional ecological significance, or exceptional fisheries resources." (N.J.A.C. 7:B, June 2005)

(b) Surface Water Quality Data

Ambient Biomonitoring Network - The NJDEP has established an Ambient Biomonitoring Network (AMNET) to document the health of the state's waterways. There are over 800 AMNET sampling sites throughout the state of New Jersey. These sites are sampled for benthic macroinvertebrates by the NJDEP on a five-year cycle. Streams are classified as non-impaired, moderately impaired, or severely impaired, based on the AMNET data. The data is used to generate a New Jersey Impairment Score (NJIS), which is based on a number of biometrics that are related to benthic macroinvertebrate community dynamics. The AMNET sites within this watershed are shown in Figure RE-4 (see Appendix A) and the most recent AMNET scores for Impaired Waters within this watershed are included in the data table in Appendix B.

Conventional Water Quality Data – The NJDEP utilizes conventional surface water quality data from a number of sources to bi-annually evaluate the impairment of surface water bodies. These water quality data include the federal Storage and Retrieval repository (STORET) data and other Existing Sources. The STORET and Existing Sources sampling locations within this watershed are shown in Figure RE-4 (Appendix A) and the most recent data for Impaired Waters within this watershed are included in Appendix B.

(c) Impaired Waters

For the purpose of evaluating surface water quality in this watershed, the NJDEP Integrated List (Sublists 1-5) were abridged and sorted to provide the locations of impaired waters within this watershed and these are listed in Table RE-2. A map showing the locations of impaired water is included as Figure RE-4 (Appendix A). There are three (3) different sites within this watershed that are considered impaired for their designated uses, because they do not meet their respective water quality standards for one or more pollutant parameters. The impaired parameters include: mercury, benthic macroinvertebrates and fecal coliform.

Table RE-2. Repaupo Creek Impaired Waters List

No.	Location	Parameter	Priority
1.	Little Timber Creek	Mercury	High
2.	Still Run at Union Rd in E. Greenwich	Benthic Macroinvertebrates	Low
3.	Still Run near Mikleton	Fecal Coliform	High

(d) TMDL Proposals

The NJDEP has proposed one TMDL to address impaired water bodies in this watershed. The full text of this proposal can be found and downloaded at the following link:

http://www.nj.gov/dep/watershedmgt/tmdl.htm#intro .

The TMDL was proposed by the NJDEP in April 2003 and is based on the 2002 Integrated Report. The TMDL was approved in September 2003, but has not yet been adopted.

A list of this watershed's TMDL proposals is included in Table RE-3. The locations of TMDLs in this watershed are shown on Figure RE-4 (see Appendix A).

Table RE-3. Repaupo Creek TMDL Proposals

Location	Parameter	Status
Still Run near Mikelton	Fecal Coliform	Approved September 2003

A TMDL was proposed for fecal coliform for Still Run near Mickelton. Waste load allocation reductions were proposed. The TMDL proposals describe the possible sources of fecal coliform as well as the method for developing the TMDL and remediation plan. (See Section 8 Water Quality-TMDL Stormwater Management Strategies.)

Category One Waters

The segment of Pargey Creek within the boundaries of the Logans Pond Wildlife Management Area is classified as a Category One Waterway.

Hydrogeology

The eastern portion of the Repaupo Creek Watershed is underlain by the Kirkwood-Cohansey aquifer system, which is unconfined at the surface and provides the water table aquifer in this portion of Gloucester County.

Moving west across the watershed, the other aquifers and confining units in the County outcrop in narrow irregular bands. The Wenonah-Mount Laurel, Englishtown, and PRM aquifers or aquifer systems are exposed in their respective outcrops, but dip into the subsurface, becoming semi-confined or confined at depth in a southeasterly direction.

In this watershed, the exposed outcrops of these four aquifers are susceptible to contamination from development, stormwater runoff and the quality of groundwater recharge.

Soils

The Repaupo Creek Watershed contains substantial areas of Group D poorly-draining soils that are associated with wetlands in both Greenwich and Logan Townships (west of Route 653), although a few areas of Group B and C soils are present. In the eastern

portion of the watershed, the soils are better drained. Group B soils are predominant and there are occasional areas of Group C and D soils.

Critical Habitats

The NJDEP Division of Fish and Wildlife Endangered Nongame Species Program developed a GIS called the *Landscape Project*, which is described as a "pro-active, ecosystem-level approach to the long-term protection of imperiled and priority species and their important habitats in New Jersey." Version 2 of the Landscape project is now available interactively on the web and for download. According to the NJDEP's Metadata "Version 2 was created by intersecting imperiled and priority species data with NJDEP 1995/97 Land Use/Land Cover update. The resulting data layer identifies, delineates and ranks (based on the conservation status of species present) habitat statewide. Each patch is coded for the number of sightings of priority, state threatened, state endangered and federally listed species present. The data is designed to be used for state and local planning, open space acquisition and land-use regulation."

The NJDEP Division of Fish and Wildlife describes the *Landscape Project* and the importance of preserving natural habitat as follows:

> New Jersey is the most densely populated state in the nation. One of the consequences of this distinction is the extreme pressure that is placed on our natural resources. As the population grows, we continue to lose or impact the remaining natural areas of the state. As more and more habitat is lost, people are beginning to appreciate the benefits and necessity of maintaining land in its natural state.
>
> For example, we know that wetlands are critical for recharging aquifers, lessening the damage from flooding and naturally breaking down contaminants in the environment. Forests and grasslands protect the quality of our drinking water, help purify the air we breathe and provide important areas for outdoor recreation. Collectively, these habitats are of critical importance to the diverse assemblage of wildlife found in New Jersey, including more than 70 species classified as threatened or endangered.
>
> Many imperiled species require large contiguous tracts of habitat for survival. The consequence of the rapid spread of suburban sprawl is the loss and fragmentation of important wildlife habitat and the isolation and degradation of the smaller habitat patches that remain. Small patches of fields, forests and wetlands interspersed with development provide habitat for common species that do well living near humans, but do not provide the necessary habitat for most of our imperiled wildlife. We need to protect large, contiguous blocks of forest, grassland and wetlands to assure the survival of imperiled species over the long-term.

> In addition to providing habitat for the conservation of imperiled species, protecting critical wildlife areas will result in more open space for outdoor recreation. Recent surveys by the U.S. Fish and Wildlife Service show that more than 60% of Americans participate in some form of wildlife-related recreation. Open spaces provide places where people can escape the confines of urban and suburban living.

Most critical habitats are supported in part or in total by the surrounding surface and ground water resources, and they are consequently impacted by development, non-point source pollution and stormwater runoff. Critical Habitats mapped by the NJDEP's Landscape Project within this watershed are shown on Figure RE-6. The Critical Habitats within this watershed may include Grassland, Forest, Forested Wetland, Emerging Wetland, Beach, Bald Eagle Foraging, Urban Peregrine Falcon Nesting, and Wood Turtle habitats that should, to the extent practical, be conserved and protected from the adverse impacts caused by uncontrolled development and stormwater runoff.

MANTUA CREEK WATERSHED

Topography

Figure MC-1 (see Appendix A) provides an aerial photograph (2000) of the Mantua Creek Watershed and depicts general land use and other planimetric relationships within the watershed. It is a "birds-eye" view of the watershed that allows a quick assessment of watershed conditions as they existed at that time. This watershed appears generally to be an urbanized and rural watershed.

Figure MC-2 (see Appendix A) provides the USGS Quadrangle (topographic map) for this watershed. Relief (elevation difference) within the Mantua Creek Watershed is about 160 feet, with elevations ranging from a low of 3.3 to a high of 164 feet above mean sea level. Lower elevations occur along the waterways and wetlands and higher elevations occur along the watershed's boundaries. The land surface elevations and relief in this watershed have been sculpted by surface runoff and erosion of the unconsolidated coastal plain sediments at the land surface. But, the relief in this watershed is generally small, although there are some localized land areas with steeper slopes. Hills with steeper slopes, often capped by more erosion resistant sediments (gravels), can generally be found within the watershed, providing some structural control and forming drainage boundaries.

The stream is about 18 miles long, and the average stream gradient (slope) along the length of the watershed's stream channel (the long profile) is 0.0015 (excluding any estuarine portions). In general, stream slopes within the watershed are extremely flat.

In this watershed, surface drainage has eroded the land surface in dendritic drainage patterns that exhibit little structural control because of the relatively uniform resistance to erosion from the underlying sediments. Generally, the streams in the watershed consist of short straight sections connected by bends and kinks. For the most part, there is little or no stream braiding or meandering and stream channels are not heavily incised. The streams in the watershed appear to be "graded." Stream base level, gradient, channel section, sediment load and flow are in relative dynamic equilibrium. Uncontrolled development within the watershed could, however, upset this equilibrium.

Hydrology

From its headwaters in Glassboro, Mantua Creek flows 18.6 miles northwest to the Delaware River at Paulsboro, draining an area of 50 square miles. Major tributaries include the Chestnut Branch (7 miles long), Edwards Run (6.9 miles long) and Duffield Run (Federation of Gloucester County Watersheds). Mantua Creek and its tributaries are shown on Figure MC-3. This watershed contains 6 HUC14 sub-watersheds and these are listed in Table MC-1.

Table MC-1. Mantua Creek Watershed HUC14s

Municipality	HUC14 Sub-Watershed	
	No.	Name
Mantua Township	02040202130020	Mantua Creek (road to Sewell to Rt 47)
	02040202130030	Chestnut Branch (above Sewell)
	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
	02040202130050	Edwards Run
Washington Township	02040202130010	Mantua Creek (above Rt 47)
	02040202130020	Mantua Creek (road to Sewell to Rt 47)
	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
Deptford Township	02040202130020	Mantua Creek (road to Sewell to Rt 47)
	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
	02040202130060	Mantua Creek (below Edwards Run)
Glassboro Borough	02040202130010	Mantua Creek (above Rt 47)
	02040202130020	Mantua Creek (road to Sewell to Rt 47)
	02040202130030	Chestnut Branch (above Sewell)
East Greenwich Township	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
	02040202130050	Edwards Run
	02040202130060	Mantua Creek (below Edwards Run)
West Deptford Township	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
	02040202130060	Mantua Creek (below Edwards Run)
Harrison Township	02040202130030	Chestnut Branch (above Sewell)
	02040202130050	Edwards Run
Pitman Borough	02040202130010	Mantua Creek (above Rt 47)
	02040202130020	Mantua Creek (Road to Sewell to Rt 47)
	02040202130030	Chestnut Branch (above Sewell)
Paulsboro Borough	02040202130060	Mantua Creek (below Edwards Run)
Wenonah Borough	02040202130040	Mantua Creek (Edwards Run to road to Sewell)
Greenwich Township	02040202130060	Mantua Creek (below Edwards Run)
Monroe Township	02040202130010	Mantua Creek (above Rt 47)
Woodbury Heights Borough	02040202130040	Mantua Creek (Edwards Run to road to Sewell)

Surface Water Quality

(a) Surface Water Classifications

The surface waters in the Mantua Creek Watershed are classified FW2-NT/SE2.

The designated uses for surface water classification FW2-NT (non-trout fresh surface waters not designated as FW1 or PL) as described by the N.J.A.C. 7:9B-1.12(c) are:

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

The designated uses for surface water classification SE2 (saline waters of estuaries not designated as SE1 or SE3) as described by N.J.A.C. 7:9B-1.12(e) are:

1. Maintenance, migration and propagation of the natural and established biota;
2. Migration of diadromous fish;
3. Maintenance of wildlife;
4. Secondary contact recreation; and
5. Any other reasonable uses.

The designated uses for surface water classification FW2-NT/SE2 are a combination of two classifications due to a salt water/fresh water interface. The location of the interface is determined by the salinity measurements. It is located where the salinity is equal to 3.5 parts per thousand (ppt) at mean high tide. This location can change dependent on a number of factors, such as tidal effects, rainfall amounts, evapotranspiration and freshwater input. The fresh water portions or where the salinity is below or equal to 3.5 ppt at mean high tide, are classified as FW2-NT and take on the designate uses as described above. The saline portions or where the salinity is above 3.5 ppt at mean high tide, are classified as SE-2 and take on the designated uses as described above.

(b) Surface Water Quality Data

Ambient Biomonitoring Network - The NJDEP has established an Ambient Biomonitoring Network (AMNET) to document the health of the state's waterways. There are over 800 AMNET sampling sites throughout the state of New Jersey. These sites are sampled for benthic macroinvertebrates by the NJDEP on a five-year cycle. Streams are classified as non-impaired, moderately impaired, or severely impaired, based on the AMNET data. The data is used to generate a New Jersey Impairment Score

(NJIS), which is based on a number of biometrics related to benthic macroinvertebrate community dynamics. The AMNET sites within this watershed are shown in Figure MC-4 (see appendix A) and the most recent AMNET scores for Impaired Waters within this watershed are included in Appendix B.

Conventional Water Quality Data – The NJDEP utilizes conventional surface water quality data from a number of sources to bi-annually evaluate the impairment of surface water bodies. These water quality data include the federal Storage and Retrieval repository (STORET) data and other Existing Sources. The STORET and Existing Sources sampling locations within this watershed are shown in Figure MC-4 (Appendix A) and the most recent data for Impaired Waters within this watershed are included in Appendix B.

(c) Impaired Waters

For the purpose of evaluating surface water quality in this watershed, the NJDEP Integrated List (Sublists 1-5) were abridged and sorted to provide the locations of impaired waters within this watershed and these are listed in Table MC-2. A map showing the locations of impaired water is included as Figure MC-4 (Appendix A). There are eight (8) different sites within this watershed that are considered impaired for their designated uses, because they do not meet their respective water quality standards for one or more pollutant parameters. The impaired parameters include: phosphorus, mercury, benthic macroinvertebrates, and fecal coliform.

Table MC-2. Mantua Creek Impaired Waters List

No.	Location	Parameter	Priority
1(a).	Edwards Run at Jefferson	Fecal Coliform	High
1(b).	Edwards Run at Jefferson	Phosphorous	Medium
2.	Edwards Run at Jessup Mill Rd in Mantua	Benthic Macroinvertebrates	Low
3.	Mantua Creek at Mantua Ave in Wenonah	Benthic Macroinvertebrates	Low
4.	Mantua Creek at Rt 45 in W. Deptford	Phosphorus	Medium
5(a).	Alcyon Lake	Mercury	High
5(b).	Alcyon Lake	Phosphorous	Medium
6.	Chestnut Branch at Mantua Blvd. in Mantua	Benthic Macroinvertebrates	Low
7.	Plank Run at Rte. 322 in Harrison	Benthic Macroinvertebrates	Low
8.	Bethel Lake	Phosphorous	Medium

(d) TMDL Proposals

The NJDEP has proposed two TMDLs to address impaired water bodies in this watershed. The full text of these proposals can be found and downloaded at the following link:

http://www.nj.gov/dep/watershedmgt/tmdl.htm#intro .

The first TMDL was proposed by the NJDEP in April 2003 for fecal coliform and is based on the 2002 Integrated Report. This TMDL was approved in September 2003, but has not yet been adopted. The other TMDL was proposed by the NJDEP in May 2005 for phosphorous and is not yet established.

A list of this watershed's TMDL proposals is included in Table MC-3. The locations of TMDLs in this watershed are shown on Figure MC-4 (Appendix A).

Table MC-3. Mantua Creek TMDL Proposals

Location	Parameter	Status
Edwards Run at Jefferson	Fecal Coliform	Proposed May 2, 2005
Bethel Lake	Phosphorous	Approved September 2003

The fecal coliform TMDL was proposed for Edwards Run at Jefferson. Waste load allocation reductions were proposed for the affected waterway. The proposal discusses the possible sources of fecal coliform, as well as the method for developing a TMDL and remediation plan.

The TMDL for phosphorous was proposed for Bethel Lake. Waste load allocation reductions have been proposed. The TMDL proposal discusses possible sources of phosphorous as well as the method for developing the TMDL and remediation plan.

Category One Waters

The Mantua Creek Watershed does not have any Category One Waterways.

Hydrogeology

The eastern portion of the Mantua Creek Watershed (to approximately the Washington Township/Deptford divide) is underlain by the Kirkwood-Cohansey aquifer system, which is unconfined at the surface and provides the water table aquifer in this portion of Gloucester County.

Moving west across the watershed, the other aquifers and confining units in the County outcrop in narrow irregular bands. The Wenonah-Mount Laurel, Englishtown, and PRM aquifers or aquifer systems are exposed in their respective outcrops, but dip into the subsurface, becoming semi-confined or confined at depth in a southeasterly direction.

In this watershed, the exposed outcrops of these four aquifers are susceptible to contamination from development, stormwater runoff and the quality of groundwater recharge.

Soils

Soils in the Mantua Creek Watershed are non-uniform in their distribution. The municipal centers of Pitman and Glassboro contain mostly urban soils. Poorly draining Group D soils dominate near the mouth of Mantua Creek. Otherwise, moderately well-draining patches of Group B soils are scattered amongst soils with lower recharge capacities. Figure MC-5 (see Appendix A) shows the potential amounts of infiltration and ground water recharge throughout the watershed

Critical Habitats

The NJDEP Division of Fish and Wildlife Endangered Nongame Species Program developed a Geographic Information System (GIS) called the *Landscape Project*, which is described as a "pro-active, ecosystem-level approach to the long-term protection of imperiled and priority species and their important habitats in New Jersey." Version 2 of the Landscape project is now available interactively on the web and for download. According to the NJDEP's Metadata, "Version 2 was created by intersecting imperiled and priority species data with NJDEP 1995/97 Land Use/Land Cover update. The resulting data layer identifies, delineates and ranks (based on the conservation status of species present) habitat statewide. Each patch is coded for the number of sightings of priority, state threatened, state endangered and federally listed species present. The data is designed to be used for state and local planning, open space acquisition and land-use regulation."

The NJDEP Division of Fish and Wildlife describes the *Landscape Project* and the importance of preserving natural habitat as follows:

> New Jersey is the most densely populated state in the nation. One of the consequences of this distinction is the extreme pressure that is placed on our natural resources. As the population grows, we continue to lose or impact the remaining natural areas of the state. As more and more habitat is lost, people are beginning to appreciate the benefits and necessity of maintaining land in its natural state.
>
> For example, we know that wetlands are critical for recharging aquifers, lessening the damage from flooding and naturally breaking down contaminants in the environment. Forests and grasslands protect the quality of our drinking water, help purify the air we breathe and provide important areas for outdoor recreation. Collectively, these habitats are of critical importance to the diverse assemblage of wildlife found in New Jersey, including more than 70 species classified as threatened or endangered.
>
> Many imperiled species require large contiguous tracts of habitat for survival. The consequence of the rapid spread of suburban sprawl is the loss and fragmentation of important wildlife habitat and the isolation and

degradation of the smaller habitat patches that remain. Small patches of fields, forests and wetlands interspersed with development provide habitat for common species that do well living near humans, but do not provide the necessary habitat for most of our imperiled wildlife. We need to protect large, contiguous blocks of forest, grassland and wetlands to assure the survival of imperiled species over the long-term.

In addition to providing habitat for the conservation of imperiled species, protecting critical wildlife areas will result in more open space for outdoor recreation. Recent surveys by the U.S. Fish and Wildlife Service show that more than 60% of Americans participate in some form of wildlife-related recreation. Open spaces provide places where people can escape the confines of urban and suburban living.

Most critical habitats are supported in part or in total by the surrounding surface and ground water resources, and they are consequently impacted by development, non-point source pollution and stormwater runoff. Critical Habitats mapped by the NJDEP's Landscape Project within this watershed are shown on Figure MC-6 (see Appendix A). The Critical Habitats within this watershed may include Grassland, Forest, Forested Wetland, Emerging Wetland, Beach, Bald Eagle Foraging, Urban Peregrine Falcon Nesting, and Wood Turtle habitats that should, to the extent practical, be conserved and protected from the adverse impacts caused by uncontrolled development and stormwater runoff.

Section 5. Build-Out Analysis and Pollutant Loading Projections

Build-out analyses and pollutant loading projections have been prepared for each municipality, HUC14 and watershed within Gloucester County, generally in accordance with the NJDEP's methodology described by their guidance and regulations. The build-out analyses and pollutant loading projections are tools to assess the potential impacts from development and stormwater runoff within each of the County's municipalities and watersheds.

Some municipalities in Gloucester County are essentially fully developed ("built–out"); little new development can or will occur in these municipalities. However, the potential for significant redevelopment exists in these highly developed municipalities, and the existing development in built-out municipalities contributes pollutants to the watershed. Thus, all of the municipalities in the County, regardless of their remaining developable land areas were evaluated in the County's build-out analyses and pollutant loading projections.

Furthermore, in order to add more meaning to the pollutant loading projections, the County has compared present land use and future (build-out) land use by projecting the pollutant loadings under both conditions. The County utilized powerful GIS data management and mapping software to perform these analyses for each municipality, HUC14 and watershed.

The build-out analyses and pollutant loading projections allow municipalities, the County and others to quantifiably project the impacts from development on surface waters. Using this tool, municipalities and the County are in a better position to develop strategies to minimize, manage and/or mitigate these impacts through improved stormwater management and construction practices and potentially through modifications to the land use and zoning, before build-out occurs.

Build-out analyses and pollutant loading projections are a tool and an initial step for assessing and quantifying adverse impacts from development and stormwater runoff. There are, however, a number of reservations associated with the NJDEP's Build-out methodology, and with build-out and pollutant loading analyses in general.

1. The methodology over-simplifies the complex hydrologic and pollutant transport mechanisms associated with these processes and development.

2. The methodology does not account for the transient nature of development within a given municipality and watershed. It ignores the differences in time over which build-out will occur. For example, one municipality or portion of a watershed

might take 10 years to essentially build-out, while another might take 100 years or more.

3. The impervious surface coverage analyses presume that all development within a zone occur at the maximum impervious coverage permitted within the zone. Although it would be reasonable to assume an average impervious coverage, the maximum permitted impervious coverage is the extreme. Furthermore, many municipal land use zones do not specify a maximum impervious coverage and an assumption must be used that may not be optimal (similar zones in other municipalities within the County were used to estimate impervious coverage).

4. The NJDEP presented very little information about the origin and conditions that apply to their land cover pollutant loading coefficients for total phosphorus, total nitrogen and total suspended solids. For example, what are the climatic, soils, hydrologic, geologic, topographic, and vegetative conditions that these coefficients represent, and even more importantly, what stormwater runoff controls were employed that generated these coefficients? Without this information, it is not possible to fully understand the implications of pollutant loadings using these coefficients. The methodology is highly sensitive to these coefficients.

5. Because the NJDEP's methodology projects pollutant loadings for only three parameters, total phosphorus, total nitrogen and total suspended solids, the pollutant loading projections are biased against agricultural land uses. For example, changes in land use from agriculture to low density rural development occurs throughout much of Gloucester County. The NJDEP's pollutant loading coefficients for agriculture are two to three times greater than those for low density residential development. The resulting annual pollutant loadings will then be two to three times lower for land transitioning from agriculture to residential development.

   This might be misconstrued to imply that the loss of agricultural lands to residential development is somehow desirable. Furthermore, because of the significant amount of agricultural land in some municipalities and watersheds in Gloucester County, the method makes residentially and commercially developed municipalities and watersheds appear less prone to the impacts of nonpoint source pollution, which is not the case.

   In Gloucester County and other similar areas in New Jersey, agriculture is recognized as being fundamentally important and vital to society, and as such the County does not advocate transitioning from agricultural land uses to residential or other more intense forms of development.

6. The NJDEP's land cover coefficients do not appear to consider or incorporate the new stormwater management techniques now required by the new New Jersey stormwater regulations and the new LID BMP strategies. Furthermore, most

municipalities have required some form of stormwater runoff control in new development for 20 years or more. The NJDEP land cover coefficients may, therefore, be very conservative with respect to present development conditions and greatly overestimate the adverse impacts at build-out.

7. In addition to nitrogen, phosphorous and suspended solids there are a number of other pollutants associated with non-point source pollution and stormwater runoff from development. These include among other parameters, petroleum hydrocarbons, metals and pathogenic organisms which are not currently accounted for by the NJDEP's methodology.

8. Malfunctioning and/or inadequate onsite wastewater disposal systems are believed to be a major source of non-point pollution. The NJDEP's method does not account for pollution resulting from onsite systems.

Despite these reservations, the build-out analyses and pollutant loading projections are valuable tools for assessing the potential impacts from development and stormwater runoff. The build out analyses and pollutant loading projections in Gloucester County have been developed with the flexibility to easily adjust the pollutant loading coefficients, zoning and other elements of the analyses and projections. The County utilized powerful GIS data management and mapping software to perform these analyses and create this flexibility for each municipality, HUC14 and Watershed. In the future, municipalities and the County may choose to make adjustments that will better project the impacts of stormwater runoff and development.

The following GIS-based method was used for the build-out analyses and pollutant loading projections and to prepare the figures presented in this report.

1. Using GIS digital coverages from the NJDEP and DVRPC (existing land use), the eight Watersheds, 54 HUC14 areas and the 24 municipalities within the County were identified, their boundaries delineated and the results saved as a GIS feature layers. ESRI's ArcGIS mapping software was then used to provide the land areas of existing land uses within each of the HUC14s, watersheds and municipalities.

2. Using the Gloucester County Planning Department's GIS data, municipal zoning areas were integrated with the HUC14 drainage areas to establish the zoning within each municipality and HUC14 drainage area. Municipal zoning is highly variable throughout the County. A "crosswalk" was used to associate all municipal zones with the zones provided by the NJDEP for pollutant loading projections.

3. Existing (present) impervious land coverage was determined for each HUC14 and municipality using aerial mapping techniques.

4. Constrained areas were determined from the NJDEP's and the County's GIS coverages, including surficial water bodies, wetland areas, Category One resource

protection areas and their associated 300 foot buffers, designated open space and protected park areas. These were saved as GIS feature layers and integrated with the existing land use, HUC14 and municipal zoning feature layers. The build-out amount of impervious land coverage within each HUC14 and municipality was then calculated from the zoning layer.

Build-out land areas available for new development and redevelopment were calculated by subtracting the constrained areas from the developable areas based on zoning for each HUC14, Watershed and municipality. In essence, the land available for new development is agricultural, forest and/or barren lands and the land available for redevelopment consists of the existing residential, commercial and industrially zoned areas.

5. The build-out (future) impervious surface coverage was calculated by multiplying build-out land areas available for new development and redevelopment by the maximum impervious surface coverage, using (whenever available) the maximum impervious surface coverage percentages specified within each municipal zoning ordinance for that area.

6. Pollutant loading projections were calculated for each municipality and HUC14, using the pollutant loading coefficients provided by the NJDEP Stormwater BMP Manual and shown in Table 9. Pollutant loading projections were made for all 24 municipalities, 54 HUC14s and the eight Watersheds for both the existing land use (present) and build-out (future) conditions.

Table 9. Pollutant Loads For Various Land Cover Types

Land Cover	Total Phosphorus Load (lbs/acre/year)	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 Urban, Other Urban	1.0	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.

EAST GREENWICH TOWNSHIP

Build-Out, Impervious Cover and Pollutant Loading Projections

The results of the East Greenwich Township Build-out analysis, including the existing and build-out (future) conditions, are presented in Table 10. This table provides the total area, constrained area, and developable area in acres for each HUC14 within East Greenwich Township.

Table 10 also provides the impervious areas in acres and percent for both existing and build-out conditions, in order to allow comparison of the results for these conditions. In general, impervious percentages greater than about 10 to 15 percent may indicate potential watershed impairment from stormwater and development. The total pollutant loadings for phosphorous, nitrogen and total suspended solids are projected in pounds per year for both the existing and build-out conditions, in order to allow comparison of the pollutant loadings.

Included in this plan and in the New Jersey Stormwater Management Regulations and guidance are strategies to minimize, manage and/or mitigate build-out impacts, through improved stormwater management and construction practices. In addition, modifications to current land use and zoning will change the build-out impacts and the County's GIS can be used to evaluate the results of such changes.

Table 10. East Greenwich Township Pollutant Loading Projections

Watershed	HUC14 Sub-Watershed		Area (Acres)			Impervious Area				Total Pollutant Load (Lbs/Year)					
	No.	Name	Total	Constrained	Developable	Acres		Percent		Phosphorus		Nitrogen		Total Suspended Solids	
						Existing	Build-Out	Existing	Build-Out	Existing	Build-Out	Existing	Build-Out	Existing	Build-Out
Mantua Creek Watershed	02040202130040	Mantua Creek (Edwards Run to road to Sewell)	184.29	62.94	121.36	5.70	42.47	3.09%	23.05%	73.0	169.9	713.8	1,820.4	16,159	16,990
	02040202130050	Edwards Run	1,236.65	248.54	988.10	66.67	313.54	5.39%	25.35%	846.3	863.4	7,374.1	8,315.0	180,335	112,451
	02040202130060	Mantua Creek (below Edwards Run)	1,090.39	395.70	694.69	109.98	293.02	10.09%	26.87%	585.3	854.4	5,189.2	8,657.9	110,335	95,438
		Sub-Total	**2,511.33**	**707.18**	**1,804.15**	**182.35**	**649.03**	**7.26%**	**25.84%**	**1,504.57**	**1,887.78**	**13,277.05**	**18,793.22**	**306,828.88**	**224,878.37**
Repaupo Creek Watershed	02040202140010	Nehonsey Bk/Clonmell Creek (Lower Delaware River to Mantua Creek)	1,909.43	744.07	1,165.35	167.89	512.75	8.79%	26.85%	1,101.5	1,490.4	9,383.9	15,142.5	217,693	164,564
	02040202140020	Still Run/London Br (above Tomlin Station Rd)	3,523.98	716.58	2,807.41	156.12	971.02	4.43%	27.55%	2,929.0	2,163.2	23,689.0	19,693.4	653,403	319,128
	02040202140030	Pargay Creek	1,598.60	319.73	1,278.86	57.28	390.36	3.58%	24.42%	1,392.7	792.1	11,101.9	6,675.5	314,628	129,541
		Sub-Total	**7,032.01**	**1,780.38**	**5,251.62**	**381.29**	**1,874.13**	**5.42%**	**26.65%**	**5,423.21**	**4,445.79**	**44,174.86**	**41,511.45**	**1,185,724.08**	**613,232.82**
		Total	**9,543.34**	**2,487.56**	**7,055.77**	**563.64**	**2,523.16**	**5.91%**	**26.44%**	**6,927.78**	**6,333.57**	**57,451.91**	**60,304.67**	**1,492,552.96**	**838,111.19**

REPAUPO CROOK WATERSHED

Build-out, Impervious Cover and Pollutant Loading Projections

The Repaupo Creek Watershed is located in the central western portion of Gloucester County. These build-out projections include Gloucester County municipalities and their relative contribution (area) to the watershed: East Greenwich Township (30%), Logan Township (29%), Greenwich Township (26%), Woolwich Township (9%), Harrison Township (3%), Mantua Township (2%), and Paulsboro Borough (2%). Figure RE-7 (see Appendix A) shows the existing land use, based on DVRPC 2000 land use data. Figure RE-8 (see Appendix A) shows the constrained areas in the watershed.

The watershed is largely undeveloped; approximately 40 percent is agriculture and approximately 30 percent is wooded land. The results of the Repaupo Creek Watershed build-out analysis, including both existing and build-out (future) conditions, are presented in Table RE-4. This table provides the total area, constrained area, and developable area in acres for each HUC14 within the watershed and County.

Table RE-4 also provides the impervious areas in both acres and percent for existing and build-out conditions, in order to allow comparison of the results. In general, impervious percentages greater than about 10 to 15 percent may indicate potential watershed impairment from stormwater and development. The total pollutant loadings for phosphorous, nitrogen and total suspended solids are projected in pounds per year for both the existing and build-out conditions, in order to allow comparison of the pollutant loadings.

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Municipality	HUC14 Sub- No.		Total Pollutant Load (Lbs/Year)				
				Nitrogen		Total Suspended Solids	
			-Out	Existing	Build-Out	Existing	Build-Out
East Greenwich Twp	02040202140010	Nehonsey Brook/C River to Mantua C	,490	9,384	15,143	217,693	164,564
	02040202140020	Still Run/London	,163	23,689	19,693	653,403	319,128
	02040202140030	Pargay Creek	792	11,102	6,676	314,628	129,541
		Sub-Total	**,446**	**44,175**	**41,511**	**1,185,724**	**613,233**
Greenwich Twp	02040202140010	Nehonsey Brook/C River to Mantua C	,540	10,403	16,422	159,625	171,804
	02040202140020	Still Run/London	371	2,132	3,918	54,905	35,949
	02040202140030	Pargay Creek	106	511	1,107	14,802	10,068
	02040202140050	Repaupo Creek (b Swamp	11	35	114	536	1,299
		Sub-Total	**,028**	**13,080**	**21,562**	**229,868**	**219,119**
Harrison Twp	02040202140020	Still Run/London	11	69	106	1,890	1,240
	02040202140030	Pargay Creek	381	4,312	3,470	120,062	54,249
		Sub-Total	**392**	**4,381**	**3,576**	**121,952**	**55,490**
Logan Twp	02040202140030	Pargay Creek	228	2,820	2,016	77,674	34,066
	02040202140040	Moss Branch/Littl	,555	15,458	14,816	409,809	206,314
	02040202140050	Repaupo Creek (b Swamp	487	2,845	4,990	45,070	53,266
		Sub-Total	**,269**	**21,123**	**21,822**	**532,552**	**293,646**
Mantua Twp	02040202140020	Still Run/London	224	3,227	1,876	93,199	37,176
	02040202140030	Pargay Creek	28	453	231	13,514	4,629
		Sub-Total	**252**	**3,680**	**2,107**	**106,713**	**41,806**
Paulsboro Boro	02040202140010	Nehonsey Brook/C River to Mantua C	343	2,194	3,645	29,045	36,586
Woolwich Twp	02040202140030	Pargay Creek	805	4,505	8,572	129,318	79,420
	02040202140040	Moss Branch/Littl	,994	11,822	21,267	324,751	197,417
		Sub-Total	**,800**	**16,327**	**29,839**	**454,069**	**276,838**
		Total					

MANTUA CREEK WATERSHED

Build-out, Impervious Cover and Pollutant Loading Projections

The Mantua Creek watershed is located in the central western portion of Gloucester County. These build-out projections include Gloucester County municipalities and their relative contribution to the watershed: Mantua Township (31%), Washington Township (20%), Deptford Township (11%), Harrison Township (8%), East Greenwich Township (8%), West Deptford Township (8%), Harrison Township (5%), Pitman Borough (5%), Paulsboro Borough (3%), Wenonah Borough (2%), Greenwich Township (.3%), Monroe Township (.3%), and Woodbury Heights Borough (.2%). Figure MC-7 (see Appendix A) shows the existing land use, based on DVRPC 2000 land use data. Figure MC-8 (see Appendix A) shows the constrained areas in the watershed.

The watershed is partially developed and Mantua, Washington and Deptford Townships are expected to develop further in the future. The results of the Mantua Creek Watershed build-out analysis, including both existing and build-out (future) conditions, are presented in Table MC-4. This table provides the total area, constrained area, and developable area in acres for each HUC14 within the watershed and County.

Table MC-4 also provides the impervious areas in both acres and percent for existing and build-out conditions, in order to allow comparison of the results. In general, impervious percentages greater than about 10 to 15 percent may indicate potential watershed impairment from stormwater and development. The total pollutant loadings for phosphorous, nitrogen and total suspended solids are projected in pounds per year for both the existing and build-out conditions, in order to allow comparison of the pollutant loadings.

Table MC-4. Mantua Creek Watershed Pollutant Loading Projections

Municipality	HUC14 Sub-Watershed		Area (Acres)			Impervious Area				Total Pollutant Load (Lbs/Year)					
	No.	Name	Total	Constrained	Developable	Acres		Percent		Phosphorus		Nitrogen		Total Suspended Solids	
						Existing	Build-Out	Existing	Build-Out	Existing	Build-Out	Existing	Build-Out	Existing	Build-Out
Deptford Twp	02040202130020	Mantua Creek (Sewell Road to Rte. 47)	120.24	23.94	96.30	3.85	45.53	3.20%	37.87%	94	77	790	720	20,467	10,583
	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	3,403.39	436.74	2,966.64	447.80	1,374.58	13.16%	40.39%	2,187	3,690	20,952	37,701	362,776	406,912
	02040202130060	Mantua Creek (below Edwards Run)	1.15	0.00	1.15	1.04	0.92	90.43%	80.00%	2	2	22	25	211	230
		Sub-Total	**3,524.78**	**460.68**	**3,064.09**	**452.69**	**1,421.03**	**12.84%**	**40.32%**	**2,283**	**3,770**	**21,764**	**38,446**	**383,454**	**417,725**
East Greenwich Twp	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	184.29	62.94	121.36	5.70	42.47	3.09%	23.05%	73	170	714	1,820	16,159	16,990
	02040202130050	Edwards Run	1,236.65	248.54	988.10	66.67	313.54	5.39%	25.35%	846	863	7,374	8,315	180,335	112,451
	02040202130060	Mantua Creek (below Edwards Run)	1,090.39	395.70	694.69	109.98	293.02	10.09%	26.87%	585	854	5,189	8,658	110,335	95,438
		Sub-Total	**2,511.33**	**707.18**	**1,804.15**	**182.35**	**649.03**	**7.26%**	**25.84%**	**1,505**	**1,888**	**13,277**	**18,793**	**306,829**	**224,878**
Glassboro Boro	02040202130010	Mantua Creek (above Rte. 47)	1,191.56	187.75	1,003.78	312.49	440.91	26.23%	37.00%	844	1,489	8,073	15,873	124,744	148,059
	02040202130020	Mantua Creek (Sewell Road to Rte. 47)	1.39	0.58	0.80	0.80	0.32	57.55%	23.02%	1	1	7	12	80	112
	02040202130030	Chestnut Branch (above Sewell)	1,416.80	137.40	1,279.40	351.65	537.32	24.82%	37.92%	1,030	1,541	9,909	15,847	151,786	169,667
		Sub-Total	**2,609.75**	**325.73**	**2,283.98**	**664.94**	**978.55**	**25.48%**	**37.50%**	**1,874**	**3,031**	**17,989**	**31,733**	**276,611**	**317,838**
Harristown Twp	02040202130030	Chestnut Branch (above Sewell)	327.59	15.67	311.92	27.73	228.21	8.46%	69.66%	371	637	3,050	6,659	77,623	61,129
	02040202130050	Edwards Run	1,167.15	125.05	1,042.10	70.14	204.25	6.01%	17.50%	931	703	7,779	6,120	203,985	109,085
		Sub-Total	**1,494.74**	**140.72**	**1,354.02**	**97.87**	**432.46**	**6.55%**	**28.93%**	**1,302**	**1,340**	**10,829**	**12,778**	**281,608**	**170,214**
Mantua Twp	02040202130020	Mantua Creek (Sewell Road to Rte. 47)	782.02	89.06	692.97	108.23	331.03	13.84%	42.33%	560	951	5,596	9,644	95,094	103,374
	02040202130030	Chestnut Branch (above Sewell)	2,340.22	496.28	1,843.93	209.50	735.60	8.95%	31.43%	1,385	2,065	12,894	20,666	253,695	249,585
	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	2,626.31	371.56	2,254.74	320.60	807.82	12.21%	30.76%	1,543	2,739	15,147	28,365	258,007	304,663
	02040202130050	Edwards Run	4,094.62	552.07	3,542.57	222.47	1,003.49	5.43%	24.51%	3,087	2,746	26,734	25,186	653,715	389,295
		Sub-Total	**9,843.17**	**1,508.97**	**8,334.21**	**860.80**	**2,877.94**	**8.75%**	**29.24%**	**6,574**	**8,500**	**60,371**	**83,861**	**1,260,511**	**1,046,917**
Monroe Twp	02040202130010	Mantua Creek (above Rte. 47)	79.74	14.56	65.18	3.03	16.30	3.80%	20.44%	47	91	436	978	9,917	9,126
Pitman Boro	02040202130010	Mantua Creek (above Rte. 47)	90.34	1.00	89.33	24.65	28.01	27.29%	31.01%	57	125	503	1,340	8,921	12,506
	02040202130020	Mantua Creek (Sewell Road to Rte. 47)	421.05	22.35	398.72	104.27	168.14	24.76%	39.93%	336	593	3,295	6,313	45,763	62,592
	02040202130030	Chestnut Branch (above Sewell)	929.74	104.53	825.19	231.84	313.80	24.94%	33.75%	583	1,136	5,405	12,028	88,852	120,385
		Sub-Total	**1,441.13**	**127.88**	**1,313.24**	**360.76**	**509.95**	**25.03%**	**35.39%**	**976**	**1,854**	**9,204**	**19,681**	**143,536**	**195,483**
Washington Twp	02040202130010	Mantua Creek (above Rte. 47)	2,511.58	327.95	2,183.64	487.97	599.03	19.43%	23.85%	1,712	2,234	15,563	22,293	282,831	266,956
	02040202130020	Mantua Creek (Sewell Road to Rte. 47)	3,826.24	827.69	2,998.55	666.63	787.35	17.42%	20.58%	2,320	3,870	21,998	39,760	366,607	428,725
	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	49.73	0.95	48.78	7.12	22.52	14.32%	45.28%	79	93	812	977	8,596	9,757
		Sub-Total	**6,387.55**	**1,156.59**	**5,230.97**	**1,161.72**	**1,408.90**	**18.19%**	**22.06%**	**4,111**	**6,196**	**38,373**	**63,030**	**658,034**	**705,437**
Wenonah Boro	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	645.49	111.99	533.49	112.02	203.16	17.35%	31.47%	306	645	2,861	6,927	49,946	68,080
West Deptford Twp	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	633.56	122.35	511.20	90.52	198.61	14.29%	31.35%	445	559	4,192	5,696	78,150	63,893
	02040202130060	Mantua Creek (below Edwards Run)	1,779.62	712.31	1,067.29	161.88	549.62	9.10%	30.88%	1,016	1,359	9,718	14,164	175,124	163,216
		Sub-Total	**2,413.18**	**834.66**	**1,578.49**	**252.40**	**748.23**	**10.46%**	**31.01%**	**1,460**	**1,918**	**13,910**	**19,860**	**253,274**	**227,109**
Greenwich Township	02040202130060	Mantua Creek (below Edwards Run)	90.35	0.98	89.38	39.93	65.28	44.19%	72.25%	120	133	1,268	1,416	15,871	17,046
Paulsboro	02040202130060	Mantua Creek (below Edwards Run)	980.53	420.70	559.83	157.02	320.90	16.01%	32.73%	464	843	4,458	8,990	64,594	91,107
Woodbury Heights Boro	02040202130040	Mantua Creek (Edwards Run to Sewell Rd)	77.24	6.26	70.98	12.70	29.67	16.44%	38.41%	42	101	421	1,081	6,454	10,902
		Total	**32,098.98**	**5,816.90**	**26,282.01**	**4,358.23**	**9,661.40**	**13.58%**	**30.10%**	**21,062**	**30,310**	**195,160**	**307,574**	**3,710,638**	**3,501,861**

Section 6. Design and Performance Standards

East Greenwich Township must amend its land use ordinances to incorporate the design and performance standards for stormwater management measures as presented in N.J.A.C. 7:8-5, to minimize the adverse impact of stormwater runoff on water quality and water quantity and loss of groundwater recharge in receiving water bodies. This requirement will be met by adopting a Municipal Stormwater Control Ordinance that meets these requirements or by amending an existing stormwater control ordinance to meet these requirements.

The design and performance standards in the adopted or amended ordinance must include the language for maintenance of stormwater management measures consistent with the stormwater management rules at N.J.A.C. 7:8-5.8 Maintenance Requirements, and language for safety standards consistent with N.J.A.C. 7:8-6 Safety Standards for Stormwater Management Basins.

After adoption or amendment of the ordinance, it must be submitted to the County, along with this MSWMP, for approval.

Furthermore, during construction of major development within East Greenwich Township, municipal inspectors must observe the construction of stormwater management measures to ensure that they are constructed and function as designed.

The New Jersey stormwater design and performance standards represent an initial effort to control non-point sources of pollution and to improve groundwater recharge. The effective control of point sources of pollution took many years. The USEPA and the NJDEP believe that further water quality improvements can now best be achieved by controlling non-point sources of pollution and stormwater runoff.

New stormwater management measures and design and performance standards will emerge over the ensuing years. The stormwater rules, NJPDES stormwater permits, and municipal stormwater plans and ordinances will similarly evolve and require amendments. Municipalities will be expected to control stormwater runoff, to improve or maintain surface water quality and groundwater recharge and to continue to utilize appropriate stormwater design and performance standards to achieve this goal.

With the increasing emphasis on non-point source pollution and concerns over the adverse impacts of uncontrolled land development, effective alternatives to the centralized stormwater conveyance and treatment strategies have been developed that are the basis for many of the new stormwater management standards in the State. New strategies have been developed to minimize and even prevent adverse stormwater runoff impacts from occurring.

Such strategies, known collectively as Low Impact Development techniques or LIDs, reduce and/or prevent adverse runoff impacts through sound site planning and both nonstructural and structural techniques that preserve or closely mimic a site's natural or pre-developed hydrologic response to precipitation. These new stormwater management strategies are explained in more detail in Section 8 of this MSWMP.

Section 7. Plan Consistency

There are no approved Regional Stormwater Management Plans (RSWMPs) in Gloucester County at this time. However, Regional Stormwater Management Planning is being conducted by the County Planning Department, NJ Soil Conservation Districts/Program and Rowan University in portions of a number of the County's watersheds. These include portions of the Maurice River (upper portions, including Scotland Run, Little Ease Run and Still Run), Raccoon Creek (upper portions) and Mantua Creek (Chestnut Branch).

The Gloucester County Stormwater Management Program is working closely with these regional efforts. When these or any future RSWMPs are approved by the appropriate regional water quality management planning agency and NJDEP, and adopted as part of the regional water quality management plan, the new New Jersey stormwater management regulations require that municipal stormwater management plans be revised to provide consistency.

Presently, TMDLs have been proposed for certain surface water bodies in Gloucester County. Section 4 of this MSWMP addresses impaired surface waters, TMDLs and supporting surface water quality data. When these ongoing TMDL proposals or any future TMDLs proposals are finally approved, the new New Jersey stormwater management regulations require that municipal stormwater management plans be revised to provide consistency.

The East Greenwich Township MSWMP is consistent with the Residential Site Improvement Standards (RSIS) at N.J.A.C. 5:21. East Greenwich Township will utilize the most current update of the RSIS in the stormwater management review of residential areas. This Municipal Stormwater Management Plan will be updated to be consistent with any future updates to the RSIS.

Furthermore, East Greenwich Township's stormwater management ordinance(s) will require all new development and redevelopment plans to comply with New Jersey's Soil Erosion and Sediment Control Standards. During construction, municipal inspectors will observe on-site soil erosion and sediment control measures and report any inconsistencies to the Gloucester County Soil Conservation District.

Section 8. Stormwater Management Strategies

Low Impact Development Techniques

The NJDEP's new Stormwater Management Rules include the specific provisions that must be addressed in a municipal stormwater management plan (N.J.A.C. 7:8-4.2(c)). One of these requirements is that the plan include an evaluation of the extent to which the master plan (including the land use element), official map, and development regulations (including zoning ordinances) implement the principles of the Stormwater Management Rules relating to nonstructural stormwater management strategies (N.J.A.C. 7:8-5.3(b)).

New stormwater management techniques have been developed that minimize and prevent adverse stormwater effects from land disturbance. These techniques are referred to by the NJDEP as Low Impact Development techniques (LIDs) and include both nonstructural and structural Best Management Practices (BMPs). LID-BMPs first minimize quantitative and qualitative changes to a site's pre-developed hydrology (i.e., employ nonstructural techniques first) and then provide stormwater management through smaller sized structural techniques distributed throughout the site. The link to the NJDEP website to download the BMP Manual is:

http://www.njstormwater.org/bmp_manual2.htm

Nonstructural LID-BMPs include such practices as minimizing site disturbance, preserving important site features, reducing and disconnecting impervious cover, flattening slopes, utilizing native vegetation, minimizing turf grass lawns and maintaining natural drainage features. It may be possible at some sites to satisfy all stormwater management requirements through nonstructural LID-BMPs. Structural BMPs are considered LIDs if they are located close to the source of runoff. Structural LID-BMPs include various types of basins, filters, devices and permeable surfaces located within residential lots and otherwise throughout residential, commercial, industrial or institutional development.

Because LIDs rely on nonstructural or relatively small structural BMPs distributed throughout a land development site, ownership and maintenance may be similarly distributed to an array of property owners. The new Stormwater Management rule requires the use of deed restrictions for LID-BMPs to ensure that property owners fully recognize, understand and support the continuing use of LID-BMPs for stormwater management.

The NJDEP believes that effective, state-wide use of such practices can best be achieved through modifications to municipal master plans and land use ordinances to include LID goals and to provide for the use of specific LID-BMPs. The Stormwater Management Rules require municipalities to review their master plans and ordinances in order to incorporate LID techniques to the maximum extent practicable.

The NJDEP Stormwater Management Rules (N.J.A.C. 7:8) require, in Section 5.2(a) that Major Development (disturbing one acre or more or increasing impervious surface by 1/4 acre) incorporate nonstructural stormwater management strategies "to the maximum extent practicable." Nonstructural LID-BMPs are to be given preference over structural BMPs. Where it is not possible to fully comply with the Stormwater Management Rules through nonstructural LIDs, structural LID-BMPs are to be used in conjunction with standard structural BMPs to meet the Rules' requirements.

N.J.A.C. 7:8-5 further requires that an applicant seeking approval for major development or redevelopment specifically identify which and how these nine nonstructural strategies are incorporated or provide an engineering, environmental, or safety reason for their non-incorporation.

The NJ BMP manual contains a LID checklist which planning boards and development applicants can use to ensure LID techniques are being applied. This checklist is available in Appendix D.

(a) Nonstructural LID-BMPs

The NJDEP's new Stormwater rule's design and performance standards require the maximum possible use of nine nonstructural strategies.

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 low maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides.
8. Provide vegetated open-channel conveyance systems discharge into and through stable vegetated areas.
9. Provide preventative source controls.

The nonstructural LID-BMPs have been grouped by the NJDEP into four general categories:

I. **Vegetation and Landscaping** – reduces runoff volumes and peaks through infiltration, surface storage, and evapotranspiration, provides pervious surface for groundwater recharge and removes pollutants from stormwater. Key techniques include:

A. **Preservation of Natural Areas** – preserve areas with significant hydrologic functions including forested areas, riparian corridors and soils/geology with high recharge potential.
B. **Native Ground Cover** – reduce the use of turf grass and preserve areas that naturally minimize runoff.
C. **Vegetative Filters and Buffers** – provide native ground cover and grass areas to filter stormwater runoff from pervious areas and to provide locations for runoff to infiltrate.

II. **Minimizing Land Disturbance** – reduces runoff volume and pollutant loads and maintains existing recharge rates and other hydrologic functions. Key techniques include:

A. Planning and design to fit the development to the terrain, limiting clearing and grading.
B. Evaluating site conditions and constraints including soil types, geology, topography, slopes, drainage areas, wetlands, and floodplains to maintain high recharge areas and provide runoff storage areas.
C. Utilizing construction techniques that limit disturbance and soil compaction.
D. Restricting the future expansion of buildings and other improvements that will adversely affect runoff volumes and rates or recharge rates.

III. **Impervious Area Management** – reduces water quality impacts, runoff volume and peak rates, runoff velocity, erosion and flooding. Key techniques include:

A. **Streets** – use minimum acceptable pavement widths and incorporate pervious vegetated medians and islands with curb cuts for runoff access.
B. **Sidewalks** – use pervious pavement with infiltration storage beneath and disconnect from the street drainage system.
C. **Parking and Driveways** – use pervious pavement wherever practical **and** reduce parking space requirements by sharing requirements in mixed uses and by reducing parking space lengths by allowing for overhang into pervious areas.
D. **Pervious Paving Materials** – Use pervious materials in parking spaces, driveways, access roadways and sidewalks, including pavers, porous pavement and gravel.
E. **Unconnected Impervious Areas** – Disconnect impervious areas and runoff form the site's drainage system allowing the sheet flow to cross pervious areas through curb cuts or by eliminating curbing and using shoulders and swales.
F. **Vegetated Roofs** – install lightweight vegetative planting beds on new or existing roofs.

IV. **Time of Concentration Modification** – minimize reductions to the time of concentration caused by changes in hydrologic characteristics in order to minimize the peak runoff rate. Key techniques include:

A. **Surface Roughness Changes** – increase surface roughness through the use of land cover and decrease the amount of connected smooth surfaces in order to increase runoff travel time throughout the drainage area.
B. **Slope Reduction** – reduce slopes in graded areas and/or provide terraces and reduced slope channels to increase runoff travel length and time.
C. **Vegetated Conveyance** – use vegetated channels and swales to increase roughness and runoff travel time and to provide opportunities for runoff treatment and infiltration.

In order to assure to the maximum extent possible the use of Nonstructural LIDs in new major development, the NJDEP prepared a Nonstructural Strategies Evaluation Worksheet, and this worksheet is included in Appendix D.

(b) Structural LID-BMPs

In addition to these nonstructural LID-BMPs, structural stormwater management measures can be LID-BMPs. These structural BMPs become LID-BMPs by storing, infiltrating, and/or treating runoff close to the source of the stormwater. Unlike standard structural BMPs that are located along a site's drainage system, structural LID-BMPs are normally dispersed throughout a development and more closely mimic the hydrology. LID-BMPs are typically standard structural BMPs, but their location, closer to the runoff source, allows them to be smaller in size. Standard structural BMPs that can be implemented at a LID scale include: drywells, infiltration systems, bioretention basins, and both surface and subsurface detention basins; downsized, to address stormwater close to its source as LIDs.

There are a number of structural stormwater BMPs that may be used to address the groundwater recharge and stormwater quality and quantity requirements of the NJDEP Stormwater Management Rules in N.J.A.C. 7:8. The structural BMPs include the following techniques (see also *New Jersey Stormwater Best Management Practices Manual,* February 2004, which includes the planning, design, construction, and maintenance guidelines for these structural BMPs):

1. Bioretention Systems
2. Constructed Stormwater Wetlands
3. Dry Wells
4. Extended Detention Basins
5. Infiltration Basins
6. Manufactured Treatment Devices
7. Pervious Paving Systems
8. Rooftop Vegetated Cover
9. Sand Filters

10. Vegetative Filters
11. Wet Ponds

Other BMPs that possess similar levels of effectiveness, efficiency, and endurance may also be utilized, provided that such levels can be demonstrated.

East Greenwich Township will review the Master Plan and local land use ordinances and incorporate structural stormwater management strategies (LID and standard structural stormwater BMPs) to the extent practicable and in accordance with sound planning, science, engineering and construction principles, as they apply to its unique environment.

Other Stormwater Management Strategies

REPAUPO CREEK WATERSHED

(a) Gloucester County Stormwater Management Program's Watershed Workshop

The Gloucester County Stormwater Management Program held a Repaupo Creek Watershed workshop, inviting representatives from each municipality in the watershed to an evening discussion of stormwater management issues and strategies.

- **Levees and Tide Gates:** An extensive levee and tide gate system exists along the Delaware River from Repaupo Creek north, preventing the water in the Delaware from entering Repaupo Creek and protecting Gibbstown from flooding. Gibbstown's location along the Delaware River, places it in a particularly vulnerable position. Further evaluation of flooding potential in this area of the watershed is warranted, particularly in lieu of potential future sea level increases.

(b) Regional Stormwater Management Planning

There is no Regional Stormwater Management Plan (RSWMP) for the Repaupo Creek Watershed. The Gloucester Soil Conservation District (GSCD) with the New Jersey Department of Agriculture, State Soil Conservation Committee (SSCC) and the Burlington, Camden and Cape-Atlantic Soil Conservation Districts prepared an Upper Maurice River Regional Stormwater Management Plan dated October 2004 and a Draft Characterization and Assessment (C&A) for the Raccoon Creek Watershed. The Maurice River and Raccoon Creek watersheds are adjacent to the Repaupo Creek Watershed. Conditions in the Repaupo Creek Watershed, particularly in the less developed upper portions, are sufficiently similar to those in the Raccoon Creek and Maurice River Watersheds to permit some extrapolation of applicable stormwater management strategies.

The regional stormwater management strategies proposed for the Repaupo Creek Watershed are described below:

- **Stormwater Recharge**: Changes in land use from rural agricultural to emerging suburban/urban development invariably alter the natural runoff and infiltration capabilities of the soil. As the landscape is altered in the construction process, the natural soil horizons are disturbed, forested areas are removed and the capacity of the soils in the post-development condition to mimic pre-development water retention and infiltration is severely impaired and reduced. This reduction results in increased overland flow, a decrease in retained moisture, and ultimately reduction in stream base flow. Stormwater recharge through infiltration or in combination with detention should be used as much as possible for stormwater management.

- **Low Impact Development Techniques** – Low Impact Development (LID) techniques provide a variety of stormwater control measures to maintain or restore the pre-developed hydrologic characteristics of a site. (See LID recommendations above)

- **Deicing Sand:** Sand used during snow storms makes its way to stormwater inlets, pipes and outfalls, where it causes both hydraulic and water quality problems. In order to reduce the maintenance costs from cleaning sand from stormwater facilities and to reduce the suspended solids loading to streams, municipalities can minimize or eliminate the use of sand for snow storms.

  The Gloucester County Stormwater Program includes an extensive anti-icing and deicing component for Gloucester County's municipalities and the County Highway Division. The program includes the provision of salt storage sheds and liquid anti-icing and deicing agents in bulk storage at five locations throughout the County, as well as liquid application equipment for county and municipal salt trucks. An anti-icing and deicing education program is part of this effort. The County's program will help municipalities and the County Highway Division minimize or eliminate the use of sand for snow storms and also reduce the amount of salt used for deicing.

- **Geese Management**: Increasing geese populations have become a problem throughout both the suburban and rural portions of southern New Jersey. Stormwater detention ponds, grass and lawn areas and farm fields provide habitat for geese. Although the populations sometimes add to the areas aesthetics, there are adverse impacts to water quality and the land that result, especially with over population.

  The New Jersey Stormwater management regulations require municipalities to pass ordinances prohibiting the feeding of waterfowl. In addition, municipalities should encourage land cover types and practices in new development that discourage geese from resting, nesting and feeding in areas that would otherwise provide attractive habitat, such as stormwater management facilities. Changes to state and federal laws regarding hunting were discussed and recommended at the workshop.

- **Stormwater Basin and Existing Development Retrofit** – Older under-maintained stormwater basins may not adequately provide mitigation for the most frequently occurring rain storms nor provide stormwater quality treatment. To improve the

water quality and mitigate peak flows during these high frequency storms, existing stormwater basins can be retrofitted. Additionally, existing development retrofit strategies can be implemented during stormwater infrastructure improvements or as a separate retrofit project, including such techniques as roof water infiltration or reuse, stormwater inlet modifications, roadside rain gardens or infiltration structures and bio-retention facilities

- **Lake and Pond Management and Maintenance** – Ponds and lakes in the watershed provide significant aesthetic benefit, and these waterbodies reduce stream slopes, provide storage and attenuate peak runoff rates and serve as sediment basins, trapping sediment carried by the streams. They also provide a diverse aquatic habitat for certain species not found in streams. Programmatic management and maintenance of public and privately held lakes and ponds, including dam maintenance, dredging and vegetation management, is needed to sustain these benefits.

- **Stream and Streambank Stabilization** – Erosion is significantly accelerated by human activities and development in the watershed. Streambank erosion introduces excess sediment loads to the stream and in turn chokes lakes and ponds with sediment. Watershed-wide stream and stream bank restoration and stabilization priorities and guidelines should be adopted by all involved municipalities and agencies working in the watershed in order to improve water quality, upgrade in-stream and riparian habitat and reduce sedimentation in receiving waterbodies.

- **Stormwater Outfall Restoration** –Failing outfalls are a concern for public safety and they may contribute excess sediment to the receiving waterway. Degraded outfalls and resulting stream bank erosion will be identified during the Gloucester County Stormwater Management Program's outfall mapping and stream bank condition assessment efforts. Repairs can be prioritized throughout the watershed.

- **Well Head Protection Areas and Aquifer Outcrops**: Additional stormwater treatment may be needed for recharge in Well Head Protection Areas and/or aquifer outcrop areas, in order to prevent drinking water and ground water contamination. Further evaluation of stormwater recharge quality and the natural attenuation of contaminants are needed. State and federal assistance may be required for these evaluations.

- **Stormwater BMP Maintenance**: BMPs required by the new stormwater regulations require long term maintenance if they are to remain effective. The NJDEP's stormwater permits require municipalities to ensure and annually certify that this maintenance is being carried out. Municipalities and their planning boards must develop a method of securing the long term maintenance of these facilities and an inspection and/or certification process that will allow them to ensure maintenance and provide the annual certification.

(d) Water Quality-TMDL Stormwater Management Strategies

The NJDEP has proposed one TMDL to address impaired water bodies in this watershed. The full text of the proposal can be found and downloaded at the following link:

http://www.nj.gov/dep/watershedmgt/tmdl.htm#intro .

The TMDL was proposed for Still Run Creek at Mikleton in April 2003 for fecal coliform and is based on the 2002 Integrated Report. This TMDL was approved in September 2003, but has not yet been adopted. Because the predominant land use in the watershed is agriculture, the NJDEP suggests geese, livestock and septic systems as potential sources of fecal coliform contamination.

Fecal Coliform contamination may be derived from either point or non-point sources or both. Point sources generally involve sewage discharges. However, because sewage treatment plants have permits that require disinfection to levels well below water quality standards, the proposed TMDLs address non-point sources, involving stormwater runoff. These non-point stormwater sources include runoff from various land uses that transport fecal coliform from geese and other wildfowl, farms, and domestic pets to the receiving water. Non-point sources also include "illicit" sources, such as failing onsite disposal systems and the illegal connections of sanitary drains from buildings to storm sewers.

A number of stormwater management strategies were suggested in the TMDL fecal coliform proposal to remediate the affected waterways.

- **Phase II NJPDES Permits and the Municipal Stormwater Regulation Program**: Fecal coliform loadings may be reduced by the new requirements to enforce a pet waste ordinance and an ordinance prohibiting the feeding of wildfowl on public property. The NJPDES permit requirements also require the annual inspection and cleaning (if necessary) of catch basins, the performance of good housekeeping practices at maintenance yards and public education and employee training aimed at reducing non-point sources of pollution, including fecal coliform. Additional reductions in fecal coliform levels may result from the elimination of illicit connections and failing on-site sewage disposal systems. Fecal coliform contributions from agricultural activities can be controlled by the implementation of agricultural conservation management plans and best management practices.

- **Further Source Identification**: Monitoring is recommended to locate and identify significant sources of fecal coliform.

- **Agricultural BMPs:** The NJDEP's TMDL proposal recommends funding for the installation of agricultural BMPs.

- **Geese Management:** The NJDEP's TMDL proposal recommends encouragement of community based goose management programs.

MANTUA CREEK WATERSHED

(a) Gloucester County Stormwater Management Program's Watershed Workshop

The Gloucester County Stormwater Management Program held a Mantua Creek Watershed workshop, inviting representatives from each municipality in the watershed to an evening discussion of stormwater management issues and strategies. The resulting issues and recommended strategies are presented below.

- **Localized Flooding and Stormwater Infrastructure Maintenance**: Localized flooding occurs at a number of locations in the watershed, including Delsea Drive in Glassboro, north of Pitman-Downer Drive (Mars Court) in Washington Township, the Westville Oaks area between Peach, Gilbert and Florence roads in Deptford, and Chestnut Branch in Glassboro near Rowan University. Furthermore, there are floodgates on Mantua Creek at the Delaware River behind the Hercules industrial facility that are critical elements in the watershed's flood protection and security. Localized flooding occurs about one to four times per year and sometimes reaches a few feet in depth.

  A number of the flooding problems are thought to be the result of siltation and obstructions in culverts and stream channels. Particularly at locations where state, county and municipal roadways intersect, runoff from state and county roadways sometimes becomes a burden to local roads and stormwater systems, and ownership and responsibility for its management is sometimes unclear and neglected.

  The new New Jersey stormwater regulations and the design and performance standards, address this issue for all new major development (defined as projects that disturb one or more acres of land or increase the amount of impervious surface by one-quarter acre or more), including new roadway construction and reconstruction. State, County and local roadway agencies must comply with these new regulations and control their stormwater runoff accordingly. Unfortunately, the new regulations can not resolve already existing, localized roadway flooding.

  Most municipalities and the County Highway Division do not have plans or maps of their stormwater system, nor is there a method in place for State, County or local agencies to share stormwater system information, even though these systems must frequently work together. Furthermore, there are typically few if any systems for inspecting and recording the stormwater system's condition or maintenance activities.

  The Gloucester County Stormwater Program includes an extensive outfall mapping component for Gloucester County's municipalities and the County Highway Division. The program is using GPS dataloggers to map and record data in a digital format for stormwater outfalls throughout the County. The County program will produce outfall

maps for each municipality and the County Highway Division and the County program is storing the digital data in a GIS for easy sharing, updates and retrieval.

The outfall maps are a first step in defining the County's stormwater systems. In order to assist municipalities with stormwater system management, the County will be purchasing dataloggers for use by municipalities in mapping the other components of their stormwater systems (inlets, pipes, ditches, culverts, basins etc.). An understanding of the stormwater systems and drainage may help resolve existing localized roadway flooding, and it will assist the municipalities and County in providing the maintenance assurances required by their new stormwater NJPDES permits. A better understanding of the stormwater system and their conditions will also reduce the likelihood of sudden stormwater infrastructure failures.

(b) Regional Stormwater Management Strategies

There is no Regional Stormwater Management Plan (RSWMP) for the Mantua Creek Watershed. The Gloucester Soil Conservation District (GSCD) with the New Jersey Department of Agriculture, State Soil Conservation Committee (SSCC) and the Burlington, Camden and Cape-Atlantic Soil Conservation Districts prepared an Upper Maurice River Regional Stormwater Management Plan dated October 2004 and a Draft Characterization and Assessment (C&A) for the Raccoon Creek Watershed. The Maurice River and Raccoon Creek watersheds are adjacent to the Mantua Creek Watershed. Conditions in the Mantua Creek Watershed, particularly in the less developed upper portions, are sufficiently similar to those in the Raccoon Creek and Maurice River Watersheds to permit some extrapolation of applicable stormwater management strategies.

The regional stormwater management strategies proposed for the Mantua Creek Watershed are described below:

- **Stormwater Recharge**: Changes in land use from rural agricultural to emerging suburban/urban development invariably alter the natural runoff and infiltration capabilities of the soil. As the landscape is altered in the construction process, the natural soil horizons are disturbed, forested areas are removed and the capacity of the soils in the post-development condition to mimic pre-development water retention and infiltration is severely impaired and reduced. This reduction results in increased overland flow, a decrease in retained moisture, and ultimately reduction in stream base flow. Stormwater recharge through infiltration or in combination with detention should be used as much as possible for stormwater management.

- **Low Impact Development Techniques** – Low Impact Development (LID) techniques provide a variety of stormwater control measures to maintain or restore the pre-developed hydrologic characteristics of a site. (See LID recommendations above)

- **Adoption of DelMarVa Peak Rate Factor:** As part of more accurately modeling existing conditions in the Mantua Creek Watershed, utilizing regionalized factors in the calculation of stormwater runoff is critical. The DelMarVa peak rate factor (PRF) replaces the national average PRF in the dimensionless unit hydrograph used by the NRCS stormwater runoff prediction methodologies. The DelMarVa hydrograph has been formally recommended for use in the coastal plain of New Jersey and should be required for all hydrologic analyses in this watershed.

- **Deicing Sand:** Sand used during snow storms makes its way to stormwater inlets, pipes and outfalls, where it causes both hydraulic and water quality problems. In order to reduce the maintenance costs from cleaning sand from stormwater facilities and to reduce the suspended solids loading to streams, municipalities can minimize or eliminate the use of sand for snow storms.

  The Gloucester County Stormwater Program includes an extensive anti-icing and deicing component for Gloucester County's municipalities and the County Highway Division. The program includes the provision of salt storage sheds and liquid anti-icing and deicing agents in bulk storage at five locations throughout the County, as well as liquid application equipment for county and municipal salt trucks. An anti-icing and deicing education program is part of this effort. The County's program will help municipalities and the County Highway Division minimize or eliminate the use of sand for snow storms and also reduce the amount of salt used for deicing.

- **Geese Management**: Increasing goose populations have become a problem throughout both the suburban and rural portions of southern New Jersey. Stormwater detention ponds, grass and lawn areas and farm fields provide habitat for geese. Although the populations sometimes add to the areas aesthetics, there are adverse impacts to water quality and the land that result, especially with over population.

  The new New Jersey Stormwater regulations require municipalities to pass ordinances prohibiting the feeding of waterfowl. In addition, municipalities should encourage land cover types and practices in new development that discourage geese from resting, nesting and feeding in areas that would otherwise provide attractive habitat, such as stormwater management facilities. Changes to state and federal laws regarding hunting were discussed and recommended at the workshop.

- **Stormwater Basin and Existing Development Retrofit** – Older under-maintained stormwater basins may not adequately provide mitigation for the most frequently occurring rain storms nor provide stormwater quality treatment. To improve the water quality and mitigate peak flows during these high frequency storms, existing stormwater basins can be retrofitted. Additionally, existing development retrofit strategies can be implemented during stormwater infrastructure improvements or as a separate retrofit project, including such techniques as roof water infiltration or reuse, stormwater inlet modifications, roadside rain gardens or infiltration structures and bio-retention facilities

- **Lake and Pond Management and Maintenance** – Ponds and lakes in the Mantua Creek Watershed provide significant aesthetic benefit, and these waterbodies reduce stream slopes, provide storage and attenuate peak runoff rates and serve as sediment basins, trapping sediment carried by the streams. They also provide a diverse aquatic habitat for certain species not found in streams. Programmatic management and maintenance of public and privately held lakes and ponds, including dam maintenance, dredging and vegetation management, is needed to sustain these benefits.

- **Stream and Streambank Stabilization** – Erosion is significantly accelerated by human activities and development in the watershed. Streambank erosion introduces excess sediment loads to the stream and in turn chokes lakes and ponds with sediment. Watershed-wide stream and stream bank restoration and stabilization priorities and guidelines should be adopted by all involved municipalities and agencies working in the watershed in order to improve water quality, upgrade in-stream and riparian habitat and reduce sedimentation in receiving waterbodies.

- **Stormwater Outfall Restoration** –Failing outfalls are a concern for public safety and they may contribute excess sediment to the receiving waterway. Degraded outfalls and resulting stream bank erosion will be identified during the Gloucester County Stormwater Management Program's outfall mapping and stream bank condition assessment efforts. Repairs can be prioritized throughout the watershed.

- **Well Head Protection Areas and Aquifer Outcrops**: Additional stormwater treatment may be needed for recharge in Well Head Protection Areas and/or aquifer outcrop areas, in order to prevent drinking water and ground water contamination. Further evaluation of stormwater recharge quality and the natural attenuation of contaminants are needed. State and federal assistance may be required for these evaluations.

- **Stormwater BMP Maintenance**: BMPs required by the new stormwater regulations require long term maintenance if they are to remain effective. The NJDEP's stormwater permits require municipalities to ensure and annually certify that this maintenance is being carried out. Municipalities and their planning boards must develop a method of securing the long term maintenance of these facilities and an inspection and/or certification process that will allow them to ensure maintenance and provide the annual certification.

(c) Lower Mantua Creek Regional Stormwater Management Strategies:

Mantua Creek is tidally influenced on the main stem up to a point in Wenonah. Edwards run is tidally influenced up to the NJTPK in East Greenwich and Chestnut Run is tidally influenced to Mantua Boulevard in Mantua. These lower tidally influenced portions of the watershed present a different hydrologic regime. The stormwater management strategies developed for the upper portions of the Mantua Creek watershed may not in some cases, be relevant or appropriate for the lower tidal portions of the watershed.

Water quality and stormwater management in the lower portions of the Mantua Creek Watershed are significantly influenced by conditions in the Delaware River. The complex nature of the interactions between the Delaware River, the Delaware Estuary and the tidally influenced lower portions of the Mantua Creek Watershed are beyond the scope of this plan and this stormwater strategy discussion.

(d) Water Quality-TMDL Stormwater Management Strategies

The NJDEP has proposed two TMDLs to address impaired waters in this watershed. The full text of these proposals can be found and downloaded at the following link:

http://www.nj.gov/dep/watershedmgt/tmdl.htm#intro .

The first TMDL was proposed for Edwards Run at Jefferson in April 2003 for fecal coliform and is based on the 2002 Integrated Report. This TMDL was approved in September 2003, but has not yet been adopted. A TMDL for phosphorous was proposed for Bethel Lake in 2005. This TMDL is not yet established.

Fecal Coliform: Fecal Coliform contamination can be derived from either point or non-point sources or both. Point sources generally involve sewage discharges. Because sewage treatment plants have permits that require disinfection to levels well below water quality standards, the proposed TMDLs address non-point sources, involving stormwater runoff. These non-point stormwater sources include runoff from various land uses that transport fecal coliform from geese and other wildfowl, farms, and domestic pets to the receiving water. Non-point sources also include "illicit" sources, such as failing onsite disposal systems and the illegal connections of sanitary drains from buildings to storm sewers.

A number of stormwater management strategies were included in the TMDL Fecal Coliform proposal to remediate the affected waterways.

- **Phase II NJPDES Permits and the Municipal Stormwater Regulation Program**: Fecal Coliform loadings may be reduced by the new requirements to enforce a pet waste ordinance and an ordinance prohibiting the feeding of wildfowl on public property. The NJPDES permit requirements also require the annual inspection and cleaning (if necessary) of catch basins, the performance of good housekeeping practices at maintenance yards and public education and employee training aimed at reducing non-point sources of pollution, including fecal coliform. Additional reductions in fecal coliform levels may result from the elimination of illicit connections and failing on-site sewage disposal systems. Fecal coliform contributions from agricultural activities can be controlled by the implementation of agricultural conservation management plans and best management practices.

- **Manure**: The application of manure in agricultural areas may be a concern. There are farms with horses, cows, goats, and chickens along the stream corridor. Buffers

along the stream are generally less than fifty feet, although access is limited by thick undergrowth. Agricultural BMPs may be needed to reduce these impacts.

- **Further Source Identification**: Monitoring was recommended to locate and identify significant sources of fecal coliform.

Phosphorous: Phosphorous sources include domestic and industrial wastewater treatment plants that discharge to surface waters, as well as stormwater discharges subject to regulation under the New Jersey Pollutant Discharge Elimination System (NJPDES) municipal stormwater permitting program. Non-point sources include stormwater runoff from land surfaces, malfunctioning sewage conveyance systems, failing or inappropriately designed septic systems and direct contributions from wildlife, livestock and pets.

- **Phase II NJPDES Permits and the Municipal Stormwater Regulation Program**: Phosphorous loadings may be reduced through the activities required by the Phase II permits.

- **Low Phosphorous Fertilizer Ordinance:** As an additional measure to their NJPDES stormwater permits, Deptford Township and Washington Township are required to adopt an ordinance that prohibits the outdoor application of fertilizers, other than low phosphorous fertilizer. The ordinance must be consistent with a model ordinance provided by the NJDEP.