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# Impact of wastewater reuse in Burlington County on surface water quality and adjacent wetlands

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# IMPACT OF WASTEWATER REUSE IN BURLINGTON COUNTY ON SURFACE WATER QUALITY AND ADJACENT WETLANDS

by
Crystal L. Mattson

A Thesis

Submitted in partial fulfillment of the requirements of the
Master of Science in Civil Engineering Degree
of
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Approved by

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Date Approved 12/06/06

# ABSTRACT

Crystal L. Mattson
IMPACT OF WASTEWATER REUSE IN
BURLINGTON COUNTY
2004/06
Dr. Kauser Jahan
Master of Science in Civil Engineering

This study was conducted to assess potential ecological impacts from application of treated wastewater effluent. Indian Springs Golf Course is currently irrigated with reclaimed wastewater. Grab water samples were collected from three (3) ponds located on the golf course over the course of a year and were analyzed for nitrate-nitrogen, total phosphorus, organics, and bacteria. A second golf course, Medford Lakes Country Club is currently irrigated with groundwater. Grab water samples were collected from both locations and analyzed for nutrients and bacteria for comparison purposes.

Results of sample analyses indicate that detriment to the quality of surface water at the monitoring locations is not related to the use of treated wastewater effluent for irrigation but can be attributed to non-point source pollution. Concentrations of nutrients and bacteria were found to be similar and more often present in greater concentrations at Medford Lakes, indicating that there are additional factors influencing any effect the treated effluent may be imparting on the surface water ponds. The results of this study indicate that the use of reclaimed water for irrigation at the Indian Springs Golf Course is not having a detrimental effect on the environment that surrounds the location.

## Acknowledgements

I would like to extend my thanks and gratitude to my family: Dad, Mom, and Kate. I cannot thank you enough for always encouraging me to do my best and strive for more. You have always supported me and I cannot think of a way to repay you. I hope I'm still making all of you proud.

Dr. Jahan, your tireless efforts during the completion of this research has made this one of the most interesting, challenging, and rewarding experiences I have ever been lucky enough to be a part of. I've gotten a chance to travel the country, meet new contacts, and present the results of this research to the top minds in our profession. Because of you, I have become the young engineer that I wanted to become during my first days as an undergraduate student. You will never know how much I appreciate your guidance and I hope you will remain a lifelong mentor and friend.

I would like to thank Dr. Orlins for being a member of my committee. I appreciate the commitment that you have made to this research to hopefully expand the reuse of wastewater to protect diminishing potable supplies in New Jersey. I am thankful to have access your knowledge and expertise.

I would also like to thank Ms. Gina Berg, Water Resources Coordinator for Burlington County. Ms. Berg was instrumental in procuring funding sources so this research could move forward. Without your help, none of this would be possible.

Vince: You are the absolute best thing that has ever happened to me. You are the only person I have ever known who would immediately drop what they were doing and give me a shoulder to cry on when the going got rough. Thank you for being there during both the rough times and the good times. I've had a wonderful time these past six years, and I know our future is going to be even better. I cannot wait to spend the rest of my life with you. I love you, always and forever.

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| | |
|---|---|
| Biological Oxygen Demand | $BOD_5$ |
| Chemical Oxygen Demand | COD |
| Colony Forming Units | CFU |
| Dissolved Air Flotation Treatment System | DAFTS |
| Division of Watershed Management | DWM |
| Elmwood Wastewater Treatment Facility | EWTF |
| Geographic Information System | GIS |
| Global Positioning System | GPS |
| Million gallons per day | MGD |
| Municipal Utility Authority | MUA |
| National Pollution Discharge Elimination System | NPDES |
| National Weather Service | NWS |
| Natural Resources Defense Council | NRDC |
| New Jersey Department of Environmental Protection | NJDEP |
| Office of the New Jersey State Climatologist | ONJSC |
| Reclaimed Water for Beneficial Reuse | RWBR |
| Sewage Treatment Plant | STP |
| Sewerage Authority | SA |
| Surface Water Quality Standards | SWQS |
| Total Maximum Daily Load | TMDL |
| Total Suspended Solids | TSS |
| United States Environmental Protection Agency | USEPA |
| United States Geological Society | USGS |
| United States Golf Association | USGA |
| Wastewater Treatment Plant | WWTP |
| Water Assessment Team | WAT |
| Watershed Management Area | WMA |
| World Health Organization | WHO |

# Chapter One

## Introduction

With a continually increasing population, the daily demand for a clean and reliable fresh water supply is placing great strain on the resources that are currently available worldwide. The reclamation and reuse of wastewater has historically been practiced in various forms throughout the world and the United States as a means of supplementing existing supplies. Developing nations have used wastewater reuse for irrigation and fertilization, effectively reducing pollutant loading to the surface water bodies from which they withdraw their potable supply. Wastewater reuse has been practiced in the United States since at least the late 19th century. Due to recent extended drought periods and increased demand for potable water, interest in wastewater reuse to augment dwindling fresh water supplies and reduce pollutant loadings to surface water bodies is increasing.

### *Wastewater*

Communities throughout the world generate liquid and solid wastes as part of everyday life. Wastewater is the used portion of the water used by humans everyday. It can be defined as a combination of liquid or water carried wastes that are removed from homes, businesses, and other establishments. It includes substances such as human waste, food scraps, oils, soaps, and chemicals. In homes, water from sinks, showers, bathtubs, toilets, washing machines, and dishwashers are wastewaters. Businesses and industries also contribute their share of water used during various industrial processes. Storm water runoff is considered wastewater because of the harmful substances that wash off roads, parking lots, and rooftops, but typically does not undergo treatment prior to being introduced into lakes, rivers, and streams.

### *Characteristics of Wastewater*

Wastewater is characterized by its physical, chemical and biological composition. The principal physical properties and the chemical and biological constituents found in wastewater are listed below in Table 1 (Metcalf & Eddy, 2003). Many of the constituents listed in Table 1 are interrelated. pH, for example, can affect the solubility of heavy metals in the waste stream. It should be noted that Table 1 is not a comprehensive list of all the possible constituents found in wastewater.

**Table 1: Common Constituents Found In Wastewater (Metcalf & Eddy, 2003)**

| *Physical Characteristics* | *Inorganic Chemical Characteristics* |
|---|---|
| Total Solids | Free ammonia |
| Total volatile solids | Organic nitrogen |
| Total suspended solids | Total Kjeldahl nitrogen |
| Volatile suspended solids | Nitrites |
| Total dissolved solids | Nitrates |
| Volatile dissolved solids | Total nitrogen |
| Settleable solids | Inorganic and Organic phosphorus |
| Particle size distribution | Total phosphorus |
| Turbidity | pH |
| Color | Alkalinity |
| Transmittance | Chloride |
| Odor | Sulfate |
| Temperature | Metals |
| Density | Various Gases |
| Conductivity | *Biological Characteristics* |
|  | Coliform organisms |
|  | Pathogens |

There are several constituents of wastewater that are a concern during treatment. Table 2 lists the principle constituents of concern in wastewater and the reason(s) for their importance (Metcalf & Eddy, 2003). In recent years, researchers have discovered that many new compounds are being added to wastewater streams each year. These compounds, particularly pharmaceuticals, are becoming constituents of increasing concern because of removal difficulties and interactions with disinfecting agents that may produce carcinogenic compounds. The full extent, magnitude, and ramifications of their presence in the aquatic environment are largely unknown (Daughton, 2001).

**Table 2: Principle Constituents of Concern in Wastewater Treatment (Metcalf & Eddy, 2003)**

| *Constituent* | *Reason for Importance* |
|---|---|
| Suspended Solids | Suspended solids can lead to the development of sludge deposits and anaerobic conditions when untreated wastewater is discharged into the aquatic environment |
| Biodegradable Organics | Composed principally of proteins, carbohydrates, and fats, the biological stabilization of biodegradable organics can lead to the depletion of natural oxygen sources and to the development of septic conditions is discharged untreated |
| Pathogens | Communicable diseases can be transmitted by pathogenic microorganisms that may be present in wastewater |
| Nutrients | Both nitrogen and phosphorus are essential nutrients for growth and when discharged into an aquatic environment, can lead to the growth of undesirable aquatic life. When discharged in excessive amounts, nutrients can lead to the contamination of groundwater |
| Priority Pollutants | Organic and inorganic compounds selected on the basis of their known or suspected carcinogenicity, mutagenicity, teratogenicity, or high acute toxicity. |
| Refractory Organics | These organics tend to resist conventional methods of wastewater treatment and include surfactants, phenols, and agricultural pesticides |
| Heavy Metals | Usually added to wastewater from commercial and industrial activities and are toxic to life at various concentrations |
| Dissolved Inorganics | Inorganic constituents added to the original domestic water supply and may have to be removed before the water can be reused |
| Surfactants | Organic compounds that are slightly water soluble and cause foaming in wastewater treatment plants and surface waters into which effluent is discharged |

The assessment and control of chemical pollution since the formation of the United States Environmental Protection Agency (USEPA) in 1970 has focused almost exclusively on conventional priority pollutants that were easily measured using the technologies available at the time. As a result, the priority pollutants were not selected solely on risks to human health, but also because they could be detected at sufficiently low detection limits (Daughton, 2001).

As medical technologies and treatments have advanced in past decades, compounds that can be classified as endocrine disruptors have increasingly been detected in the aquatic environment. Endocrine disruptors are synthetic chemicals that either mimic or block hormones and disrupt the body's normal functions when absorbed. Disruptions can occur when normal hormone levels are altered, halting or stimulating the production of hormones, or changing the way hormones travel through the body, thus affecting the functions that these hormones control (NRDC, 1998).

### *Why Treat Wastewater*

The primary reason for the treatment of wastewater is the protection of human health. The health risks for the public from wastewater can come from microbial pathogens, toxic chemicals, and heavy metals. The major aim of wastewater treatment is to remove as much of the constituents that may pose a risk to human health as possible before effluent is discharged back to the environment. Other reasons for the treatment of wastewater are outlined as follows:

- Untreated wastewater contains constituents that are detrimental to the aquatic environment. High levels of organics can lead to depleted levels of dissolved oxygen in receiving waters. Dissolved oxygen is vital to the survival of aquatic organisms such as fish and plants, and depletion can lead to large scale fish kills and degradation of water quality.

- Good water quality is critical to the economic stability of regions in close proximity coastal areas. Many coastal towns relay on tourism and the fishing industry to remain viable. Discharging untreated effluent into receiving waters that ultimately mix with fishing waters and oceans creates an environment unsuitable for economic viability.

Much of the water used by homes, industries, and businesses must be treated before it is released back to the environment. Nature has the ability to cope with small amounts of water wastes and pollution, but would be overwhelmed if the billions of gallons of wastewater and sewage produced every day were not treated before being released back to the environment. A wastewater treatment plant (WWTP) reduces pollutants in wastewater to reduce the impact on the aquatic environment. Quality and treatment requirements for wastewater effluent become more stringent as the chances for direct human contact and ingestion increase.

*Wastewater Treatment Processes*

A variety of methods are employed in WWTPs to remove contaminants from the influent before it is discharged as treated effluent into receiving streams and/or groundwater. Two types of treatment methods are involved during the process of wastewater treatment. Treatment methods which use the tendency of certain contaminants to settle due to their weight and the influence of gravitational forces are known as unit operations. Methods using chemical and biological processes to remove contaminants are known as unit processes. Unit operations and processes are used in various combinations during wastewater treatment and all are implemented to reduce contaminant levels to meet required permitted discharge levels. The levels of treatment that can be found in a WWTP are shown in Table 3 and a schematic of a typical wastewater treatment plant process train is presented in Figure 1.

**Table 3: Levels of Wastewater Treatment (Metcalf & Eddy, 2003)**

| Treatment Level | Description |
|---|---|
| Preliminary | Removal of wastewater constituents such as rags, sticks, floatables, grit, and grease that may cause maintenance or operational problems with the treatment operations, processes, and ancillary systems |
| Primary | Removal of a portion of the suspended solids and organic matter from the wastewater |
| Advanced Primary | Enhanced removal of suspended solids and organic matter from the wastewater. Typically accomplished by chemical addition or filtration |
| Secondary | Removal of biodegradable organics (in solution or suspension) and suspended solids. Disinfection is also typically included in the definition of conventional secondary treatment |
| Secondary with Nutrient Removal | Removal of biodegradable organics, suspended solids, and nutrients (nitrogen, phosphorus, or both) |
| Tertiary | Removal of residual suspended solids (after secondary treatment), usually by granular media filtration or microscreens. Disinfection is also typically a part of tertiary treatment. Nutrient removal is often included in this definition. |
| Advanced | Removal of dissolved and suspended materials remaining after normal biological treatment when required for various water reuse applications. |

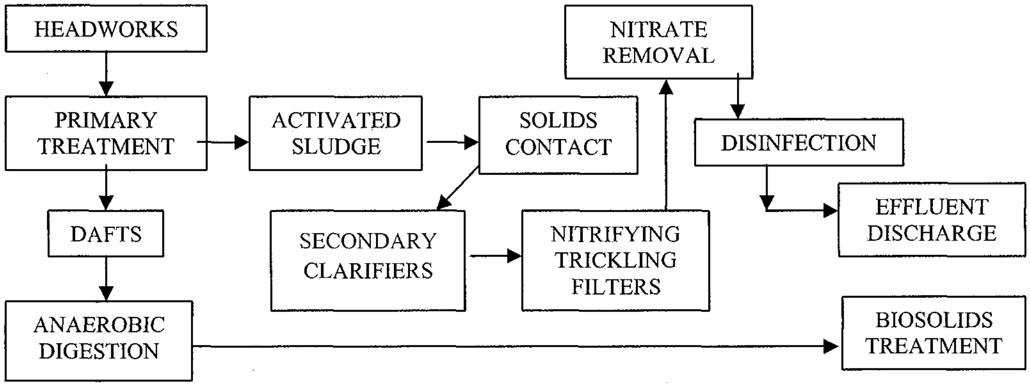


**Figure 1: Typical Wastewater Treatment Processes**

The passage of the Federal Water Pollution Control Act (P.L. 92-500) in 1972, also known as the Clean Water Act, and amended by P.L. 95-217 in 1977, requires that all WWTPs in the United States treat their influent to at least the secondary level (33 USC § 1251 *et. seq.*, 1972), which is defined as the removal of organic material and suspended solids. Nutrient removal is not always required during secondary treatment, but permitting agencies may place strict limits on the concentrations of nutrients in the effluent. Treatment plants required to provide processes for nutrient removal are known as tertiary treatment plants. Restrictions on effluent nutrient concentrations are of particular importance when effluent is discharged into a nutrient impaired body of water.

Reduction of constituents found in untreated wastewater is required to meet the standards of the National Pollution Discharge Elimination System (NPDES) for discharge into surface or ground waters. The USEPA has set strict standards pertaining to the quality of secondary treated effluent. Wastewater influent treated to the secondary level must meet or exceed these standards before discharge into receiving waters. Technology-based regulations apply to all municipal wastewater treatment plants and represent the minimum level of effluent quality attainable by secondary treatment (USEPA, 2002). The technology-based requirements for municipal treatment plants employing secondary treatment processes are shown in Table 4 below.

**Table 4: Technology-based Requirements for Municipal Treatment Plants (USEPA, 2002)**

| | *30-day Average* | *7-day Average* |
|---|---|---|
| $BOD_5$ | 30 mg/L | 45 mg/L |
| TSS | 30 mg/L | 45 mg/L |
| pH | 6-9 | -- |
| Removal | 85% of $BOD_5$ and TSS | -- |

### *Wastewater Reuse*

Reclaimed wastewater can be a valuable resource in cities or towns where population is growing and water supplies are limited. In addition to easing the strain on limited freshwater supplies, the reuse of wastewater can improve the quality of streams and lakes by reducing concentration of point source nutrients and oxygen consuming organics introduced. Wastewater may be reclaimed and reused for crop and landscape irrigation, groundwater recharge, or recreational purposes. Reclamation for drinking is technically possible, but this reuse faces significant public resistance due to the fear of disease outbreak from any remaining pathogenic organisms that may survive the treatment and disinfection processes.

Reuse of wastewater can be classified into two distinct categories: direct and indirect reuse. Direct reuse involves the flow of treated effluent through a water system, separate from that of potable water supply, and is not diluted prior to use. Crop and landscape irrigation via effluent treated and supplied by a municipal WWTP are examples of direct reuse. Indirect reuse involves the dilution of reclaimed wastewater with another body of water before reuse. Communities that use surface water supplies as a source of potable water that are downstream of a WWTP are indirectly reusing wastewater. Federal and state regulations set limitations on the location of both new water and wastewater treatment plants. This allows for dispersion and dilution of wastewater effluent discharged upstream of potential potable water intake systems.

Treated wastewater effluent is indirectly reused during artificial recharge of groundwater aquifers. Artificial recharge can effectively supplement potable water supplies during months of drought while reducing the potential for salt water intrusion and contamination of aquifers in areas that are in coastal zones. Treated effluent is generally introduced into groundwater aquifers in two ways: deep-well injection or shallow surface spreading (Vesilind, 1997).

### *Project Objectives*

With a growing population and economy, how we choose to collect, use and dispose of water has never been more critical. Every drop of water not used by a household, farm or business can be used to create higher river flows to benefit fisheries and floodways. Likewise, recycled water stored in reservoirs can be used to recharge overdrawn groundwater aquifers.

Water reuse has rapidly become an integral part of wastewater management and water resource management in many countries around the world and within the United States. Burlington County, the largest county in the State of New Jersey, is taking interest in the feasibility of using wastewater as part of their water resources program. Saltwater intrusion problems in the Potomac-Raritan-Magothy (PRM) aquifer have led the NJDEP to mandate a portion of this aquifer as Critical Water Area #2 and limit water withdrawals from the major source of potable water in the County. The County subsequently began to address future water demands and investigate alternate sources of water. One such potential source is the beneficial reuse of reclaimed wastewater.

The primary objective for this project was to determine the impact, if any, reclaimed effluent reuse has on wetlands and surface water bodies in Burlington County, New Jersey that are adjacent to areas currently using treated effluent for irrigation purposes. The overall objectives of this project were:

- Identification of current and potential wastewater treatment plants in Burlington County that can supply treated wastewater for beneficial reuse,
- Identification of effluent quality of WWTPs that currently have permitting in place to supply treated effluent and WWTPs that have the potential to supply treated effluent,
- Identify potential reuse sites in Burlington County for monitoring,
- Develop a monitoring plan for identifying the impact of treated wastewater on surface water bodies in Burlington County, and
- Implement the monitoring plan and collect water samples from identified monitoring sites for analysis of bacteria, organics, nitrate-nitrogen, and total phosphorus.

The following chapter, Chapter Two, briefly summarizes wastewater reuse in the United States and around the world, regulatory agency guidelines and regulations regarding the use of treated wastewater for irrigation, and potential human health risks associated with the use of treated effluent for irrigation purposes. A brief overview of Burlington County, New Jersey is provided in Chapter Three and includes information pertaining to land use changes, climate, precipitation, and water usage. Chapter Four details experimental procedures and analytical methods and also includes the selected monitoring sites, the source of treated effluent, and the digital data sources used to create project maps. Results of the monitoring plan developed specifically for this study are presented and interpreted in Chapter Five. Conclusions drawn from the results of the study and recommendations for the future are presented in Chapter Six.

Full scale images of figures provided in Chapter Three of the text can be found in Appendix A. Digital data sources used to create project maps are provided in Appendix B. Water use by watershed management area is provided in Appendix C. A list of impaired water bodies in

Burlington County is provided in Appendix D. Monitoring Reports submitted to the NJDEP by the Evesham MUA are provided in Appendix E. Analytical summary tables are provided in Appendix F. Quality Assurance and Quality Control Procedures are provided in Appendix G.

# Chapter Two
## Literature Review

Permitting agency guidelines and regulations have consistently updated and revised concentration and parameter limits to provide for the protection of human health and the environment. Due to these limits, it has become feasible to provide high quality wastewater effluent that can be used for a variety of beneficial applications without fear of a catastrophic disease outbreak. The following is a brief summary of available literature regarding potential human health risks resulting from wastewater reuse, wastewater reuse worldwide, wastewater reuse in the United States, and the current status of wastewater reuse in the State of New Jersey.

### *Human Health Risks*

A large number of enteric viruses and parasites are found in raw sewage. There is potential for disease causing organisms to survive the wastewater treatment process and be reintroduced into environments when used in crop irrigation, turf irrigation, etc. The type and concentration of pathogenic organisms found in raw sewage depends on the source of the influent. Typical pathogens found in raw municipal wastewater and typical concentrations are shown in Table 5.

**Table 5: Pathogens in Raw Municipal Wastewater (Pescod, 1992)**

| Type of Pathogen | | Number per Liter in Raw Municipal Wastewater |
|---|---|---|
| Viruses | Enteroviruses | 5000 |
| Bacteria | Pathogenic *Escherichia Coli* | unknown |
| | *Salmonella* spp. | 7000 |
| | *Shigella* spp. | 7000 |
| | *Vibrio cholerae* | 1000 |
| Protozoa | *Entamoeba histolytica* | 4500 |
| Helminths | *Ascaris lumbricoides* | 600 |
| | Hookworms | 32 |
| | *Schistosoma mansoni* | 1 |
| | *Taenia saginata* | 10 |
| | *Trichuris trichiura* | 120 |

Disinfection by chlorination or ozonation is required to ensure adequate precautions are taken against the risk of disease outbreaks associated with pathogenic organisms found in wastewater. Destruction of pathogens is dictated by various parameters including disinfection agent contact time, pH, organic content, and temperature (Pescod, 1992). Human contact with and consumption of treated wastewater can result in infection and disease outbreak if protocols fail to decrease the number of pathogens found in wastewater below the infectious dose.

Disease outbreaks associated with contaminated drinking water occur due to ingesting drinking water containing pathogenic microorganisms at levels above the infective dose. Very often the pathogen presence is due to contamination of the source water and insufficient reduction of their concentrations in the water treatment process (Smith & Perdek, 2004). The infectious dose of selected pathogenic organisms is shown below in Table 6.

**Table 6: Infectious Dose of Selected Pathogens Found in Municipal Wastewater (USEPA, 1992)**

| Organism | Infectious Dose (Number of Organisms) |
|---|---|
| *Ascaris lumbricoides* | 1 - 10 |
| *Clostridium perfringens* | 1 x $10^{10}$ |
| *Entamoeba histolytica* | 20 |
| *Escherichia coli* (enteropathogenic) | $10^{6}$ - $10^{10}$ |
| *Giardia lamblia* | <10 |
| *Salmonella typhi* | $10^{4}$ - $10^{7}$ |
| *Shigella dysnetariae* 1 | 10 |
| *Shigella flexneri* 2A | 180 |
| *Vibrio cholerae* | $10^{3}$ - $10^{7}$ |
| Viruses | 1 - 10 |

Disinfection does not fully eliminate all pathogenic organisms from the treated effluent stream. Pathogen concentration limits are set by permitting agencies and the USEPA and do not require 100% destruction or inactivation of pathogens. Irrigation with treated effluent introduces any surviving pathogens onto soil and crops. Studies have shown that pathogens can survive in a variety of environments for extended periods of time as described in Table 7.

**Table 7: Environmental Survival Times of Selected Pathogens in Wastewater Effluent (Pescod, 1992)**

| | Survival Times in Days | | | |
|---|---|---|---|---|
| **Type of Pathogen** | **Feces, Nightsoil, and Sludge** | **Fresh Water and Sewage** | **Soil** | **Crops** |
| ***Viruses*** | | | | |
| Enteroviruses | <100 (<20) | <120 (<50) | <100 (<20) | <60 (<15) |
| ***Bacteria*** | | | | |
| Fecal Coliform | <90 (<50) | <60 (<30) | <70 (<20) | <30 (<15) |
| *Salmonella* spp. | <60 (<30) | <60 (<30) | <70 (<20) | <30 (<15) |
| *Shigella* spp. | <30 (<10) | <30 (<10) | - | <10 (<5) |
| *Vibrio cholerae* | <30 (<5) | <30 (<10) | <20 (<10) | <5 (<2) |
| ***Protozoa*** | | | | |
| *Entamoeba histolytica* cysts | <30 (<15) | <30 (<15) | <20 (<10) | <10 (<2) |
| ***Helminths*** | | | | |
| *Ascaris lumbricoides* eggs | Many Months | Many Months | Many Months | <60 (<30) |

*Figures in parenthesis indicate usual survival time

According to the United States Golf Association (1994), treated wastewater effluent is being widely used because it is ideal for turf irrigation. Large volumes of water are necessary for the growth of turf on large surface areas and there is an almost limitless supply of wastewater effluent. Plant nutrients that are common in wastewater, such as nitrogen and phosphorus, reduce the need for commercial fertilizer, potentially offsetting the cost for purchasing treated wastewater effluent. The risk of potential health problems associated with effluent use on turf has been found to be less than effluent irrigation of food crops (USGA, 1994).

The probability of human disease occurring through the use of secondary and tertiary treated wastewater for turf irrigation is low. According to recorded waterborne outbreak data, the risk of illness from the consumption of contaminated water in the U.S. has been estimated to only 4 x $10^{-5}$ per year (USGA, 1994). These waterborne pathogens most often cause gastroenteritis, which is generally not severe enough to require medical attention, and it is important to note that infection will not necessarily result in illness in all cases.

Ongerth and Ongerth (1982) reviewed the health consequences of wastewater reuse and indicated that the popularity of reuse would depend on preventing harm to the population exposed. They indicated that human exposure could occur by contact, inhalation or ingestion. A study conducted by Frerichs (1984) investigated the possible human health implications of wastewater reuse. The study focused on epidemiologic effects as a result of the consumption of groundwater supplemented with treated wastewater effluent in Los Angeles County, located the State of California in the United States. The study period was divided into three (3) phases: 1969-1971, 1972-1978, and 1979-1980 and Census data was available for analysis of health outcomes for the first and third phases (Frerichs, 1984). The study specifically investigated the occurrence of cancer rates and female reproductive problems due to toxic chemicals in areas of Los Angeles County receiving potable water from suppliers supplementing their groundwater withdrawals with treated wastewater effluent.

Frerichs (1984) concluded that the disease risk to the population drinking potable water supplemented with treated wastewater effluent within the study area was minimal compared to those consuming non-supplemented potable supply. In order for the presence of a contaminant to be detected in potable water due to recharge practices with treated wastewater, the concentration of the contaminant would have to have been present in high concentration in the treated wastewater effluent stream. The contaminant would also have to survive the percolation process, dilution with groundwater, and be relatively stable over time (Frerichs, 1984).

Although Frerichs limited the investigations of the study to potentially carcinogenic compounds, the same holds true for microbiologic and pathogenic organisms in the treated effluent stream. Removal requirements and allowable discharge limits for reclaimed wastewater have been enforced by various regulatory and governing organizations specifically to defend the population against disease outbreak resulting from the consumption of contaminated water.

Cooper (1991) addressed public health concerns in wastewater reuse and indicated that the risk of infectious disease among sewage plant operators is minimal. There is some evidence from isolated incidents that exposed workers have contracted related infectious diseases of bacterial, viral, and parasitic origin. Jolis, et. al. (1999) conducted a risk assessment for *Cryptosporidium parvum* in reclaimed wastewater produced by the City and County of San Francisco for landscape irrigation and golf courses. The authors reported that the observed *C. parvum* concentrations in filtered secondary effluent present less than a 1 in 10,000 annual risk of contracting a water borne disease through regular exposure at parks and golf courses irrigated with tertiary reclaimed water. Devaux, et. al. (2001) used an epidemiological and environmental approach to check the security for the exposed populations surrounding an agricultural population in Clermont-Ferrand, France. Four information systems were set up: two sentinel systems joining general physicians (15) and pharmacists (7) for the surrounding population and two follow-up surveys among field workers and farmers. Water quality monitoring and a study of aerosols from spray irrigation were performed. No epidemic event was identified with only some case clusters not related to water exposure being observed. All the declared cases were benign. The workers' survey underlined a substantial incidence of nettle rashes, itchy skin, sunburns, and cuts. The follow-up study among farmers and their families did not reveal any particular phenomena. The bacteriological quality of treated wastewater throughout conformed to the recommendations of the Superior Council of Public Health of France (1,000 fecal coliforms/100 mL). No fecal bacteria were observed in aerosols with water concentrations equal to 103 CFU/100mL and an exposure time of 20 minutes. The survey of such an irrigation system, towards potential and actual risks, required the conjunction of different epidemiological information sources and microbiological data.

Bacterial and virulent contamination of drinking water supplies before the development of current drinking water treatment technologies has been well documented. Even though treatment requirements in the United States have become more stringent since the passage of the Clean Water Act, contamination of drinking water still occurs. Since 1971, the Centers for Disease Control (CDC), the USEPA, and the Council of State and Territorial Epidemiologists (CSTE) have maintained a collaborative surveillance system that tracks the occurrences and causes of waterborne disease outbreaks associated with drinking water (CDC, 2004).

During 2001-2002, thirty one (31) disease outbreaks associated with drinking water were reported in the United States. These 31 outbreaks caused illness among an estimated 1,020 persons, resulting in fifty one (51) hospitalizations and seven deaths (7) (CDC, 2004). The CDC identified the infectious etiology of nineteen (19) of the thirty one (31) outbreaks. The remaining outbreaks were of unknown etiology (seven) or attributed to chemical poisoning (five). The outbreaks of known infectious etiology included six (6) that were caused by *Legionella* species, five (5) by viruses, five (5) by parasites, and three (5) by bacteria other than *Legionella* species (CDC, 2004).

The waterborne disease outbreaks reported during 2001-2002 were associated with the consumption of contaminated water supplied from a variety of sources. Outbreaks were associated with water withdrawn from both surface and groundwater sources. Out of the twenty five (25) outbreaks whose causes were attributed to etiology other than *Legionella* species, two (2) were associated with systems served by surface water and twenty three (23) were associated with systems served by groundwater. Among the two surface water related outbreaks, one was an outbreak of copper poisoning related to a distribution system deficiency, and one was an outbreak of giardiasis in a rural Colorado town during 2001 caused by the failure of a bag filtration system (CDC, 2004).

Nitrate contamination of groundwater is of concern when using treated effluent for irrigation in areas where drinking water is supplied via groundwater extraction. Nitrates are an essential source of nitrogen for plants, however high levels of nitrate may endanger human health. High concentrations of nitrate can lead to methemoglobinemia in human infants (Broadbent and Reisenauer, 1985), which is characterized by a bluish discoloration of the skin and mucous membranes (Owens, 2005) and the inability of red blood cells to transport oxygen throughout the body. The USEPA has established a Maximum Contamination Level ("MCL") for nitrate of 10 mg/L to provide adequate protection from the risk of methemoglobinemia (Qasim, et. al, 2000). Before the implementation of a treated effluent irrigation program, it would be prudent to determine the susceptibility of drinking water supplies to nitrate contamination and to implement a drinking water supply monitoring program to determine the effects of nearby reuse applications.

### *Reuse Guidelines of the World Health Organization*

The World Health Organization (WHO), the United Nations' specialized agency for health, was established in 1948. The Organization's objective is the attainment by all peoples of the highest possible level of health. WHO has created guidelines for all areas of human health, including drinking water standards, ambient air quality standards, and regulations regarding the use of treated wastewater effluent for irrigation purposes.

In 1985 (WHO, 1989), a group of experts met in Engelberg, Switzerland to review epidemiological evidence concerning the agricultural use of human wastes and formulated the Engelberg Guidelines for the microbiological quality of treated wastewater intended for crop irrigation. The WHO published the Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture in 1989. These Guidelines have had a major impact on the rational reuse of wastewater and excreta in countries world-wide (WHO, 1989).

The Guidelines recommend that treated wastewater should contain less than one (1) viable intestinal nematode egg per liter (on an arithmetic mean basis) for restricted or unrestricted irrigation and less than 1000 fecal coliform bacteria per 100 mL (on a geometric mean basis) for unrestricted irrigation.

Unrestricted irrigation refers to irrigation of trees, fodder and industrial crops, fruit trees and pasture. Restricted irrigation refers to the irrigation of edible crops, sports fields, and public parks. The guidelines are also applicable to agricultural use if the excreta, in the form of liquid nightsoil for example, is applied to the field while crops are growing (WHO, 1989).

WHO further specifies that if the Engelberg standards are not fully met, the possibility still exists for the use of treated wastewater for irrigation purposes. The type of crops that can still be irrigated using treated wastewater can be broken down into three categories. Table 8 outlines the applicable protection measures and crops that fall under these restrictions.

**Table 8: WHO Crop Restriction Parameters (WHO, 1989)**

| *Category* | *Protection Measures* | ***Crops*** |
|---|---|---|
| A | **Protection needed only for field workers** | cotton, sisal, grains and forestry, as well as food crops for canning |
| B | **Further measures may be needed** | pasture, green fodder and tree crops and to fruit and vegetables that are peeled or cooked before eating |
| **C** | Treatment to Engelberg "unrestricted " guidelines essential | fresh vegetables, spray-irrigated fruit, and parks, lawns and golf courses |

### *Worldwide Wastewater Reuse*

Seventy percent of the water found on earth is contained in the oceans. The remaining thirty percent supplies drinking water to a world population of over 6.3 billion people. Water is essential to all life and the availability of a potable source is becoming more critical. Many developing nations lack the necessary infrastructure to reuse their wastewater for irrigation purposes. They resort to using the available fresh water supply and this leads to a decrease in the amount of fresh water available for consumption. Reuse of wastewater is becoming a valuable resource in countries that experience droughts in combination with increased demand due to exploding populations.

Many countries are facing shortages in available drinking water sources, and have resorted to recycling wastewater for irrigation purposes. After being treated to reduce pathogenic organisms, toxic chemicals, and heavy metals, wastewater effluent can be profitably reused to grow crops and fish, and to provide a source of clean drinking water. Crop yields have been found to be higher than with freshwater irrigation because the treated wastewater not only supplies water, but also supplies plant nutrients such as nitrogen and phosphorus.

Along with reuse of a valuable water resource during times of drought and shortages, the appropriate use of the nutrients found in wastewater has been a primary objective of most wastewater reuse systems. Nutrient cycling has been the predominant objective of wastewater irrigation for centuries.

The European AQUAREC project was developed to provide guidance for European end-users facing decisions in the planning and implementation of wastewater reuse schemes as well as for public institutions on various levels (AQUAREC, 2003). The AQUAREC project identified over 3,300 water reclamation projects throughout the world. The review considered seven geographical regions: North America, Latin America, Europe, the Mediterranean Region and Middle East, Sub-Saharan Africa, Oceania and Japan. Japan was found to have the largest number of reuse projects (over 1,800), followed by the United States, with over 800 reuse projects. The United States was estimated to produce a volume of reused water close to 6.5

Mm$^3$/d (Durham, et. al, 2005). Figure 2 depicts the number of reuse project distributed across the globe according to the intended reuse application.

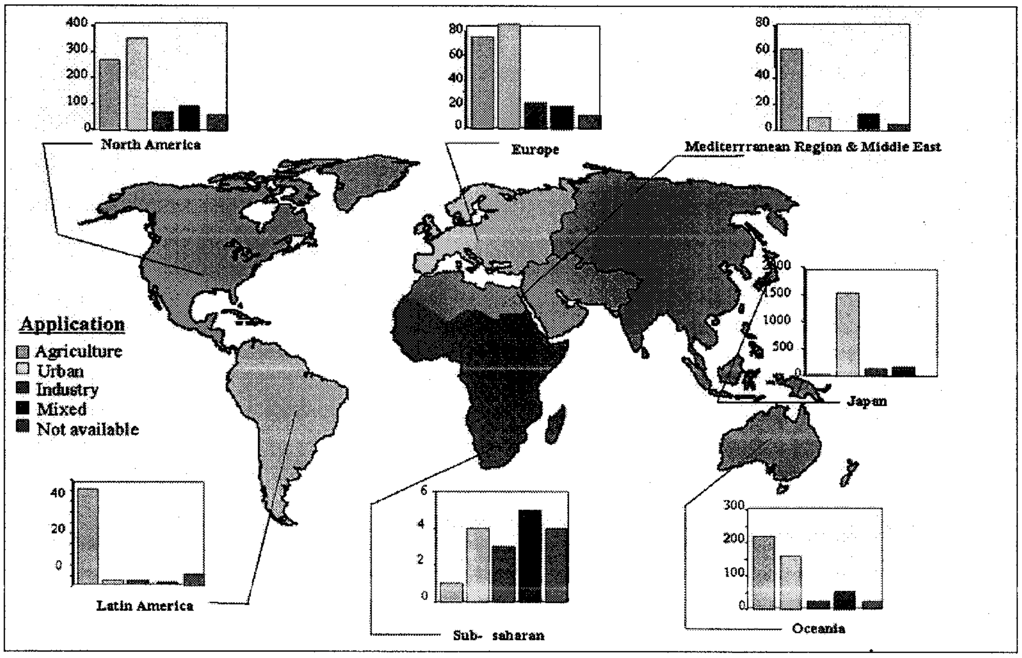


**Figure 2: Reuse Projects Around the World Identified by Use (Durham, et. al, 2005)**

The following are examples of how a handful of the many countries identified in the AQUAREC study are incorporating the reuse of wastewater effluent to lower the demand on potable water sources.

### *France*

In 1989, only six (6) wastewater reuse projects were in operation in France. Reuse was not widely applied at the time because water resources were available to match the needs of the people. A survey conducted by the Ministry of Health showed that more than fifteen (15) new projects were underway in 1996 (Faby, et. al, 1999). As a result of renewed interest in using treated effluent for wastewater reuse in the early 1990s, the French Health Authorities issued the *Health Guidelines for Reuse, After Treatment, of Wastewater for Crop and Green Spaces Irrigation*. The Guidelines adopted by the Health Authorities closely follow the Guidelines set forth by the WHO, with the exception that they have incorporated restrictions in regard to irrigation techniques and set back distances between sites irrigated with treated effluent and residential areas and roadways (Angelakis & Bontoux, 2001).

Islands located off the Atlantic coast, where some of the more recent reuse projects have been implemented, are facing serious water shortages due to an increase in tourism in the last twenty years. The main objectives of the projects are to reuse treated wastewater effluent for the irrigation of staple food crops and maize, thus increasing the amount of potable water available to sustain a permanent population. The projects also supply treated water for the irrigation of golf courses vital to the tourist economy. Another objective of these projects is the prevention of pollution of bathing waters, shellfish breeding areas, and aquaculture water (Faby, et. al, 1999).

Table 9 below lists the wastewater irrigation projects that have been developed in France between 1981 and 1997 (Faby, et. al, 1999). The majority of the reclaimed water is used for the irrigation of staple food crops and maize. The reclaimed water used for the irrigation of golf courses uses a tertiary treatment process to protect the public from exposure to enteric viruses and bacteria.

**Table 9: Main Wastewater Irrigation Projects Developed in France from 1981-1997 (Faby, et. al, 1999)**

| Projects | Irrigated Area (ha) | Date | Specific Application | Treatment | Geographic Location |
|---|---|---|---|---|---|
| Mont Saint Michel | 265 | 1994 | Meadows and maize | Activated sludge and 3 lagoons | Atlantic Coast |
| Saint Armel | 120 | 1997 | Market gardening | 4 lagoons | |
| Porquerolles | 35 | 1986 | Market gardening and orchards | Activated sludge and 3 lagoons | Mediterranean Islands |
| Noirmoutier-La Salaisiere | 220 | 1981 | Potatoes, cabbage, and maize | Activated sludge and 4 lagoons | Atlantic Islands |
| Noirmoutier-La Barbatre | 35 | 1991 | Potatoes | Aerated lagoon and stabilization reservoir | |
| Ars en Re | 90 | 1985 | Maize and potatoes | Activated sludge, chlorination, and reservoir | |
| Saint Pierre la Continiere | 25 | 1994 | Golf Courses | Activated sludge and ultraviolet radiation | |
| Port en Re | unknown | | | Underground irrigation | |
| Pornic | 34 | 1992 | | Activated sludge and chlorination | Atlantic Coast |
| Baden | 7 | 1989 | | 2 lagoons and stabilization reservoir | |
| Saintes | unknown | | | unknown | |
| Saint Palais | 55 | 1991 | | Activated sludge and chlorination | |
| Le Lavandou | 30 | 1994 | | Biofiltration and ground filtration | Mediterranean Coast |
| Chanceaux sure Choisille | 5 | 1993 | Sports areas and parks | Activated sludge and lagoon | Hinterland |
| Le Mesnil en Vaillee | 85 | 1995 | Maize and nursery | Aerated lagoon | |
| Clermont Ferrand | 600 | 1996 | Maize | Activated sludge and lagoon | |
| Coullons | 94 | 1994 | Maize | Physicochemical, aerated lagoon, and 2 lagoons | |
| Melle | unknown | 1994 | Maize | Activated sludge, 2 lagoons, and reservoir | |
| Noisilly | 50 | 1993 | Maize and alfalfa | Activated sludge and stabilization reservoir | |

### ***The United Kingdom***

Development of reuse projects within the United Kingdom has not been aggressively researched or implemented due to the presence of sufficient water to meet the potable and irrigation needs of the population. The United Kingdom has been utilizing effluent flows from wastewater treatment facilities to supplement river flows that are ultimately drawn upon to provide a potable drinking water supply and means of agricultural irrigation. A limited number of reuse projects have been developed mainly for irrigation applications including, but not limited to, golf courses, parks, and medians, but also for commercial applications such as car washing (Angelakis & Bontoux, 2001).

England's first major recycling scheme to be incorporated into a building system was employed at the Millennium Dome. The system uses greywater collected from sinks, rainwater runoff, and from a groundwater extraction point onsite. The onsite recycling facility can provide 500 $m^3$/day of treated wastewater through a distribution system independent of potable water supply to flush over 400 toilets and 150 urinals (Radcliffe, 2004).

### *Australia*

Australia is one of the driest continents of the world, receiving an annual rainfall of approximately 50 mm (Anderson, 1996). Serious degradation of river basins has been noticed in urbanized areas in the past few decades, mainly due to the diversion of water supply for irrigation and the high amount of nutrients present in storm water runoff and reclaimed water.

The Sydney Water Corporation operates 27 wastewater treatment plants within the Australian State of New South Wales that collect and treat approximately 1.2 billion liters of wastewater. Approximately 39 million liters per day of wastewater is treated and the effluent is recycled for reuse applications (Sydney Water Corporation, 2004). There are currently 13 reuse projects: five (5) are regulatory driven, and the remaining eight (8) are customer driven (Radcliffe, 2004). The Sydney Water Corporation operates major water recycling schemes at Rouse Hill, provides treated wastewater effluent to more than 15,000 residences, Dunheved, Richmond, Ashlar, Castle Hill and Kiama Golf Courses, Warwick Farm Race Course, the

University of Western Sydney (Hawkesbury Campus), Picton and Gerroa (agricultural reuse) (Sydney Water Corporation, 2004).

### *Wastewater Reuse in the United States*

With a growing population and economy, the collection, use, and disposal of water has never been more critical. Every drop of water not used by a household, farm or business can be used to create higher river flows to benefit fisheries and floodways. Likewise, recycled water stored in reservoirs can be used to recharge over drafted groundwater aquifers.

Wastewater treatment systems in the United States collect, treat, and discharge approximately four (4) billion gallons (15 million $m^3$) of treated effluent per day from an estimated 26 million homes, businesses, and recreational facilities nationwide. Twenty-five percent of the U.S. population and 40% of new development projects rely on onsite wastewater treatment systems (Census Bureau, 1997).

### ***USEPA Reuse Guidelines***

The USEPA, in conjunction with the United States Agency for International Development, published the technical manual *Guidelines for Water Reuse* in 1992 to present guidelines for utilities and regulatory agencies within the United States to aid in the development of reuse programs and appropriate regulations regarding the use of reclaimed wastewater (USEPA, 1992).

In the United States the development of water reclamation regulations and the standards dictating the quality of water needed for a particular reuse application are left to state agencies. The Guidelines for Water Reuse primarily address water reclamation for non-potable urban, industrial, and agricultural reuse (USEPA, 1992), expanding upon the guidelines prepared by the WHO, which are limited to agricultural irrigation.

In response to increasing population and demand of a viable water supply, as illustrated in Figure 3, it became necessary for the USEPA to introduce guidance for non-potable water reuse. The United States Geological Survey (USGS) compiled data regarding the end use of all water withdrawals in the United States by category in 2004. Figure 4 shows that behind the generation of thermoelectric power, irrigation is the most common use for fresh water withdrawn from surface and groundwater.

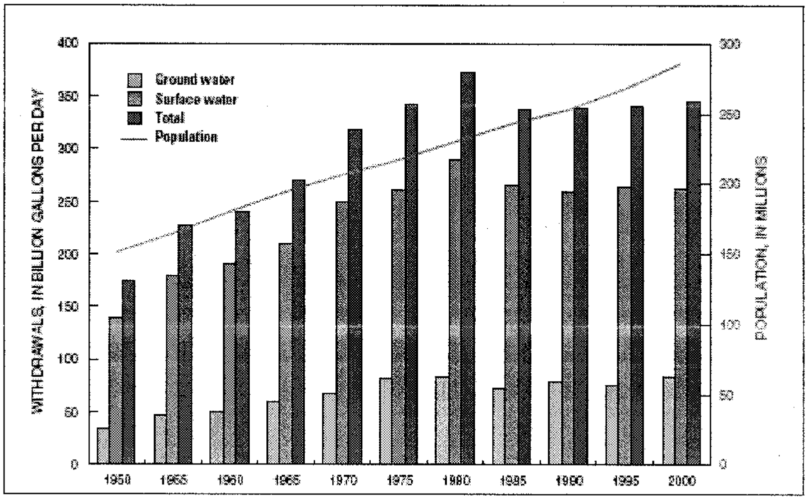


**Figure 3: Trends in Population and Freshwater Withdrawals by Source in the United States, 1950 - 2000 (Hutson, et. al, 2004)**

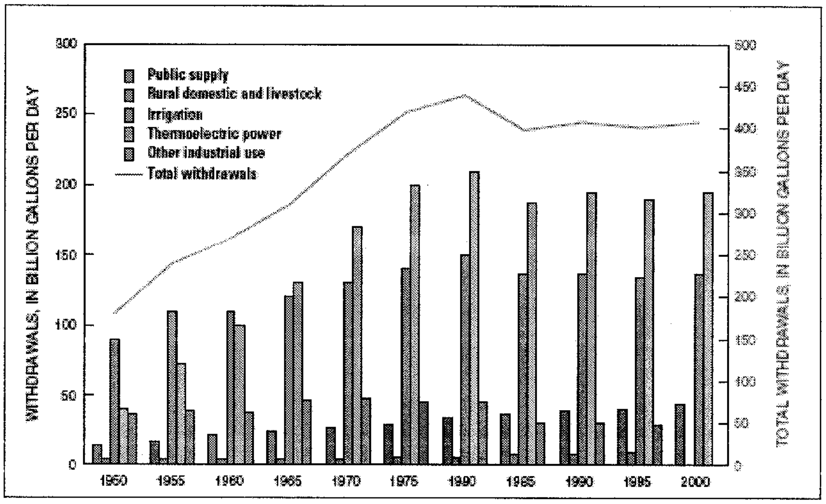


**Figure 4: Trends in Total Water Withdrawals by Water Use Category in the United States, 1950 - 2000 (Hutson, et. al, 2004)**

Increasing population and urbanization have placed a large strain on the potable water supply to provide water for daily needs. Billions of gallons of water are being withdrawn daily from surface water bodies and groundwater aquifers and being diverted from the drinking water supply for power generation and irrigation purposes. Harnessing and reusing reclaimed water for irrigation will provide much needed relief to the current water supply. In order to protect public health and the environment, the USEPA proposed the guidelines for reclaimed water quality, depending on application, as shown in Table 10.

Several states within the United States have actively incorporated wastewater reuse into their environmental regulations as a means of providing an alternative supply for irrigation and to protect dwindling groundwater supplies. California and Florida have been in the forefront of wastewater reuse in the United States since the 1970s.

**Table 10: USEPA Guidelines for Wastewater Reuse (adapted from USEPA, 1992)**

| Type of Reuse | Treatment Required | Reclaimed Water Quality | Recommended Monitoring | Setback Distances |
|---|---|---|---|---|
| **URBAN REUSE** | | | | |
| All types of landscape irrigation, vehicle washing, toilet flushing, fire protection, commercial air conditioners, and other uses with similar access or exposure to the water | Secondary Treatment | pH = 6-9 | Weekly | 50 ft (15 m) to potable supply wells |
| | | BOD ≤ 10 mg/L BOD | Weekly | |
| | Filtration | NTU ≤ 2 | Continuous | |
| | Disinfection | Minimum 1 mg/L $Cl_2$ residual | Continuous | |
| | | No detectable fecal coliform/100 mL | Daily | |
| **RESTRICTED ACCESS AREA IRRIGATION** | | | | |
| Sod farms, silviculture sites, and other areas where public access is prohibited, restricted, or infrequent | Secondary Treatment | pH = 6-9 | Weekly | 300 ft (90 m) to potable water supply wells; 100 ft (30 m) to areas accessible to the public (if spray irrigation) |
| | | BOD ≤ 30 mg/L | Weekly | |
| | | SS ≤ 30 mg/L | Daily | |
| | Disinfection | $Cl_2$ residual = 1 mg/l min. | Continuous | |
| | | FC ≤ 200/100 ml | Daily | |
| **AGRICULTURE** | | | | |
| ***FOOD CROPS NOT COMMERCIALLY PROCESSED*** | | | | |
| Surface or spray irrigation of any food crop, including crops eaten raw | Secondary Treatment | pH = 6-9 | Weekly | 50 ft (15 m) to potable supply wells |
| | | BOD ≤ 10 mg/L BOD | Weekly | |
| | Filtration | NTU ≤ 2 | Continuous | |
| | Disinfection | Minimum 1 mg/L $Cl_2$ residual | Continuous | |
| | | No detectable fecal coliform/100 mL | Daily | |
| ***FOOD CROPS COMMERCIALLY PROCESSED*** | | | | |
| Surface irrigation of orchards and vineyards | Secondary Treatment | pH = 6-9 | Weekly | 300 ft (90 m) to potable water supply wells; 100 ft (30 m) to areas accessible to the public (if spray irrigation) |
| | | BOD ≤ 30 mg/L | Weekly | |
| | | SS ≤ 30 mg/L | Daily | |
| | Disinfection | $Cl_2$ residual = 1 mg/l min. | Continuous | |
| | | FC ≤ 200/100 ml | Daily | |
| ***NON FOOD CROPS*** | | | | |
| Pasture for milking animals, fodder, fiber, and seed crops | Secondary Treatment | pH = 6-9 | Weekly | 300 ft (90 m) to potable water supply wells; 100 ft (30 m) to areas accessible to the public (if spray irrigation) |
| | | BOD ≤ 30 mg/L | Weekly | |
| | | SS ≤ 30 mg/L | Daily | |
| | Disinfection | $Cl_2$ residual = 1 mg/l min. | Continuous | |
| | | FC ≤ 200/100 ml | Daily | |

| **Type of Reuse** | **Treatment Required** | **Reclaimed Water Quality** | **Recommended Monitoring** | **Setback Distances** |
|---|---|---|---|---|
| **GROUNDWATER RECHARGE** | | | | |
| Spreading or injection into nonpotable aquifers | Site specific and use dependent | Site specific and use dependent | Depends on treatment and use | 300 ft (90 m) to potable water supply wells; 100 ft (30 m) to areas accessible to the public (if spray irrigation) |
| | Minimum primary treatment for spreading | | | |
| | Minimum secondary treatment for injection | | | |
| **INDIRECT POTABLE REUSE** | | | | |
| Groundwater recharge by spreading into potable aquifers | Site specific | Site specific | pH - daily | 2000 ft (600 m) to extraction wells; Distance may vary depending on treatment provided and site specific conditions |
| | Minimum of secondary treatment and disinfection | | Coliform - daily | |
| | Filtration and/or advanced wastewater treatment process may be required | Must meet drinking water standards after percolation through vadose zone | $Cl_2$ residual - continuous | |
| | | | Drinking water standards - quarterly | |
| Groundwater recharge by injection into potable aquifers | Secondary Treatment | pH = 6.5 - 8.5 | Daily | 2000 ft (600 m) to extraction wells; Distance may vary depending on treatment provided and site specific conditions |
| | Filtration | NTU $\leq$ 2 | Continuous | |
| | Disinfection | Minimum 1 mg/L $Cl_2$ residual | Continuous | |
| | Advanced wastewater treatment | No detectable fecal coliform/100 mL | Daily | |
| | | Must meet drinking water standards | Quarterly | |

### *State of California*

California was at the forefront of the development of reclaimed wastewater regulations and use, as water reuse has been practiced in California since the 1890s, when raw sewage was applied on sewer farms. Wastewater reuse programs have continually increased throughout the State. Historically, agricultural use has dominated, and continues to do so, but over the past decade reclaimed wastewater has been increasingly used for landscape irrigation in urban areas and for groundwater recharge (Pescod, 1992). The amount of reclaimed water used in California during 2001 is shown in Figure 5.

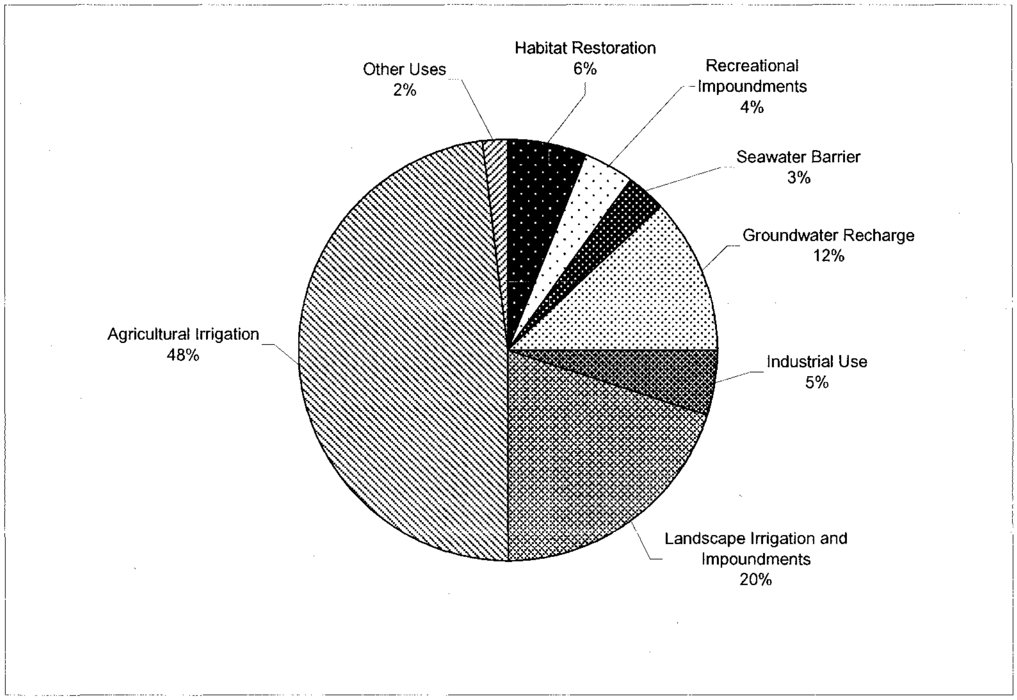


**Figure 5: Reclaimed Water Usage by Flow Percentage in California, 2001**

Wastewater reclamation criteria have been in force in California since 1978, as issued by the California Department of Health Services. For surface irrigation of food crops the requirement is for the effluent to be adequately disinfected and oxidized so that the median number of fecal coliform organisms does not exceed 2.2 CFU per 100 ml over 7 days (Pescod, 1992).

### *State of Florida*

Water reuse has rapidly become an integral part of wastewater management and water resource management in Florida. In 2001, reuse capacity in Florida totaled 1,151 million gallons per day (MGD) and 584 MGD of reclaimed water was actually used for a range of beneficial purposes.

Like many other areas, golf courses in Florida benefit greatly from the reclaimed wastewater. In 2001, 185 reuse systems included one or more golf courses within their list of reclaimed water customers. Reuse systems featuring golf course irrigation represent about 43 percent of all reuse systems in Florida. Approximately 187 MGD of freshwater is added to 110 MGD of reclaimed water used to irrigate 419 of Florida's golf courses (Use of Reclaimed Water on Golf Courses, 2001). According to the Florida DEP 2003 Reuse Inventory, the number of golf courses irrigated with reclaimed water rose to 427. Additional information from the Florida DEP (2004) showed that 486 parks, 213 schools, and 154,234 residences were using reclaimed water for irrigation purposes during 2003. Reclaimed water use by application type and percentage of total reuse flow for 2003 is shown in Figure 6.

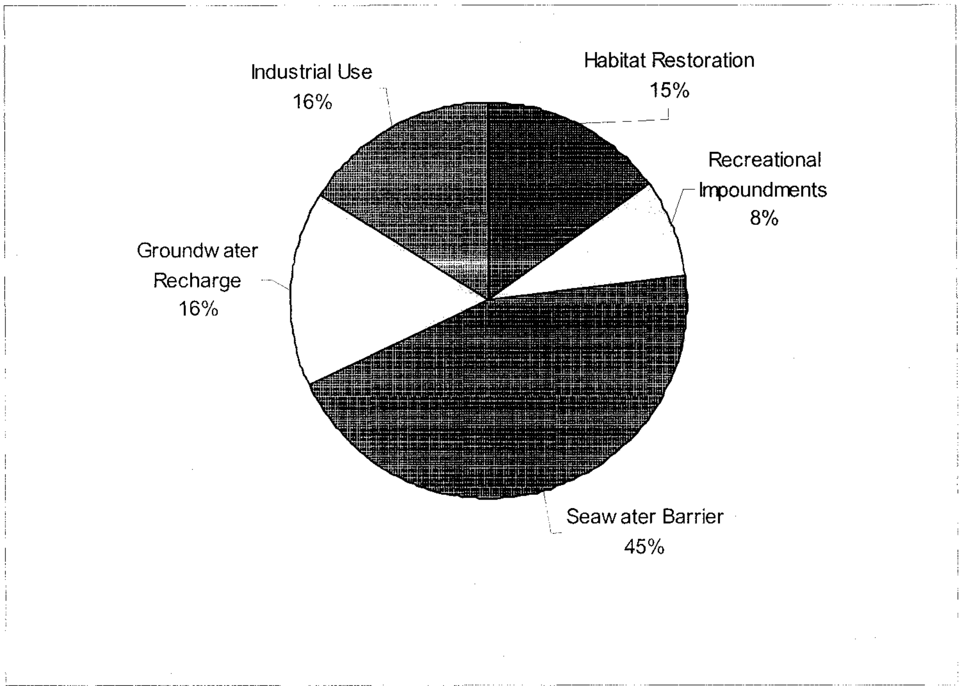


**Figure 6: Reclaimed Water Usage by Flow Percentage in Florida, 2003 (Florida DEP, 2004)**

In an effort to protect the sensitive environment and the population residing in Florida from the effects of wastewater effluent discharge, all WWTPs are required to be designed and operated to meet established primary and secondary drinking water standards (FAC, 1999). Recent increases in detection of rates of new organic compounds within the wastewater stream, as discussed previously, has led Florida to implement limits on the concentration of total organic compounds. The allowable concentration of total organic carbon (TOC) is limited to an average of 3.0 mg/L on a monthly basis, and no single sample is permitted to exceed 5.0 mg/L, as established by FAC Chapter 62-610 *et. seq.* (FAC, 1999).

### *State of New Jersey*

New Jersey has approximately 5,200 actively permitted wastewater treatment facilities treating various type of wastewater, including municipal and industrial wastewaters. Of the actively permitted wastewater treatment facilities, 157 are classified as major municipal and non-municipal facilities. Major municipal and non-municipal wastewater treatment facilities, defined as those facilities with a treatment throughput of greater than 0.1 MGD, located in New Jersey are depicted in Figure 7 below.

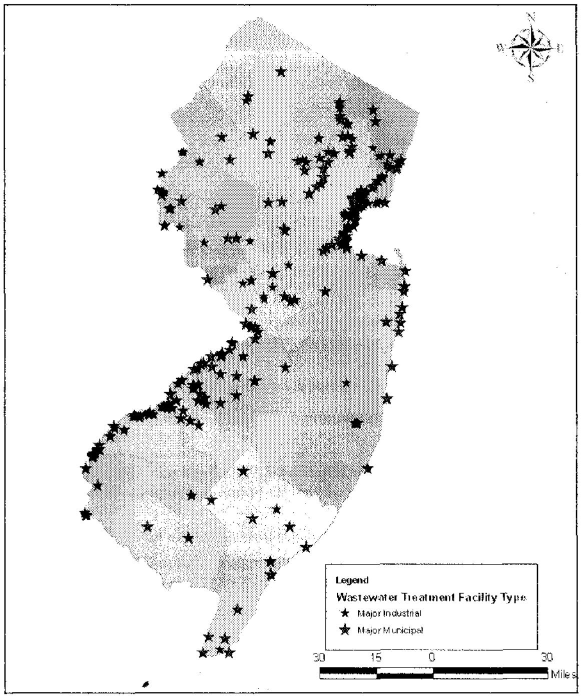


**Figure 7: Major Municipal and Non-Municipal Facilities Located in New Jersey**

In the state of New Jersey, wastewater reuse is just beginning to be incorporated as a means of alleviating water shortages. Municipalities and treatment plants across the state are working to receive permits to use reclaimed wastewater. Several projects have already been permitted to provide treated effluent for use in beneficial applications. These facilities are shown in Figure 8 and the annual usage of treated wastewater by these facilities in 2003 is shown in Table 11 (Grob, 2004). The table indicates that wastewater is being used more for non-contact cooling and street cleaning purposes than irrigation.

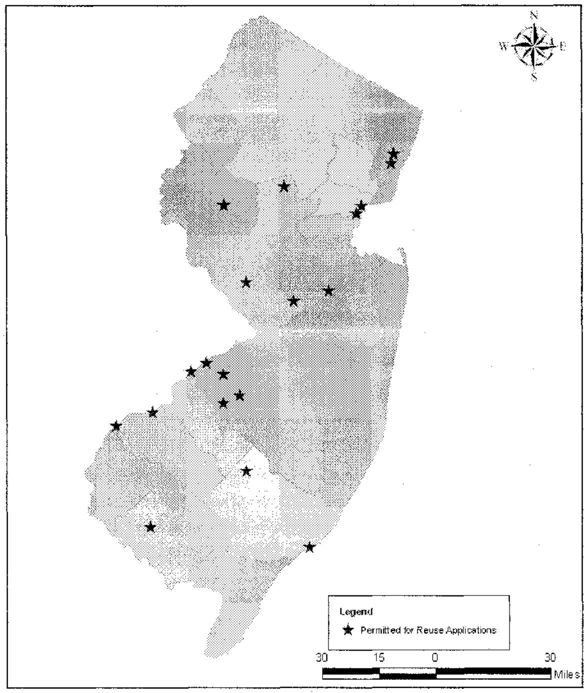


**Figure 8: Major Wastewater Treatment Facilities Permitted to Provide Reclaimed Water for Beneficial Reuse in New Jersey**

**Table 11: Annual Use Reports for Permitted Beneficial Reuse Projects in New Jersey (Grob, 2004)**

| Reuse Facility | Type of Reuse | 2003 Reuse (MG/year) |
|---|---|---|
| Elmwood WWTP | Spray Irrigation/golf course | 11.4 |
| Atlantic County Utility Authority | Cooling water for Incinerators | 918.8 |
| Riverside STP | Sewer Jetting/Street Cleaning | 0.133 |
| Secaucus | Sewer Jetting/Street Cleaning | 0.0 |
| Gloucester County Utility Authority | Non Contact Cooling water | 0.0 |
| Bergen County Utility Authority | Non Contact Cooling Water | 224.7 |
| Lower Township MUA | Spray Irrigation/Golf Course | 0.0 |
| Bristol Myers Squibb | Non Contact Cooling Water | 0.0127 |
| Mt. Laurel Township MUA | Spray Irrigation, Composting | 0.0 |

| Reuse Facility | Type of Reuse | 2003 Reuse (MG/year) |
|---|---|---|
| Clinton MUA | Spray Irrigation | 0.0354 |
| Exxon Mobil | Cooling Tower Water | 1.78 |
| Linden Roselle SA | Non Contact Cooling Water | 0.0 |
| Joint Meeting of Essex & Union | Non Contact Cooling Water | 0.0 |
| Medford Township | Restricted Access Reuse Activities | 2.286 |
| Hightstown Advanced WWTP | Sewer Jetting & Street Sweeping | 0.0586 |

After a record breaking drought in 2002, the New Jersey Department of Environmental Protection (NJDEP) requested proposals from more than 450 water purveyors, wastewater dischargers and agricultural users for projects that would best supplement New Jersey's water resources through reuse (NJDEP, 2005). Fifty two proposals were submitted to the NJDEP and in January 2005, NJDEP awarded 23 water demonstration projects $35 million in funding for implementation that has the potential to preserve more than six (6) million gallons of water on a daily basis. The selected projects will use treated wastewater in a variety of applications including irrigation, cooling operations at industrial facilities, groundwater recharge, and the prevention of saltwater intrusion (NJDEP, 2005). The selected water demonstration projects are listed in Table 12 below:

**Table 12: Projects Awarded NJDEP Funding for Wastewater Reuse (NJDEP, 2005)**

| Project Name | Municipality | DEP Funding |
|---|---|---|
| Borgata/Marina Thermal | Atlantic City | $3,260,000 |
| K. Hovnanian Four Seasons | Galloway Township | $1,536,745 |
| Bayway Refinery | Linden City | $333,333 |
| Cape May County MUA | Cape May City | $5,200,000 |
| Cape May County MUA | Countywide | $640,000 |
| Clayton Borough | Clayton Borough | $430,000 |
| Deerwood Country Club | Mount Holly | $533,333 |
| Glassboro Borough | Glassboro Borough | $3,750,000 |
| Homestead at Mansfield | Mansfield Township | $116,241 |
| Island Beach State Park | Seaside Park | $600,000 |
| Lakewood Cogen Facility | Lakewood Township | $2,466,667 |
| Laurel Creek Country Club | Moorestown Township | $240,000 |
| Logan Twp. MUA | Logan Township | $4,112,000 |
| New Jersey State Climatologist | Statewide | $195,000 |
| Pennsauken Country Club | Pennsauken Township | $1,213,333 |
| Maple Shade Township | Maple Shade Township | $313,333 |
| Rowan University/Pitman Golf Course | Borough of Glassboro | $1,666,667 |

| **Project Name** | **Municipality** | **DEP Funding** |
|---|---|---|
| Scrub Oaks Mine Storage Plan | Mine Hill Township | $500,000 |
| Shark River Golf Course | Neptune Township | $2,666,667 |
| Vineland Power Plant | Vineland | $170,799 |
| Water Treatment Technology | Statewide | $2,000,000 |
| Waywayanda State Park | Hewitt | $400,000 |
| Whitlock Packaging Corporation | Wharton Borough | $233,333 |

Permitted reuse programs within the State of New Jersey currently provide approximately 1,160 MGD of treated effluent for beneficial reuse. It should be noted that not all of the permitted reuse programs are providing treated effluent for beneficial reuse. Great potential to provide a viable, renewable supply of water for irrigation and groundwater recharge purposes exists in New Jersey. A movement towards investigation of the possibility of incorporating a wastewater reuse plan into water management initiatives is currently being investigated by Burlington County, as discussed in the following Chapter.

# Chapter Three

## Burlington County, New Jersey

The State of New Jersey is composed of 21 counties covering an area of approximately 7,788 square miles. Burlington County is located in the southern portion of New Jersey, south of the capital of Trenton, and is the largest county in New Jersey. Covering an area of approximately 827 square miles, Burlington County is bordered to the west by the Delaware River and to the east by the Atlantic Ocean. Burlington County and the municipalities that are found within its borders can be seen in Figure 9 below. Full scale figures provided in this chapter are provided in Appendix A.

### *Environmental Management in Burlington County*

Burlington County has been engaged in land use planning through a number of programs. The County is taking bold measures for environmental protection through open space acquisition and preservation, farmland preservation, watershed management initiatives, and smart growth planning. Areas of open space that have been preserved in Burlington County are shown in Figure 10.

The County has taken initiative in managing water supply from the State-designated Critical Water Area #2 of the Potomac-Raritan-Magothy (PRM) aquifer. Saltwater intrusion problems in the PRM aquifer have led the NJDEP to delineate the Critical Water Area #2 wherein new water withdrawals are restricted. The Board of Freeholders created an allocation plan for the restricted supply from the PRM and that allocation plan is carried out through a Water Allocation Credit Bank. In addition, the Burlington County began to consider alternate sources of water to address future water demands. A promising potential source is the beneficial reuse of reclaimed wastewater.

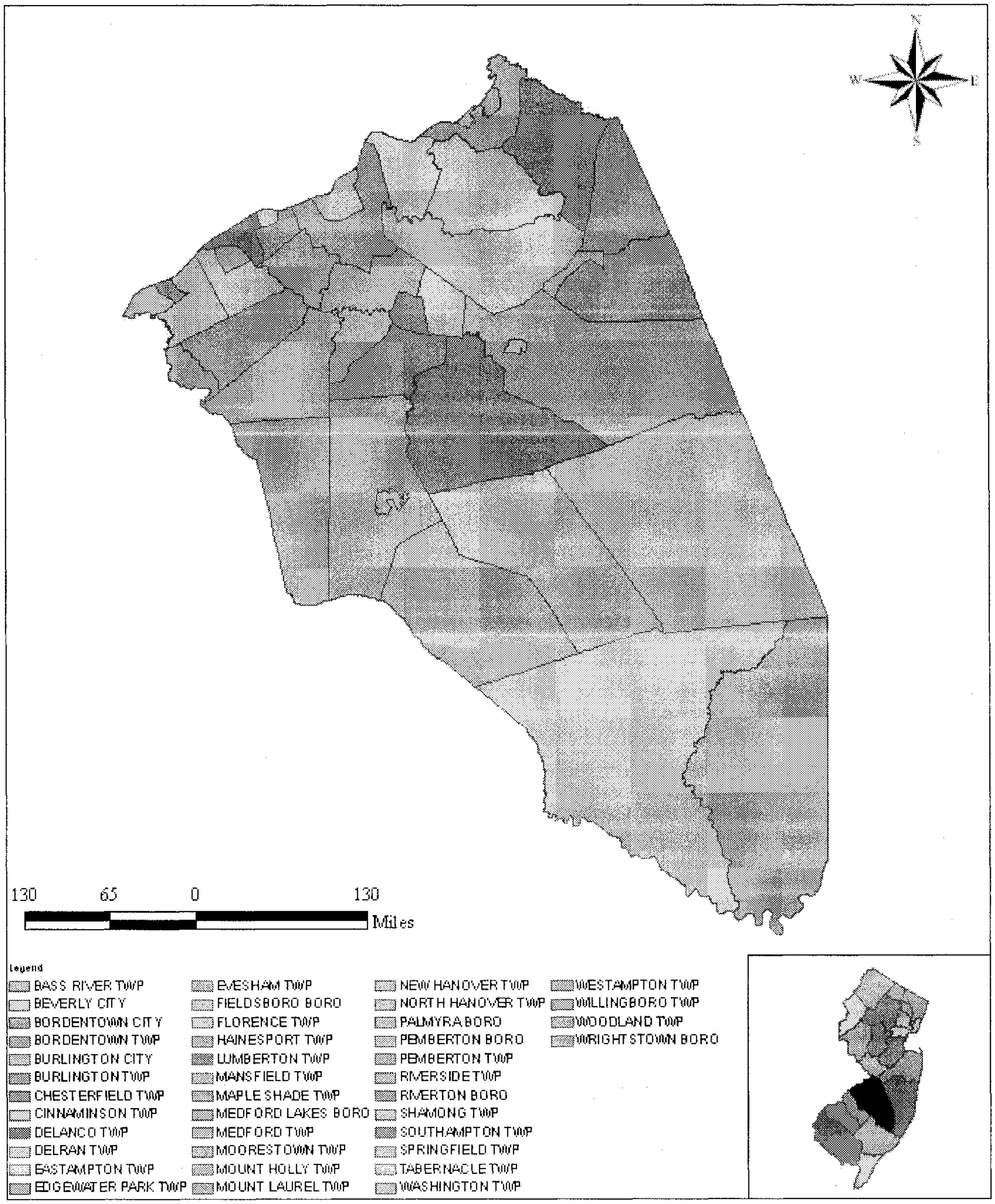


Figure 9: Burlington County, New Jersey

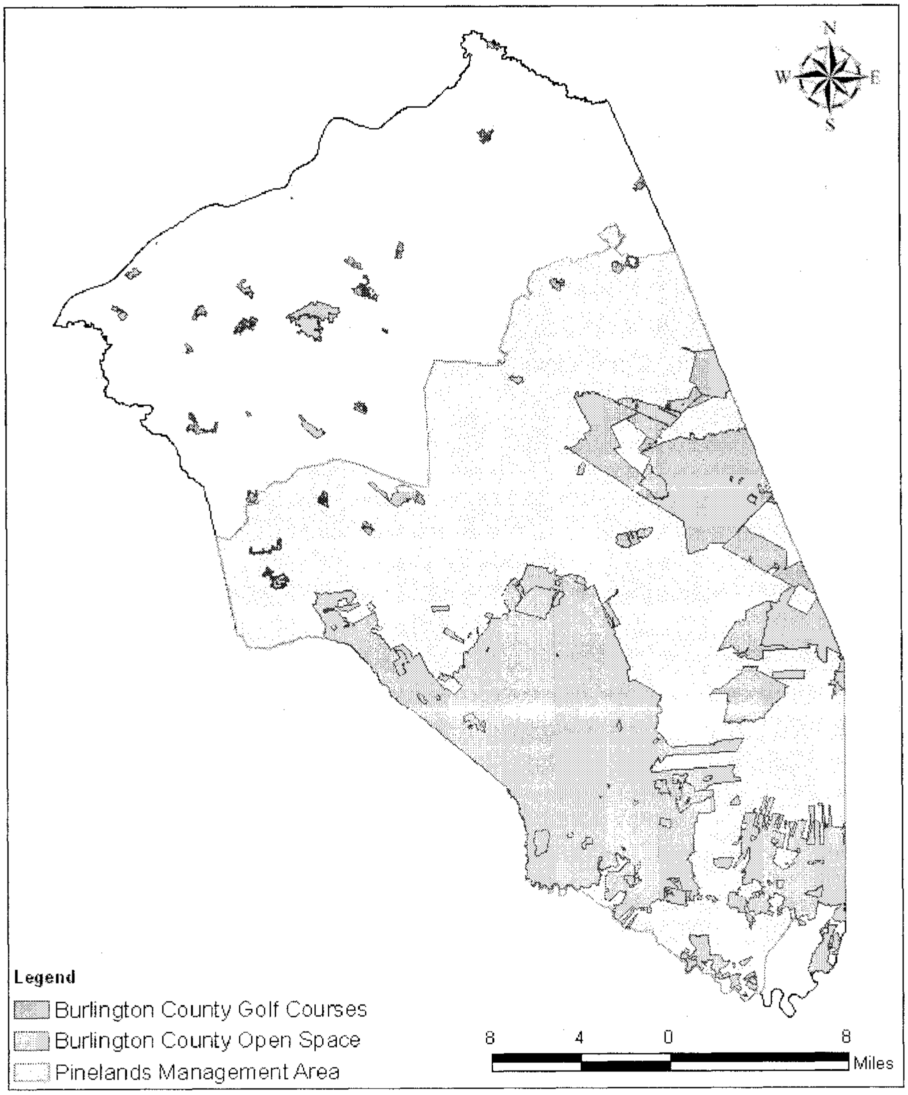


**Figure 10: Open Space Preservation in Burlington County**

The importance of reclaimed wastewater for beneficial reuse (RWBR) became significant during the drought of 1999 in New Jersey. During the drought period many wastewater treatment plants received authorization to reuse their treated effluent for various beneficial reuse applications. Several facilities have now built in effluent reuse as part of their NJPDES permit. Reclaimed wastewater is now considered a valuable resource by municipalities, industries, and County parks.

The majority of Burlington County falls within the boundaries of the Pinelands National Reserve, which was created by Congress under the National Parks and Recreation Act in 1978. The Pinelands National Reserve encompasses approximately 1.1 million acres and occupies 22% of New Jersey's land area. The Pinelands Protection Act, N.J.S.A. 13:18A-1 et. seq., promote the orderly development of the Pinelands National Reserve to preserve and protect the significant and unique natural, ecological, agricultural, archaeological, historical, scenic, cultural and recreational resources of the Pinelands National Reserve (State of New Jersey Pinelands Commission, 2004).

### *Geologic Setting of Burlington County*

The State of New Jersey is separated into four distinct physiographic provinces. Three of these physiographic provinces are located in the northern half of the state and include the Appalachian Valley, the Highlands, and the Piedmont. The remaining province fully encompasses the southern half of the state. This province is known as the Atlantic Coastal Plain. Burlington County lies wholly within the Atlantic Coastal Plain. The physiographic provinces of New Jersey are shown in Figure 11 below.

The Atlantic Coastal Plain consists of a series of unconsolidated deposits of sand with some clay, silt, and gravel. The formations found in the Atlantic Coastal Plain date from the Cretaceous through Tertiary periods plus the Quaternary period (Tedrow, 1986). The formations range from heavy clays to coarse gravelly sands. Mineralogy within the Atlantic Coastal Plain varies from nearly all quartz to all glauconite.

Glauconite is a finely divided, dioctahedral micaceous mineral of marine origin. While globally it is present in deposits dating from the pre-Cambrian to the present, in New Jersey it is concentrated in the Cretaceous and lower Tertiary age deposits (Tedrow, 2002). Glauconite is described as predominantly sand-size, generally greenish aggregates found in unconsolidated deposits and sedimentary rocks. It is also described as an iron-rich, mica-like mineral analogous of an illite. The mineral is rich in iron and consists of various colors: green, yellow, bluish, red, or black. Some glauconite may be nearly colorless (Tedrow, 2002).

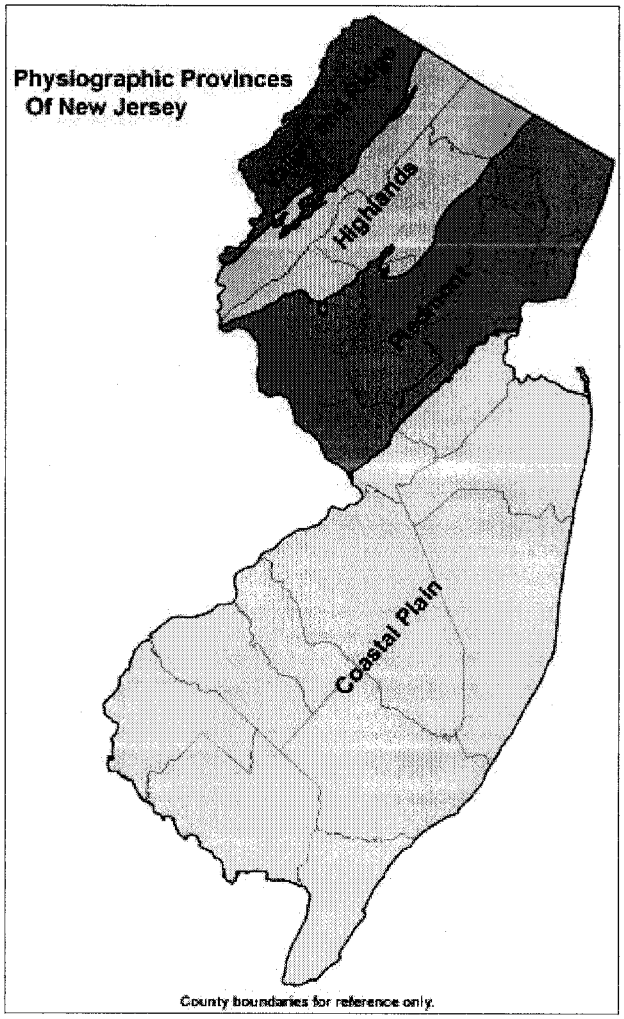


**Figure 11: Physiographic Provinces of New Jersey (NJ Geological Survey, 2002)**

Glauconite deposits, as illustrated by New Jersey conditions, are generally unconsolidated but, in many parts of the world glauconite is a constituent of consolidated rock types such as sandstone, shale, limestone and dolomite. Both New Jersey and Burlington County have a rich history in mining glauconite rich sandy materials, known as greensand, for use as a fertilizing agent in agriculture. Greensand is described by Tedrow (2002) as a predominantly sand-sized generally unconsolidated deposit that is usually green owing to a considerable proportion of glauconite.

Greensand pits were located throughout the southern half of New Jersey, as greensand deposits have generally been associated with formations located in the Atlantic Coastal Plain. Figure 12 depicts the location of the greensand mining pits in the early 20th century (Tedrow, 2002). It should be noted that Burlington County and Monmouth County appear to have the most greensand mining pits in the Atlantic Coastal Plain.

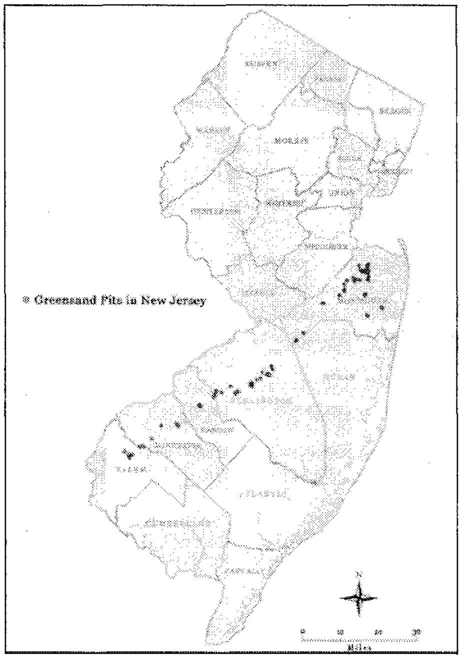


**Figure 12: Greensand Pits in New Jersey (Tedrow, 2002)**

Greensands were typically mined, mixed with quick lime for stabilization, and then applied at a rate of 40 to 250 tons per acre for fertilization (Tedrow, 2002), depending on the needs of crops and the soil type. No detailed records are available as to where greensand applications were made to the land in New Jersey. Of the million tons or so dug each year during the mid 1860s it has been estimated that about one half was used locally and distribution was generally within a distance of fifteen (15) to twenty (20) miles or so from the pits. Literature of the late 19th century mentions application to sections such as the "sandy soils in the vicinity of the Monmouth-Ocean County border" and "further to the south". Application of greensand to areas having an appreciable amount of native glauconite such as the Pemberton and Medford Lakes areas was also common practice (Tedrow, 2002). The application of greensands has invariably altered the soil type classification within the County, but this problem does not appear to have been addressed.

Greensands are of importance in Burlington County due to a rich agricultural history and also due to the phosphorus impairment of water bodies throughout the County. Greensands have been identified as having trace amounts of phosphorus, a necessary nutrient for plant and crop growth. Phosphoric acid has been found in greensands at percentages ranging from 0.19% to 6.87%, depending on sample location and depth (Tedrow, 2002). Application of greensands with higher percentages of phosphoric acid may have led to increased amount of phosphorus leaching and runoff in the past.

### *Burlington County Land Use*

Data obtained from the NJDEP, New Jersey Office of Information Resources Management (OIRM), and New Jersey Bureau of Geographic Information and Analysis (BGIA) (NJDEP, et. al., 1986 and NJDEP, et. al., 2000a, 2000b, 2000c, and 2000d) shows that Burlington County covers an area of 524,206 acres and a large portion of the County falls within the Pinelands Protection Area as shown in Figure 13 below. Development is strictly controlled within the limits of the Pinelands Protection Area, resulting in a large amount of forest conservation. Forested areas amounted to a substantial amount, 192,168 acres in 1986, of land usage in

Burlington County. Forested areas decreased by 1,878 acres by 1995, a reduction of less than one percent.

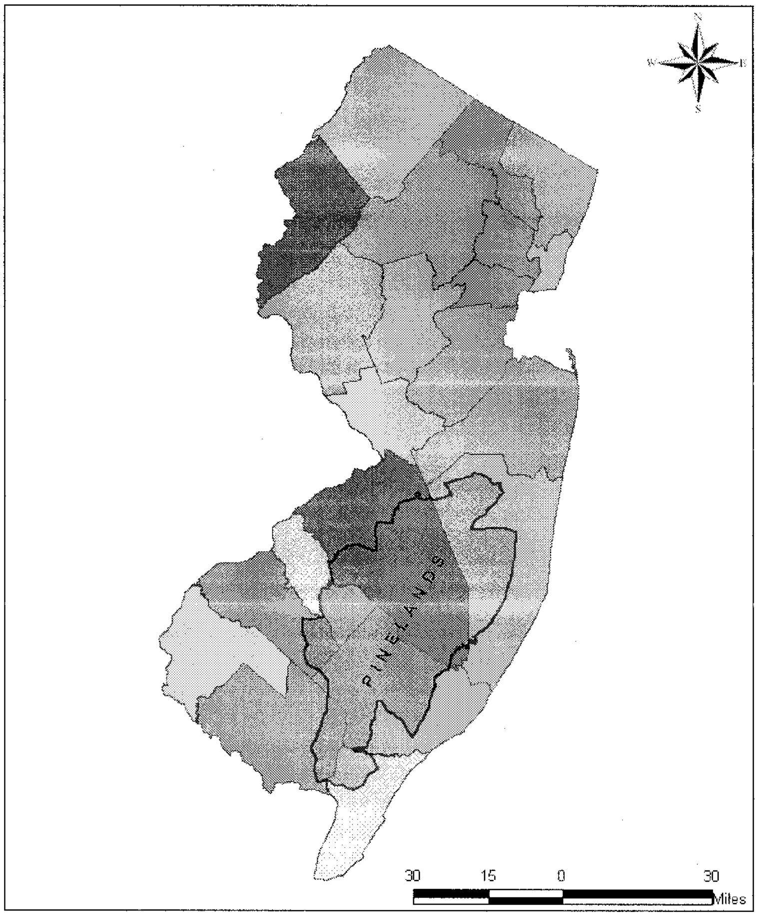
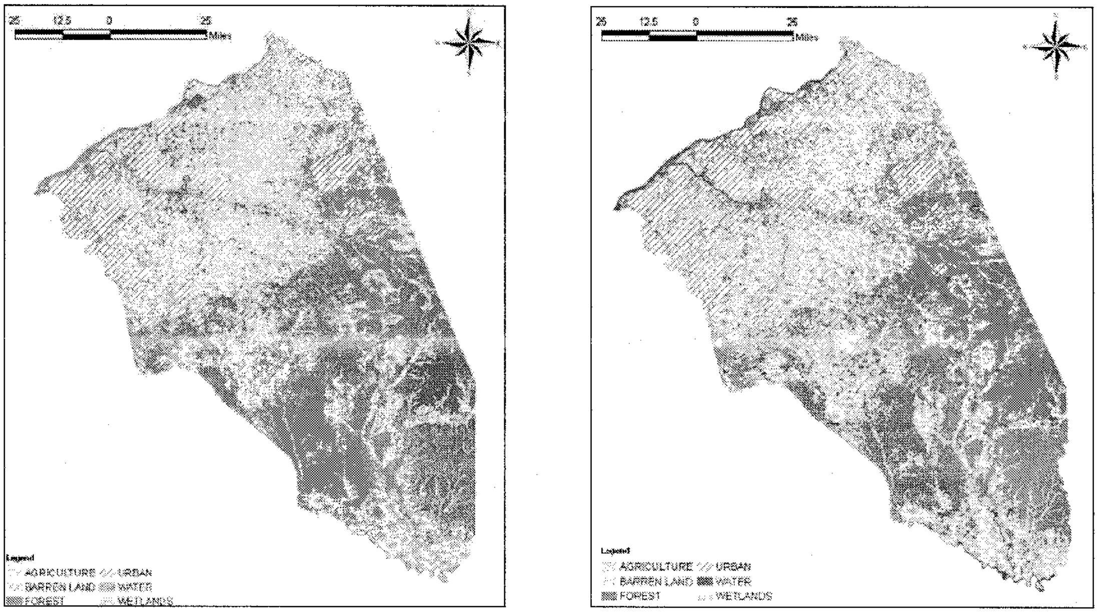


**Figure 13: Boundary of the Pinelands Protection Area in New Jersey**

Wetland areas, as identified by the NJDEP, constitute the second largest land use type in the County and constituted 162,368 acres of Burlington County in 1986. Wetlands are protected both on the federal and state level and are shown to cover approximately the same area in 1995. Urbanization within the County has increased steadily over the past decade. Land use classified as urban totaled 77,234 acres in 1986 and increased to cover 90,746 acres in 1995. Agricultural land use totaled 75,350 acres in 1986 and as a result of increased urbanization, decreased by approximately 10,000 acres to 64,826 in 1995. The remaining acreage in the County is classified as barren land (4,012 acres in 1986 and 4,201 acres in 1995) and water (13,074 acres in 1986 and 13,377 acres in 1995). Figure 14 shows a comparison between land use in Burlington County in 1986 and 1995.



**1986 Land Use** **1995 Land Use**

**Figure 14: Comparison of 1986 Land Use and 1995 Land Use in Burlington County**

Land use changes have influenced the past and current status of water quality throughout the County. Historically agricultural areas are being converted to urban areas in which ground cover becomes impervious. Any contaminants present on the ground surface will be picked up by sheet flow resulting from water travel across impervious areas and deposited in more permeable areas. Burlington County has a number of water bodies that have impaired water quality ratings, as discussed below, as a result of a combination of increased impervious surface area and over fertilization of agricultural and landscaped areas.

### *Water Use by Watershed Management Area in Burlington County*

Burlington County encompasses four (4) NJDEP defined Watershed Management Areas (WMAs): Assiscunk, Crosswicks, and Doctors (WMA 20), Lower Delaware (WMA 18), Mullica (WMA 14), and Rancocas (WMA 19). The majority of Burlington County is within the boundaries of WMA 14 and WMA 19 and the majority of these WMAs fall within the boundaries of the Pinelands Protection Area.

The NJDEP Land Use Management Program and the New Jersey Geological Society created a Microsoft Excel workbook documenting fresh-water withdrawals, fresh-water transfers, sewage transfers, and reclaimed-water discharges in New Jersey on a watershed management areas basis from 1990 to 1999. It also presents withdrawals and discharges on a statewide basis. Withdrawal and use data are presented for potable, commercial, industrial, agricultural, and power-generation uses of more than 100,000 gallons of water a day (Domber & Hoffman, 2004). The data contained in the Excel workbook is summarized by WMA in the following sections. Raw data obtained from the worksheet for each WMA is included as Appendix D.

### ***Assiscunk, Crosswicks, and Doctors (WMA 20) Water Usage***

Freshwater withdrawals from ground water and surface water sources in WMA 20 totaled 2,181,141 million gallons from 1990 through 1999, with an average withdrawal of 218,114 million gallons per year. The majority of the freshwater withdrawals in WMA 20 were from surface water sources. Over the course of the decade, an average of 211,590 million gallons of surface water was withdrawn per year, in contrast to the 6,524 million gallons of ground water withdrawn for use.

Figure 15 below shows annual fresh-water withdrawals, use, imports, and exports. It is divided into two halves. The left half shows fresh-water sources for WMA 20: imports, surface water withdrawals and ground water withdrawals. The right hand side shows what happens to the water: non-consumptive use, consumptive, or exports (Domber & Hoffman, 2004).

The end uses of water withdrawn and used for consumptive and non-consumptive purposes are further divided into use by group. Figure 16 shows annual use of water in WMA 20 by use group. The usage values in the figure are stacked to show the portion of the total usage by group. It can be seen that most water withdrawals were used in power generation, industrial applications, and potable drinking water.

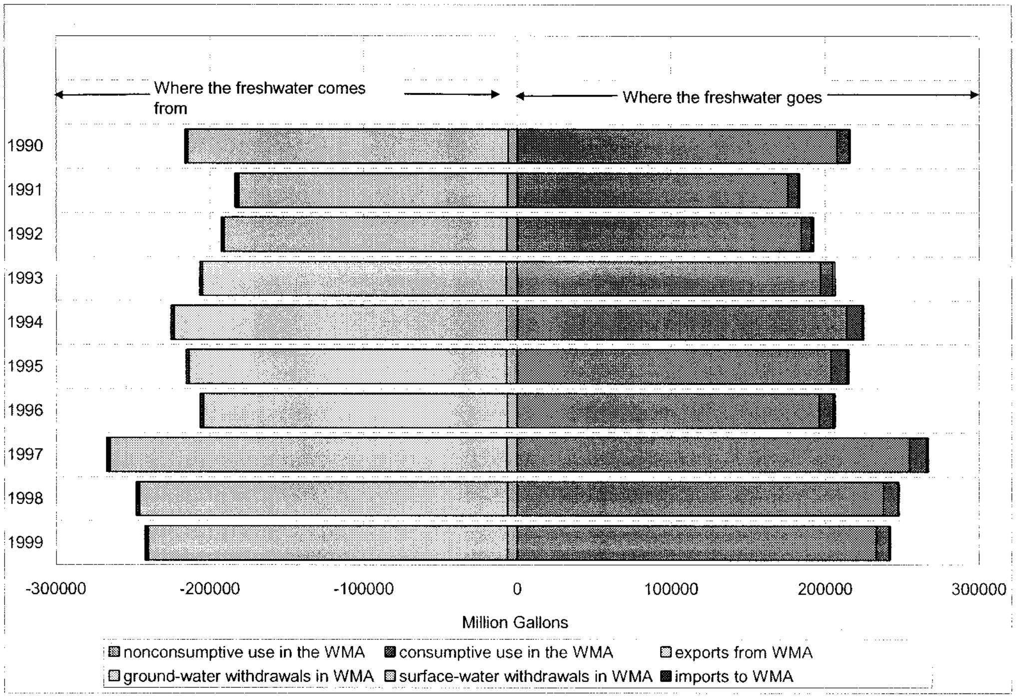


**Figure 15: Freshwater Withdrawals, Use, Imports, and Exports in WMA 20**

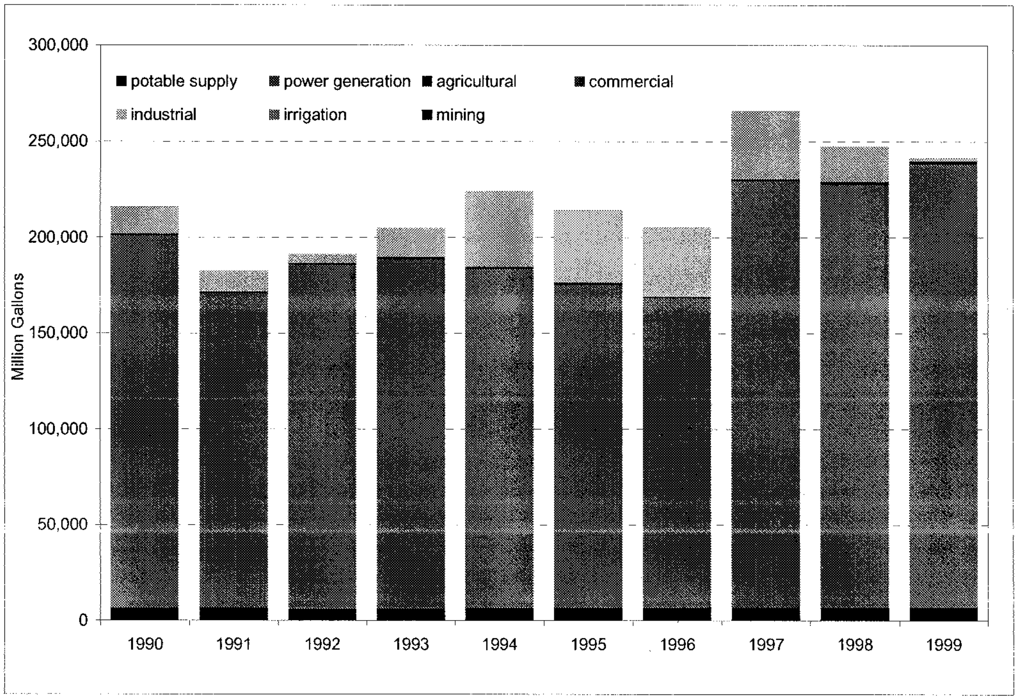


**Figure 16: Uses of Fresh Water in WMA 20**

Total monthly water use in WMA 20 is shown in Figure 17. The figure divides monthly usage into non-consumptive use and consumptive use. This allows for a visual analysis of the seasonal changes in total water used and in consumptive use patterns. Consumptive loss is at a peak in the summer due to evaporation and transpiration impacts on outdoor water use (Domber & Hoffman, 2004).

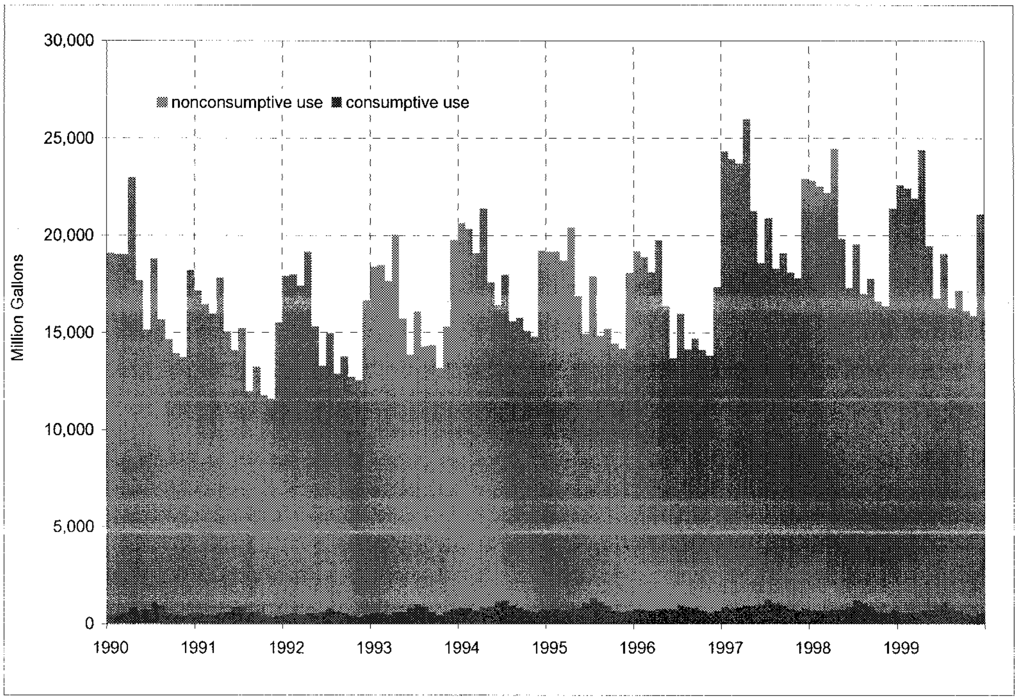


**Figure 17: Monthly Consumptive & Non-Consumptive Water Use in WMA 20**

The movement of sewage and discharge of treated effluent in WMA 20 is shown in Figure 18. The volume of sewage imported into WMA 20 and the volume generated inside WMA 20 are shown on the left hand side. The right hand side shows the volume of sewage exported from WMA 20 and the volume of reclaimed water discharged to fresh water, brackish water, and salt water.

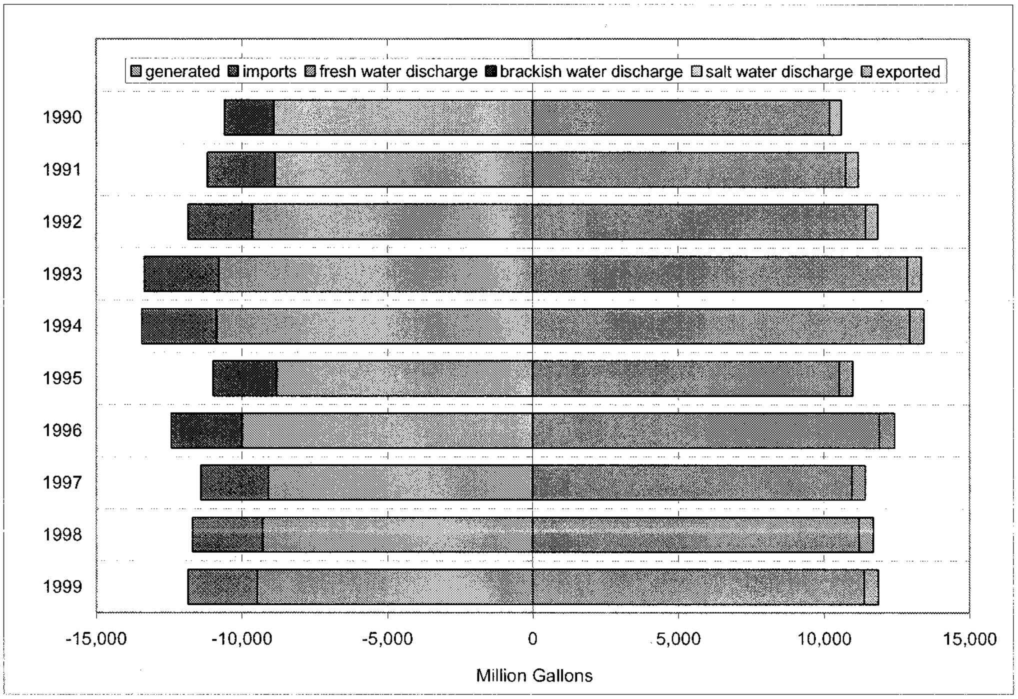


**Figure 18: Sewage Generation, Transfers, and Reclaimed-Water Discharges in WMA 20**

### *Lower Delaware (WMA 18) Water Usage*

Freshwater withdrawals from ground water and surface water sources in WMA 18 totaled 561,624 million gallons from 1990 through 1999, with an average withdrawal of 56,162 million gallons per year. The majority of the freshwater withdrawals in WMA 18 were from ground water sources. Over the course of the decade, an average of 34,532 million gallons of ground water was withdrawn per year, in contrast to the 21,630 million gallons of surface water withdrawn for use.

Figure 19 below shows annual fresh-water withdrawals, use, imports, and exports in WMA 18. Figure 20 shows annual use of water in WMA 18 by use group. It can be seen that most water withdrawals were used for potable supply and industrial applications. Total monthly water use in WMA 18 is shown in Figure 21. The movement of sewage and discharge of reclaimed water in WMA 18 is shown in Figure 22.

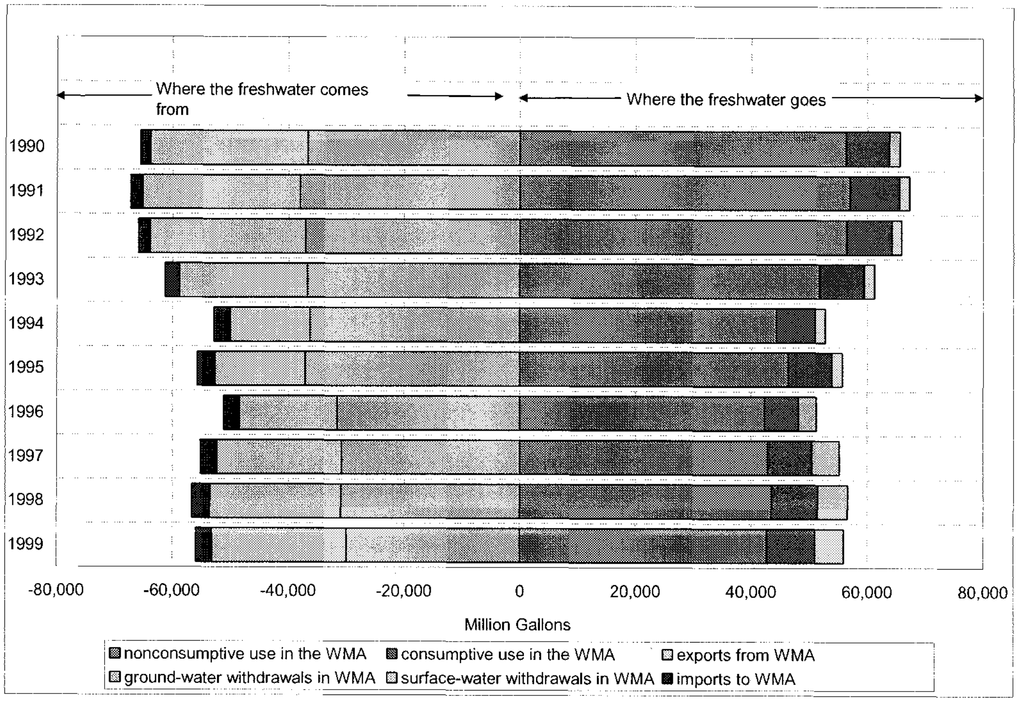


Figure 19: Freshwater Withdrawals, Use, Imports, and Exports in WMA 18

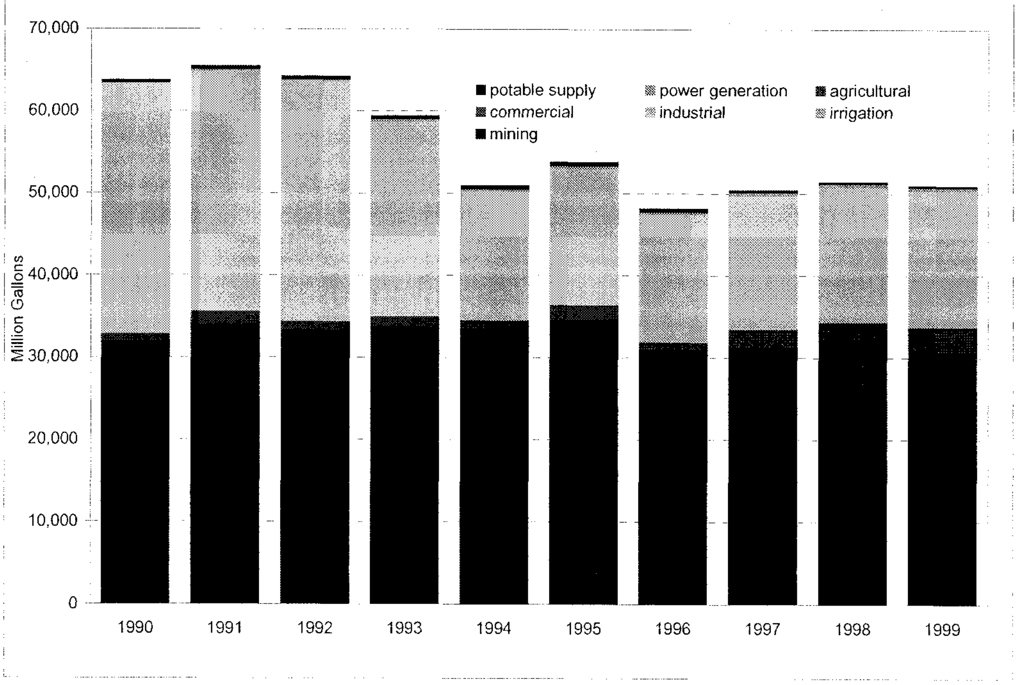


Figure 20: Uses of Fresh Water in WMA 18

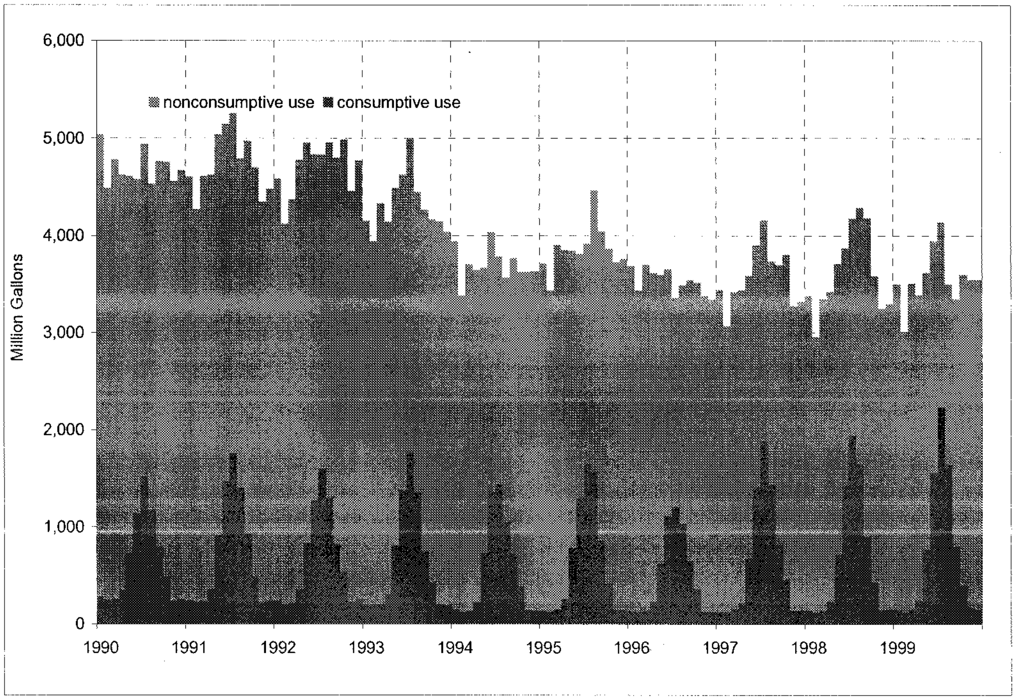


Figure 21: Monthly Consumptive & Non-Consumptive Water Use in WMA 18

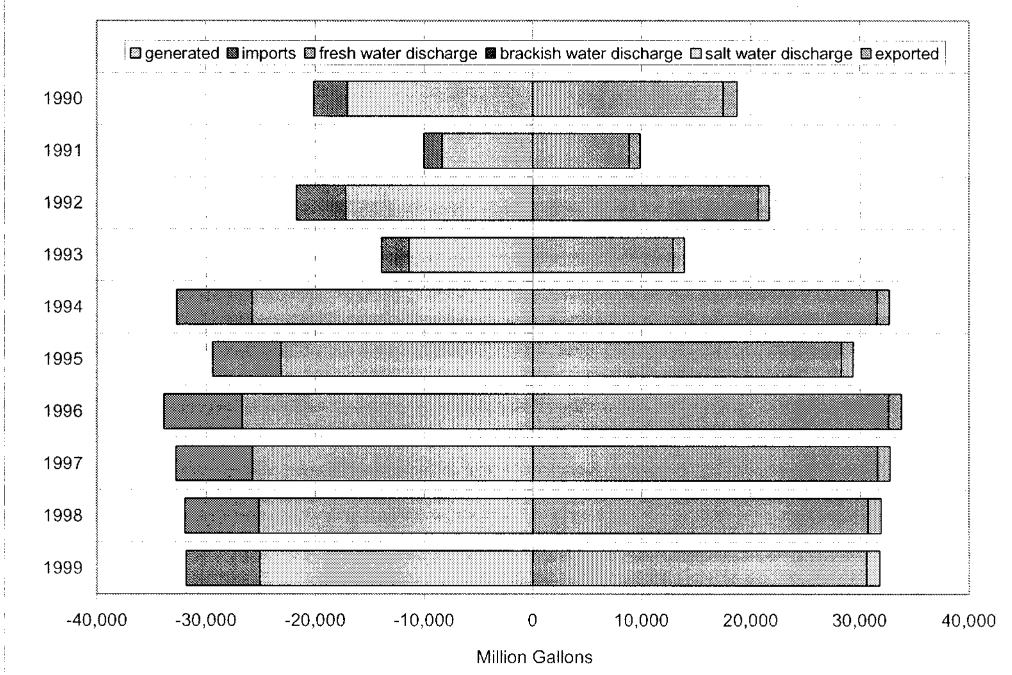


Figure 22: Sewage Generation, Transfers, and Reclaimed-Water Discharges in WMA 18

### *Rancocas (WMA 19) Water Usage*

Freshwater withdrawals from ground water and surface water sources in WMA 19 totaled 166,956 million gallons from 1990 through 1999, with an average withdrawal of 16,696 million gallons per year. The majority of the freshwater withdrawals in WMA 19 were from ground water sources. Over the course of the decade, an average of 10,259 million gallons of ground water was withdrawn per year, in contrast to the 6,437 million gallons of surface water withdrawn for use.

Figure 23 below shows annual fresh-water withdrawals, use, imports, and exports in WMA 19. Figure 24 shows annual use of water in WMA 19 by use group. It can be seen that most water withdrawals were used for potable supply and agricultural operations. Total monthly water use in WMA 19 is shown in Figure 25. The movement of sewage and discharge of reclaimed water in WMA 19 is shown in Figure 26.

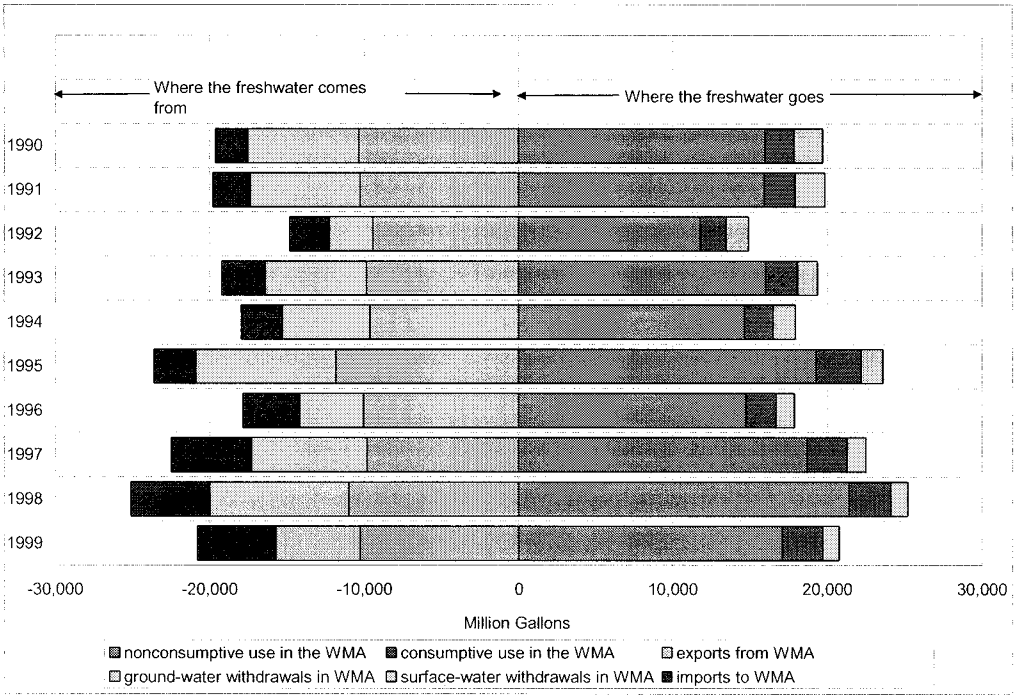


**Figure 23: Freshwater Withdrawals, Use, Imports, and Exports in WMA 19**

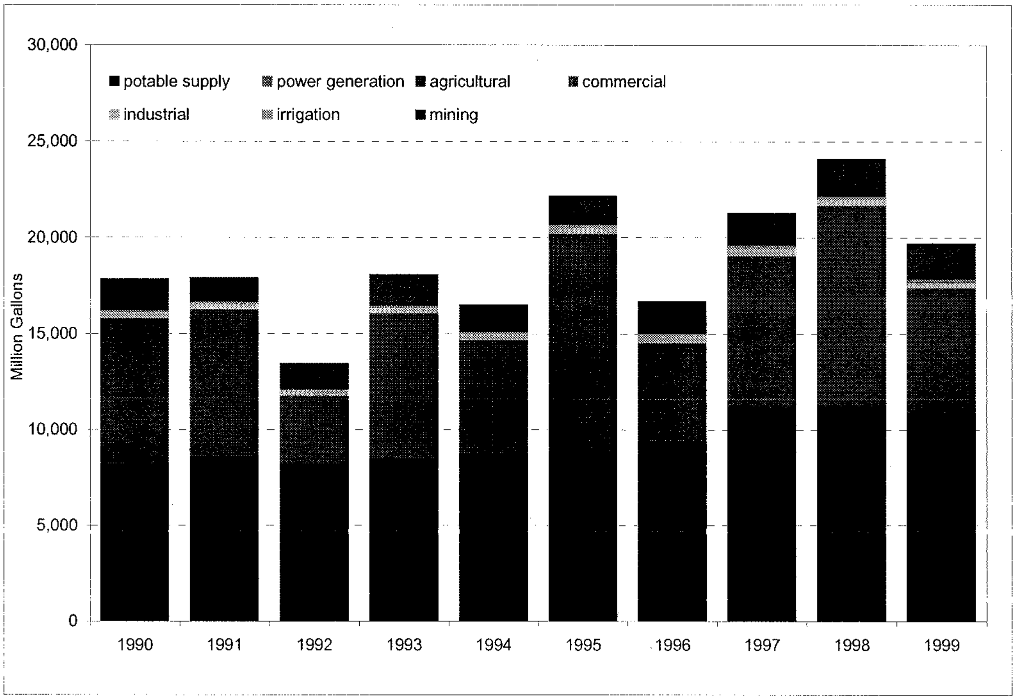


Figure 24: Uses of Fresh Water in WMA 19

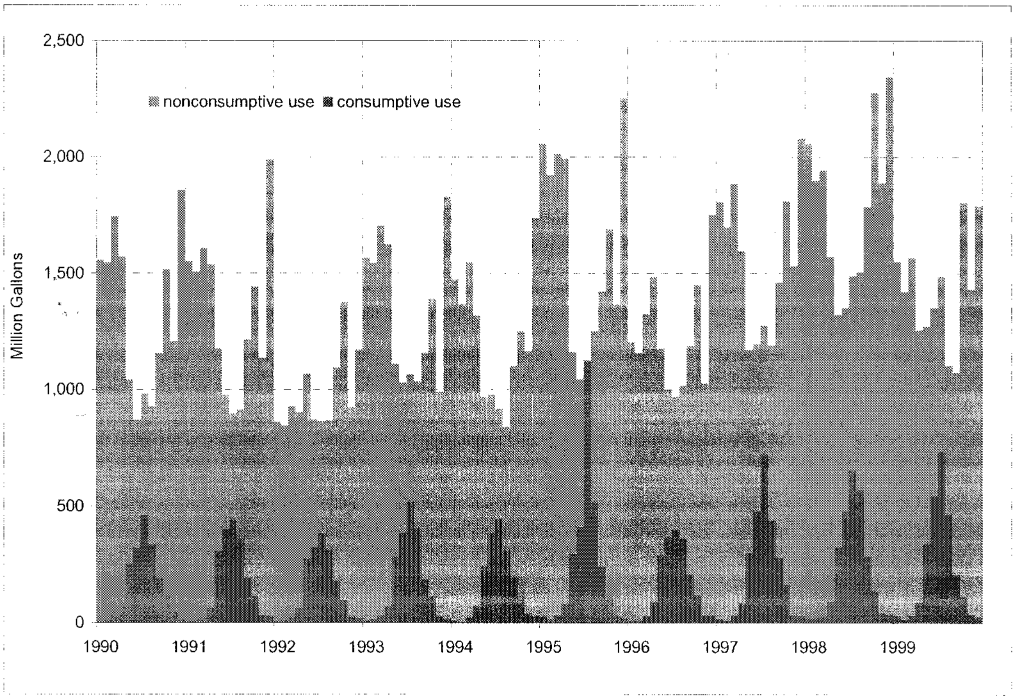


Figure 25: Monthly Consumptive & Non-Consumptive Water Use in WMA 19

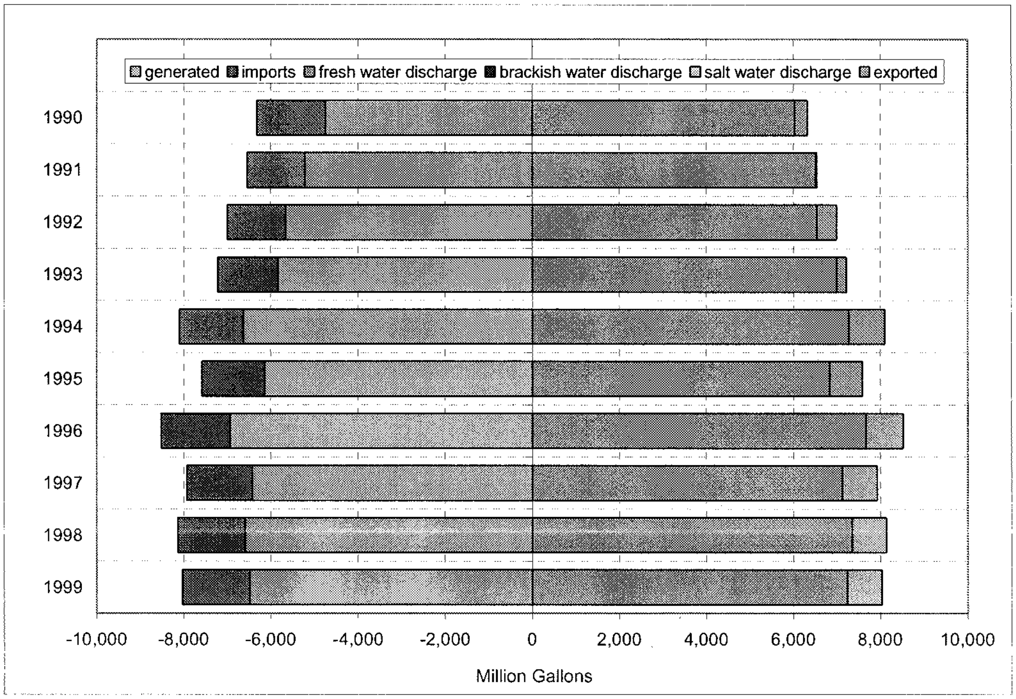


**Figure 26: Sewage Generation, Transfers, and Reclaimed-Water Discharges in WMA 19**

### *Mullica (WMA 14) Water Usage*

Freshwater withdrawals from ground water and surface water sources in WMA 14 totaled 364,588 million gallons from 1990 through 1999, with an average withdrawal of 36,459 million gallons per year. The majority of the freshwater withdrawals in WMA 14 were from surface water sources. Over the course of the decade, an average of 25,004 million gallons of surface water was withdrawn per year, in contrast to an average of 11,455 million gallons of ground water withdrawn for use per year.

Figure 27 below shows annual fresh-water withdrawals, use, imports, and exports in WMA 14. Figure 28 shows annual use of water in WMA 14 by use group. It can be seen that most water withdrawals were used for agricultural operations. Total monthly water use in WMA 14 is shown in Figure 29. The movement of sewage and discharge of reclaimed water in WMA 14 is shown in Figure 30.

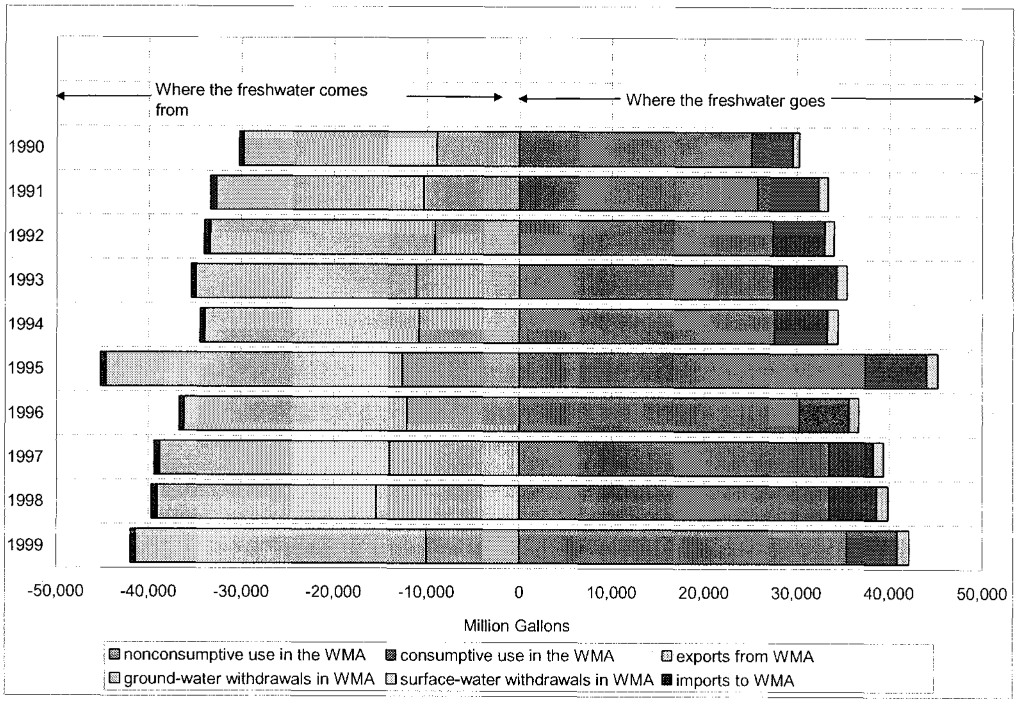


Figure 27: Freshwater Withdrawals, Use, Imports, and Exports in WMA 14

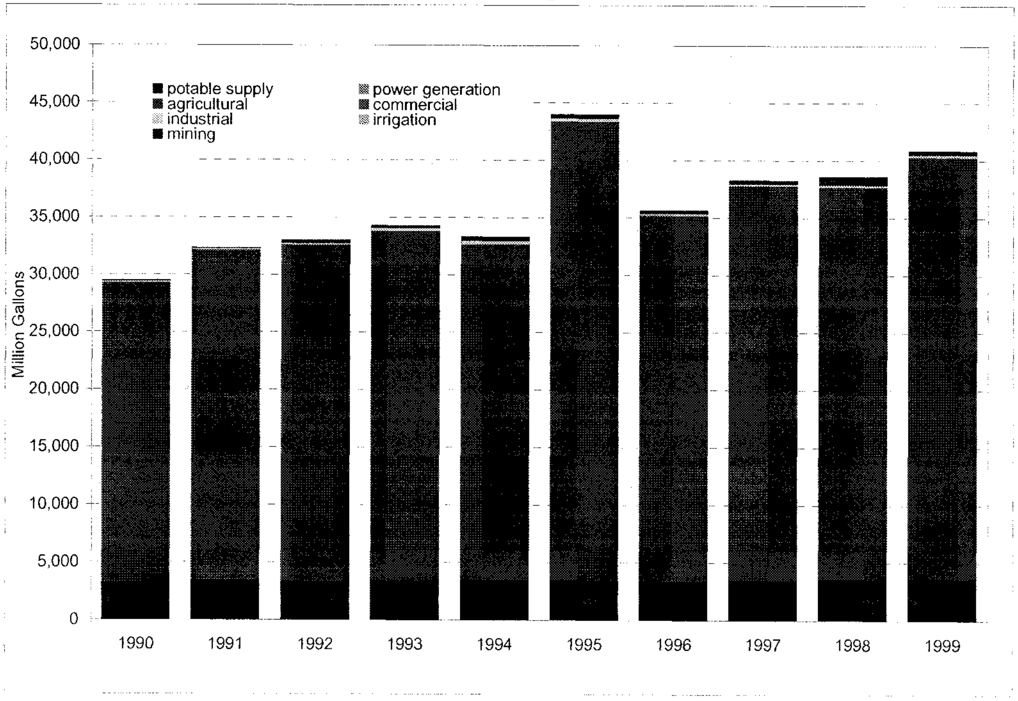


Figure 28: Uses of Fresh Water in WMA 14

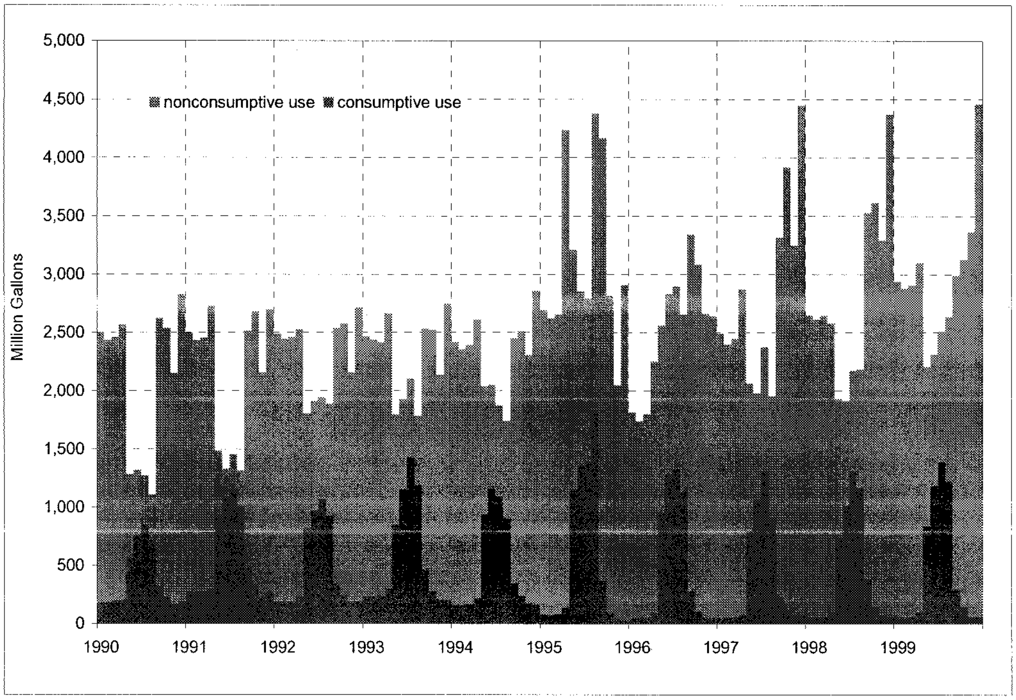


**Figure 29: Monthly Consumptive & Non-Consumptive Water Use in WMA 14**

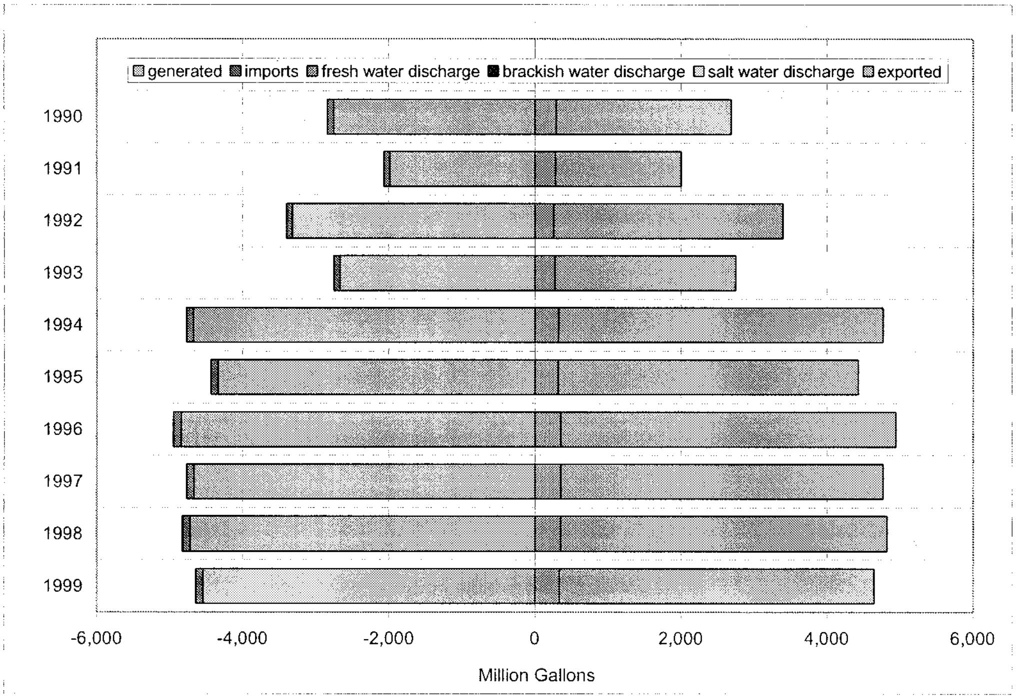


**Figure 30: Sewage Generation, Transfers, and Reclaimed-Water Discharges in WMA 14**

Burlington County relies heavily on freshwater sources for a variety of end use applications. Based upon projected population increases and subsequent demand for potable water, Burlington

County determined to assess the potential use of reclaimed wastewater in suitable situations. Reclaimed water is typically of a higher quality than water withdrawn from surface waters for such uses and is in endless supply. Supplementing irrigation and power generation supplies with reclaimed wastewater is a viable alternative to ground and surface water withdrawal. Depending on the type of industrial application, reclaimed water can substitute and/or augment available resources.

### *Burlington County Groundwater Quality*

The USGS and the NJDEP Source Water Assessment Program (SWAP) (2004) conducted a study to determine the susceptibility of groundwater wells in Burlington County to contamination from nutrients, fecal coliform, organics, and radionuclide contamination. Susceptibility to contamination was determined based on several factors: location, use, ground water or surface water, and amount and type of potential contaminants within the source water assessment area (NJDEP SWAP, 2004).

A public water system's susceptibility rating (L for low, M for medium or H for high) is a combination of two factors: H, M, and L ratings are based on the potential for a contaminant to be at or above 50% of the Drinking Water Standard or Maximum Contaminant Level (H), between 10 and 50% of the standard (M) and less than 10% of the standard (L) (NJDEP, SWAP 2004). The study indicated that all of the 241 groundwater wells drawn upon for potable drinking water supply were determined to have low susceptibility to nutrient and fecal contamination. The reported results are indicated in Table 13 and Table 14. A low susceptibility rating for nutrient and fecal coliform contamination in all public wells is a promising beginning to the future of wastewater reuse in Burlington County.

**Table 13: Approximate Number of Groundwater Withdrawal Wells for Potable Drinking Water Supply by Municipality in Burlington County**

| Municipality Name | Approximate Number of Wells | Municipality Name | Approximate Number of Wells |
|---|---|---|---|
| Beverly City | 71 | Medford Township | 12 |
| Bordentown City | 4 | Moorestown Township | 6 |
| Bordentown Township | 0 | Mount Holly Township | 0 |
| Burlington City | 9 | Mount Laurel Township | 11 |
| Burlington Township | 6 | New Hanover Township | 5 |
| Chesterfield Township | 7 | North Hanover Township | 22 |
| Cinnaminson Township | 0 | Palmyra Boro | 0 |
| Delanco Township | 0 | Pemberton Boro | 4 |
| Delran Township | 0 | Pemberton Township | 17 |
| Eastampton Township | 12 | Riverside Township | 0 |
| Edgewater Park Township | 0 | Riverton Boro | 0 |
| Evesham Township | 11 | Shamong Township | 4 |
| Fieldsboro Boro | 0 | Southampton Township | 11 |
| Florence Township | 5 | Tabernacle Township | 2 |
| Hainesport Township | 0 | Westampton Township | 7 |
| Lumberton Township | 0 | Willingboro Township | 0 |
| Mansfield Township | 2 | Woodland Township | 4 |
| Maple Shade Township | 5 | Wrightstown Boro | 4 |
| **Total** | | **241** | |

**Table 14: Susceptibility of Groundwater Wells in Burlington County to Contamination**

| **Pathogen** | | | **Nutrients** | | |
|---|---|---|---|---|---|
| *High* | *Medium* | *Low* | *High* | *Medium* | *Low* |
| 1 | 29 | 211 | 56 | 6 | 179 |
| **Pathogen** | | | **Nutrients** | | |
| *Pathogen % High* | *Pathogen % Medium* | *Pathogen % Low* | *Nutrient % High* | *Nutrient % Medium* | *Nutrient % Low* |
| 0.41 | 12.03 | 87.55 | 23.24 | 2.49 | 74.27 |

### *Burlington County Climate*

According to the Office of the New Jersey State Climatologist (ONJSC) (2004), Burlington County falls within three (3) of the five (5) climactic zones found in New Jersey. The majority of Burlington County falls within the Pine Barrens Climactic Zone, while the remaining portions are found in the Southwest and Coastal Climactic Zones. The three (3) regions are shown in Figure 31 and briefly described in the following sections from information obtained from the ONJSC.

### *Pine Barrens Climactic Zone*

The Pinelands Protection Area, locally known as the Pine Barrens, consists of forests dominated by scrub pine and oak. The Pine Barrens consists mainly of porous sandy soils which have a major effect on the climate. The porous soil permits any precipitation to rapidly infiltrate and leave surfaces quite dry. Drier conditions allow for a wider range between the daily maximum and minimum temperatures, and make the area vulnerable to forest fires (ONJSC, 2004).

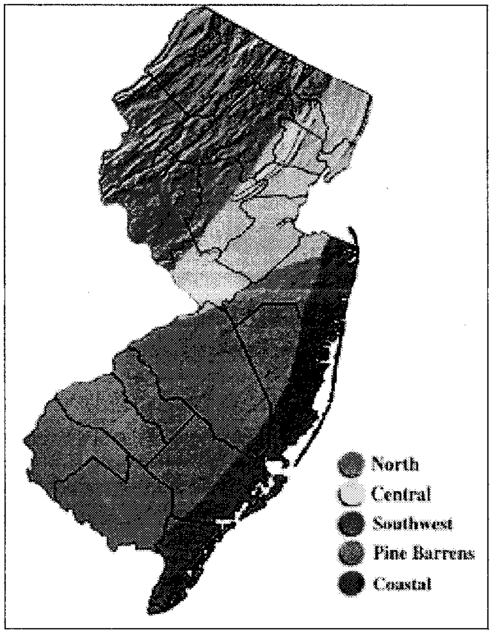


**Figure 31: Climactic Zones of New Jersey (ONJSC, 2004)**

### *Southwest Climactic Zone*

The Southwest Zone is in close proximity to the Delaware River and Bay, adding a maritime influence to the climate of this region. The Southwest Zone receives less precipitation than other regions of the state and it is far enough inland to be away from the heavier rains from some coastal storms. Prevailing winds are from the southwest, except in winter when west to northwest winds dominate. High humidity and moderate temperatures prevail when winds flow from the south or east. Autumn frosts usually occur about four weeks later in the Southwest Zone than in the North and the last spring frosts are about four weeks earlier, giving this region the longest growing season in New Jersey (ONJSC, 2004).

### ***Coastal Climactic Zone***

In the Coastal Zone, continental and oceanic influences battle for dominance on daily to weekly bases. In autumn and early winter, when the ocean is warmer than the land surface, the Coastal Zone will experience warmer temperatures than interior regions of the state. In the spring months, ocean breezes keep temperatures along the coast cooler. Being adjacent to the Atlantic Ocean, with its high heat capacity (compared to land), seasonal temperature fluctuations tend to be more gradual and less prone to extremes. Sea breezes play a major role in the coastal climate. When the land is warmed by the sun, heated air rises, allowing cooler air at the ocean surface to spread inland.

Coastal storms, often characterized as nor'easters, are most frequent between October and April. These storms track over the coastal plain or up to several hundred miles offshore, bringing strong winds and heavy rains. Tropical storms and hurricanes are also a special concern along the coast. In some years, they contribute a significant amount to the precipitation totals of the region (ONJSC, 2004).

### *Precipitation Data for New Jersey and Burlington County*

New Jersey is bordered on three (3) sides by major bodies of water. The Atlantic Ocean touches the entire eastern shoreline and the Delaware River stretches from the northwestern corner of the state and expands into the Delaware Bay at the southern tip of the State. New Jersey's geographic location results in the State being influenced by wet, dry, hot, and cold airstreams, making for daily weather that is highly variable (ONJSC, 2004). Average annual precipitation amounts in many areas across the State range from 43 inches to 47 inches. Some areas along the northern and central portions of the State average 52 inches a year of precipitation.

Data was gathered from several dozen stations across the State by the ONJSC. Liquid equivalent precipitation totals, correcting for snowfall in winter months, for the State are presented as a spatially weighted average of the data collected. Precipitation data collected from 1894 through 2004 is presented in Figure 32.

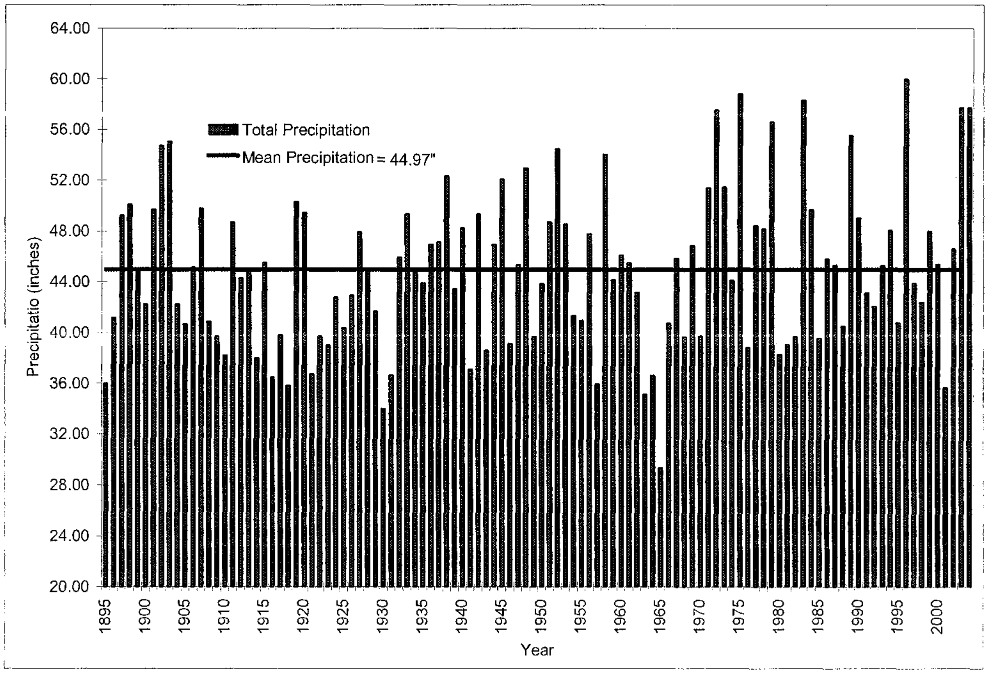


**Figure 32: Annual Precipitation Observed in New Jersey (1895-2004)**

Precipitation in New Jersey varies, sometimes drastically, from year to year. Over the course of the available recorded data, it can be observed that more often than not, the State experienced periods of below normal rainfall. Heavy reliance on ground and surface water sources places the population of New Jersey at risk of water shortages and restrictions in times of minimal rainfall.

The statewide precipitation data was separated into three (3) divisions, of which Burlington County falls into Division 2. Division 2 covers 56% of the land area of New Jersey and precipitation data for Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Middlesex, Monmouth, Ocean, and Salem Counties are represented within the Division (ONJSC, 2004). Precipitation for Division 2 from 1895 through 2004 is represented in Figure 33.

Historical monthly precipitation data from a weather station located in Burlington County was obtained from the ONJSC's cooperative station network partner, the National Weather Service (NWS). The Indian Mills Station (COOP ID: 284229) is located approximately five (5) miles from the Borough of Medford Lakes and approximately thirteen (13) miles from the Township of Marlton. The monthly precipitation was summed to obtain the yearly precipitation totals shown in Figure 34. Full data sets were not available for the years 1988 and 1989, leading to a two (2) year gap in the precipitation data presented. The average yearly precipitation was determined without the inclusion of the missing data sets.

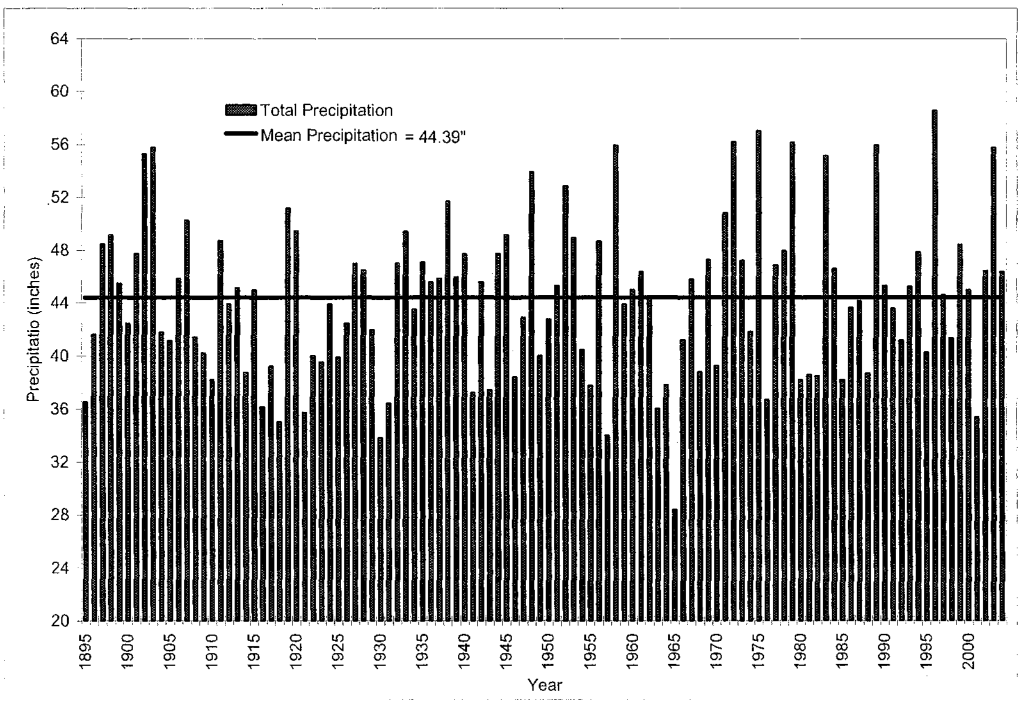


**Figure 33: Annual Precipitation Observed in Southern New Jersey (1895-2004)**

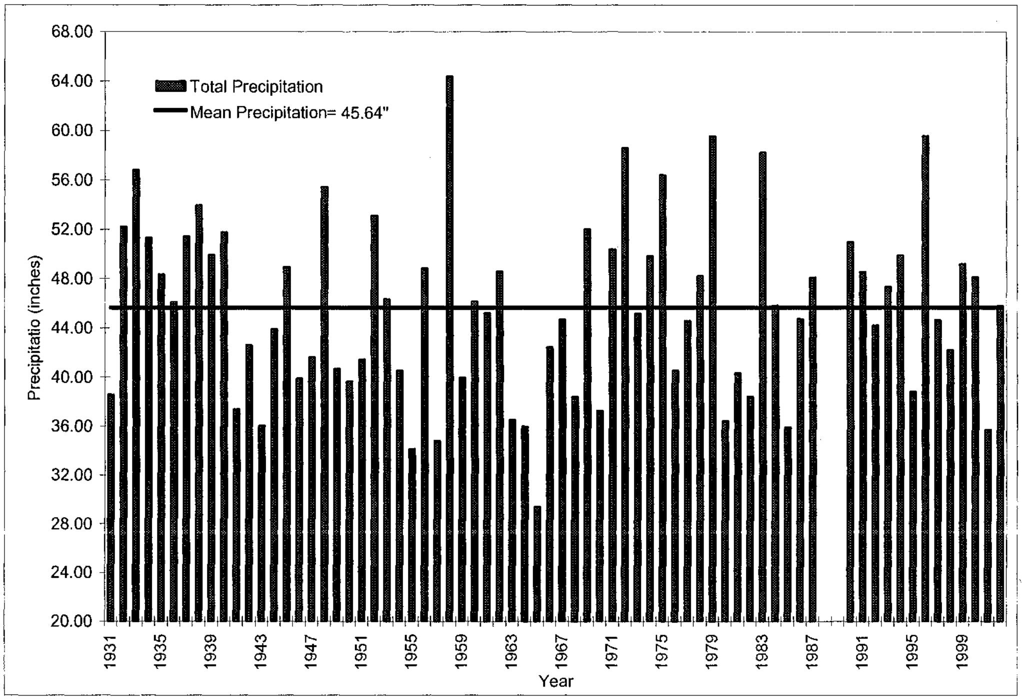


**Figure 34: Annual Precipitation Observed at Weather Station Indian Mills 2 W (1931-2001)**

### *Wastewater Treatment Facilities in Burlington County*

Currently, there are 22 permitted municipal wastewater treatment facilities in the County and all but seven (7) treat their wastewater to tertiary standards. In addition to the municipal facilities, there are 23 non-municipal wastewater facilities in the County. A list of municipal wastewater treatment facilities, their location, design and average flows, and nitrogen and phosphorus monitoring requirements is shown below in Table 13 and depicted in Figure 35. A list of non-municipal wastewater treatment facilities, their location, and nitrogen and phosphorus monitoring requirements is shown in Table 14 and depicted in Figure 36. Only permitted major facilities in Burlington County are identified in Figure 36 as the minimum design capacity of a wastewater treatment facility must be 0.1 MGD to qualify for a permit to provide public access reclaimed wastewater for beneficial reuse (RWBR) in the State of New Jersey (NJDEP DWQ, 2003).

It should be noted that all of the major wastewater treatment facilities in Burlington County are located outside of the Pinelands Protection Area, a federally designated reserve. Within the Pinelands Protection Area, the Pinelands Commission strictly regulates discharge to ground and surface water and a small number of minor wastewater treatment facilities are permitted to operate within the boundaries of the Pinelands Protection Area.

**Table 15: Municipal Wastewater Treatment Facilities Located in Burlington County**

| Facility | Location | Nitrogen Monitoring | Phosphorus Monitoring | Design Flow (MGD) | Monthly Average Flow 1994-2002 (MGD) |
|---|---|---|---|---|---|
| Beverly STP | Beverly | Yes | no | 1.00 | 0.41 |
| Bordentown STP | Bordentown | Yes | no | 3.00 | 1.63 |
| Burlington City STP | Burlington | Yes | no | 2.70 | 2.03 |
| Burlington Twp Main STP | Burlington | Yes | yes | 1.65 | 1.36 |
| Cinnaminson Twp SA | Cinnaminson | Yes | no | 2.00 | 1.20 |
| Delran SA | Delran | Yes | yes | 2.50 | 1.88 |
| Elmwood WWTP | Marlton | Yes | yes | 2.30 | 1.84 |
| Fieldsboro WWTP | Fieldsboro | Yes | yes | 0.10 | 0.04 |
| Florence Twp DPW STP | Florence | Yes | no | 2.50 | 1.05 |
| Maple Shade Utilities Authority | Maple Shade | Yes | yes | 3.40 | 2.63 |
| Medford Lakes STP | Medford Lakes | Yes | yes | 0.55 | 0.37 |
| Medford Twp STP | Medford | Yes | yes | 1.75 | 1.30 |
| Moorestown Twp STP | Moorestown | Yes | yes | 3.50 | 2.36 |
| Mount Holly SAPC | Mount Holly | Yes | yes | 7.68 | 3.03 |
| Mount Laurel Twp MUA | Mount Laurel | Yes | yes | 4.00 | 3.78 |
| Palmyra Boro STP | Palmyra | Yes | no | 0.79 | 0.50 |
| Pemberton Twp MUA STP | Pemberton | Yes | yes | 2.50 | 1.75 |
| Pinelands Wastewater Company | Southampton | Yes | yes | 0.50 | 0.31 |
| Riverside STP | Riverside | Yes | yes | 1.00 | 0.74 |
| Riverton STP | Riverton | Yes | yes | 0.22 | 0.18 |
| Willingboro Water PCF | Willingboro | Yes | yes | 5.20 | 4.41 |
| Wrightstown Borough STP | Wrightstown | Yes | yes | 0.20 | 1.20 |

**Table 16: Non-Municipal Wastewater Treatment Facilities Located in Burlington County**

| Facility | Location | Nitrogen Monitoring | Phosphorus Monitoring |
|---|---|---|---|
| Albert C. Wagner Youth Correctional Facility | Bordentown | ammonia, nitrate | yes |
| Burlington County Composting | Columbus | ammonia | yes |
| Conn Dee Industrial, Inc. | Cinnaminson | no record of permit | no record of permit |
| Interstate Storage & Pipeline Corporation | Bordentown | no record of permit | no record of permit |
| Green Street WTP | Mount Holly | no | no |
| Hartford Rd WTP | Moorestown | no | no |
| Mount Holly Water Company | Mount Holly | no | no |
| Woodlane WTP | Westampton | no | no |
| American AGIP Co., Inc. | Hainesport | no record of permit | no record of permit |
| American Custom Drying Company | Burlington | no record of permit | no record of permit |
| Armotek Industries, Inc. | Palmyra | no record of permit | no record of permit |
| Atco Pallet Company | Delanco | no record of permit | no record of permit |
| Atlantic Wood Industries, Inc. | Hainesport | no | no |
| California Village Mobile Home Park Sewer Plant | North Hanover | ammonia | yes |
| Hanover Mobile Village STP | Wrightstown | ammonia, nitrate | yes |
| Viking Yacht Company | New Gretna | no | no |
| Chemique, Inc. | Moorestown | no record of permit | no record of permit |
| Chianti Cheese Company | Pemberton | no record of permit | no record of permit |
| Colonial Pipeline Co. – Allentown Station | Bordentown | no | no |
| Colorite Polymers | Burlington | ammonia | no |
| CVC Speciality Chemicals, Inc. | Maple Shade | no record of permit | no record of permit |
| Rexam Medical Packaging | Mount Holly | no record of permit | no record of permit |
| Sybron Chemicals Inc. | Birmingham | ammonia | no |

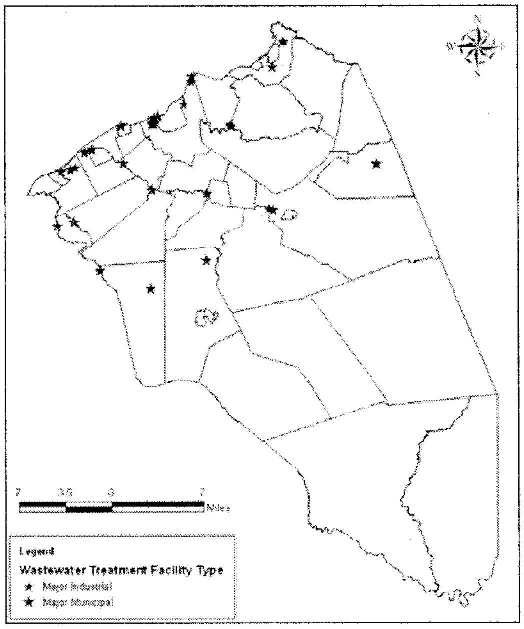


**Figure 35: Major Municipal and Non-Municipal Facilities Located in Burlington County, New Jersey**

Of the 22 municipal wastewater treatment facilities, five (5) are currently permitted to provide RWBR. The treatment facilities are permitted to provide reclaimed wastewater for activities such as spray irrigation, sewer jetting, street cleaning, and composting. The currently permitted facilities are identified in Figure 37. The municipal wastewater treatment facilities identified in Table 13 that are not currently supplying RWBR have the potential to provide an additional 20.25 MGD of reclaimed water to users within the County.

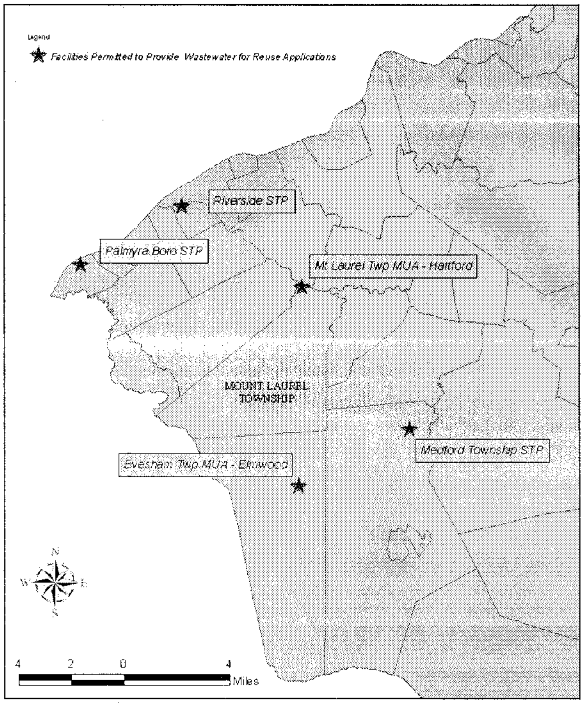


**Figure 36: Major Wastewater Treatment Facilities Permitted to Provide Reclaimed Water for Beneficial Reuse in Burlington County**

Presently, one (1) of the facilities shown in Figure 37 is supplying reclaimed wastewater for beneficial reuse applications. The Elmwood MUA is located in Evesham Township and supplies treated effluent for the irrigation of the Indian Springs Golf Course, located in the Township of Medford. Indian Springs was chosen as a monitoring location to determine the impact of the use of reclaimed wastewater for irrigation purposes on adjacent surface water bodies. A second location, Medford Lakes Country Club, located in the Borough of Medford Lakes, was chosen as a control as the golf course is currently irrigated with groundwater withdrawn from onsite wells. The monitoring locations and the Elmwood MUA are discussed further in Chapter Four.

### *Impaired Water Bodies*

Determining the effects on surface water to areas utilizing treated wastewater effluent for irrigation is of significant importance throughout the State of New Jersey due to the prevalence of impaired water bodies throughout the various WMAs. Section 303(d) of the Federal Clean Water Act requires states to identify "Impaired Waters" where specific designated uses are not fully supported. For these waters, the State is required to establish Total Maximum Daily Loads (TMDLs) in accordance with a priority ranking. To carry out this mandate, the NJDEP biennially prepares a list of impaired waters for submission to the USEPA (NJDEP WAT, 2004).

TMDLs represent the assimilative or carrying capacity of the receiving water taking into consideration point and nonpoint sources of pollution, natural background, and surface water withdrawals. A TMDL is developed as a mechanism for identifying all the contributors to surface water quality impacts and setting goals for load reductions for specific pollutants as necessary to meet surface water quality standards (NJDEP DWM, 2005).

New Jersey has approximately 2,900 impaired water bodies. The water bodies of New Jersey are impaired by excessive amounts of nutrients, bacteria, and metals, high temperatures, pH, dissolved and suspended solids, turbidity, and low dissolved oxygen concentrations. There are 371 water bodies within the four (4) WMAs that encompass Burlington County in which the water quality standard is not attained and the waterway is impaired or threatened for one or more designated uses by a pollutant(s) and requires the determination of a TMDL (NJDEP WAT, 2004).

The identified impaired water bodies within Burlington County are further classified based on their pollutant. For the purpose of this research, fecal coliform and nutrient impaired water bodies were isolated. Fecal coliform and nutrient impaired water bodies are identified by WMA in Table 5 through Table 8 in Appendix C.

The following sections present the water bodies for which TMDLs have been approved by the USEPA or are currently being developed by the NJDEP.

***Fecal Coliform TMDLs***

Excessive concentrations of pathogens, indicated by elevated concentrations of fecal coliform bacteria, have led to the development of a fecal coliform TMDL. Fecal coliform concentrations were found to exceed New Jersey's Surface Water Quality Standards (SWQS), published as N.J.A.C. 7-9B et seq. The segments are graphically represented in Figure 37 through Figure 40 (NJDEP DWM, 2004).

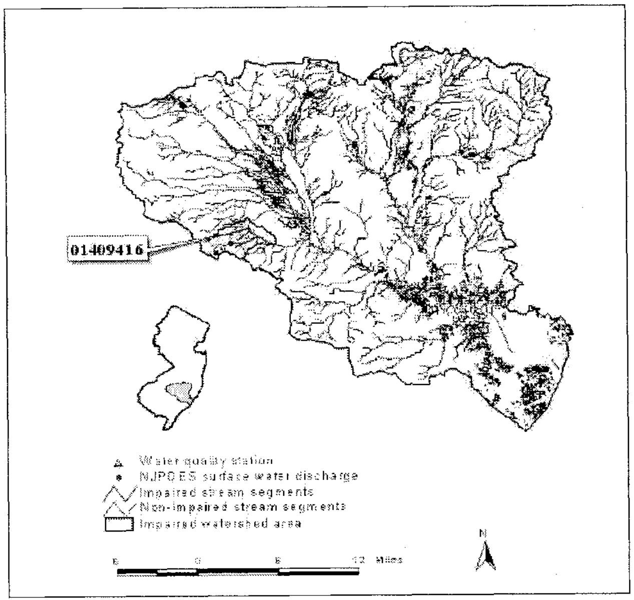


**Figure 37: Spatial Extent of Impaired Water Bodies for which Fecal Coliform TMDLs Are In Development in WMA 14**

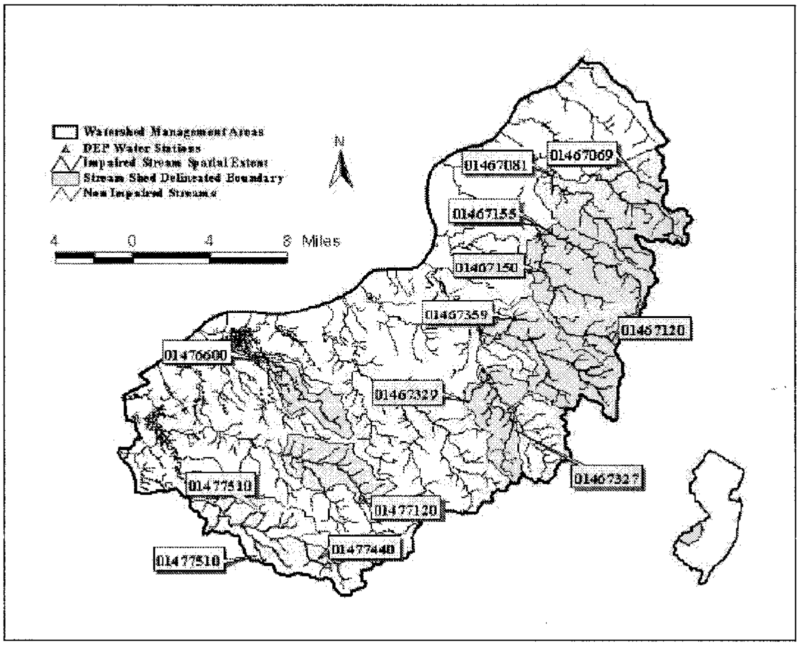


Figure 38: Spatial Extent of Impaired Water Bodies for which Fecal Coliform TMDLs Are In Development in WMA 18

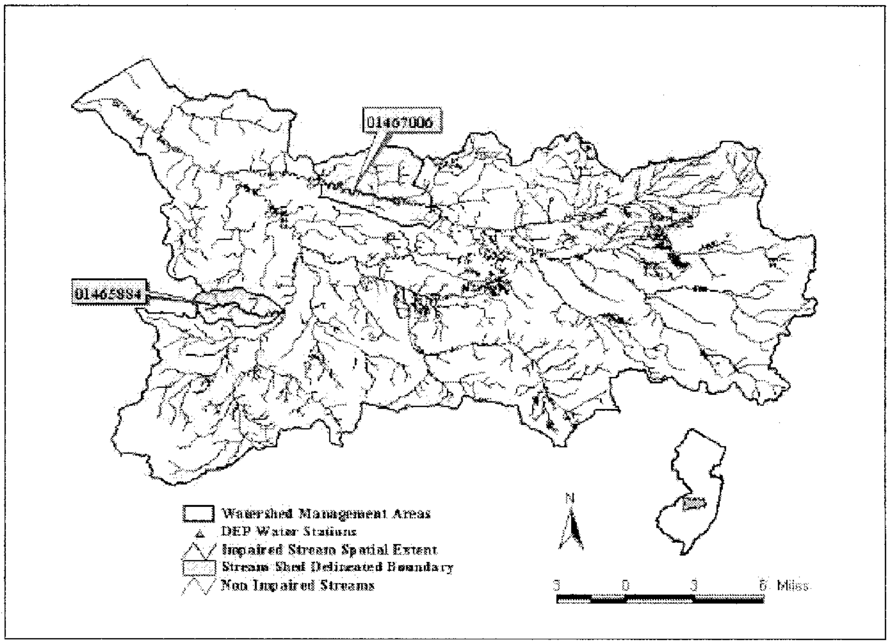


Figure 39: Spatial Extent of Impaired Water Bodies for which Fecal Coliform TMDLs Are In Development in WMA 19

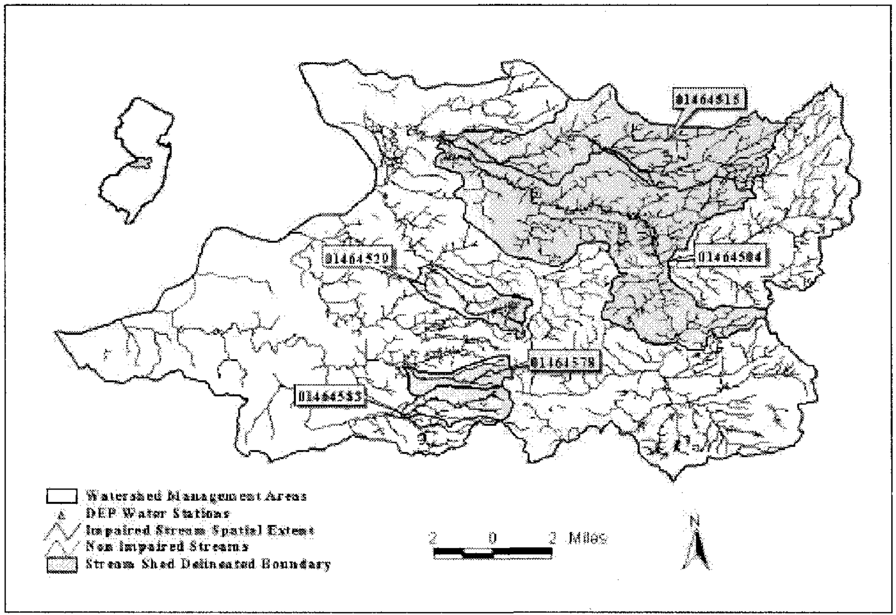


**Figure 40: Spatial Extent of Impaired Water Bodies for which Fecal Coliform TMDLs Are In Development in WMA 20**

### *Nutrient TMDLs*

The major pollutant of concern for nutrient TMDLs is phosphorus. As a result of monitoring conducted by the NJDEP, total phosphorus concentrations were found to exceed New Jersey's SWQS Strawbridge Lake, located in Moorestown Township, Burlington County. The drainage area contributing to the water stored in Strawbridge Lake extends into portions of neighboring Mount Laurel and Evesham Township. The water draining into Strawbridge Lake from Evesham Township is of particular importance during this study due to the use of reclaimed wastewater effluent for irrigation purposes as discussed further in Chapter Four. The drainage area of Strawbridge Lake is depicted in Figure 41 below.

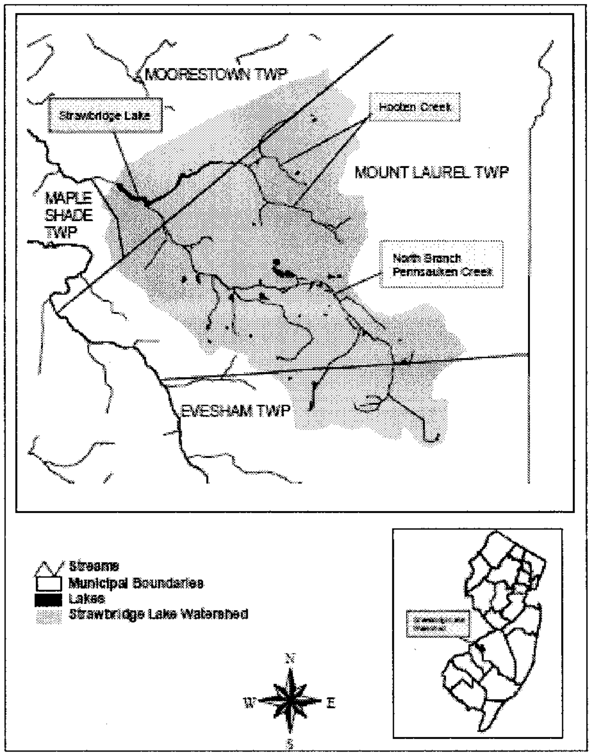


**Figure 41: Strawbridge Lake Watershed**

## Chapter Four

### Water Quality Monitoring

In order to determine ecological impacts to surface waters located adjacent to areas irrigated with treated wastewater effluent, a location currently using treated wastewater effluent for irrigation was identified and a monitoring plan was developed to observe surface water quality. The monitoring sites and the methods used during the monitoring period to determine the effect of treated wastewater effluent are discussed in the following sections.

### *Monitoring Sites*

Currently, one golf course in Burlington County, Indian Springs, located in Evesham Township, is using reclaimed wastewater for turf irrigation. The Indian Springs Golf Course receives its reclaimed wastewater from the Elmwood Wastewater Treatment Facility (EWTF), a 2.3 MGD tertiary treatment facility discharging to the southwest branch of Rancocas Creek. The EWTF is operated by the Evesham Municipal Utilities Authority (MUA). The Indian Springs golf course covers an area in excess of 100 acres. The hydraulic loading rate of treated effluent is less than two inches per week. There are no potable water supply wells within seventy-five feet of any portion of the course. There is one non-potable water supply well on the course property that is located over ninety feet from the closest transmission main (Alaimo, 2001).

A second location, Medford Lakes Golf Course, located in Medford Lakes, is currently investigating the feasibility of reusing wastewater for the irrigation of their courses. The course covers a land area of 117.5 acres. A 2.5 acre pond with an average depth of 12 feet collects freshwater extracted from the PRM for irrigation. If the course should decide to irrigate using wastewater, the Medford Lakes Municipal Utilities Authority would be the main provider of the effluent. The Medford Lakes MUA is a 144 MGD plant that discharges to the Pinelands Protection Area, a federally designated reserve. Within the Pinelands Protection Area, discharge to ground and surface water is strictly regulated by the Pinelands Commission. The Pinelands Commission is a state governmental agency that manages land use and growth in the Pinelands Area. In order for the Medford Lakes MUA to provide treated effluent for beneficial reuse, it must demonstrate the ability to meet the stringent discharge standards of the Pinelands Commission.

Heavy rainstorms led to the breach of 12 dams in Burlington County during June 2004. As a result, many areas of Burlington County were flooded and the cost of devastation was great. Many areas affected by flooding were located in or around Medford Lakes, New Jersey. As a result, the Medford Lakes Golf Course chose to rescind their permit application to the NJDEP for permission to use treated wastewater for irrigation.

### *Evesham MUA - Elmwood Wastewater Treatment Facility*

The Elmwood Wastewater Treatment Facility (EWTF) is a 2.63 MGD tertiary wastewater treatment facility located in Evesham Township that received authorization by the NJDEP to begin supplying treated wastewater effluent for beneficial reuse to the Evesham Township owned Indian Springs Golf Course. Figure 42 is a schematic illustrating the process train used by the EWTF for wastewater treatment.

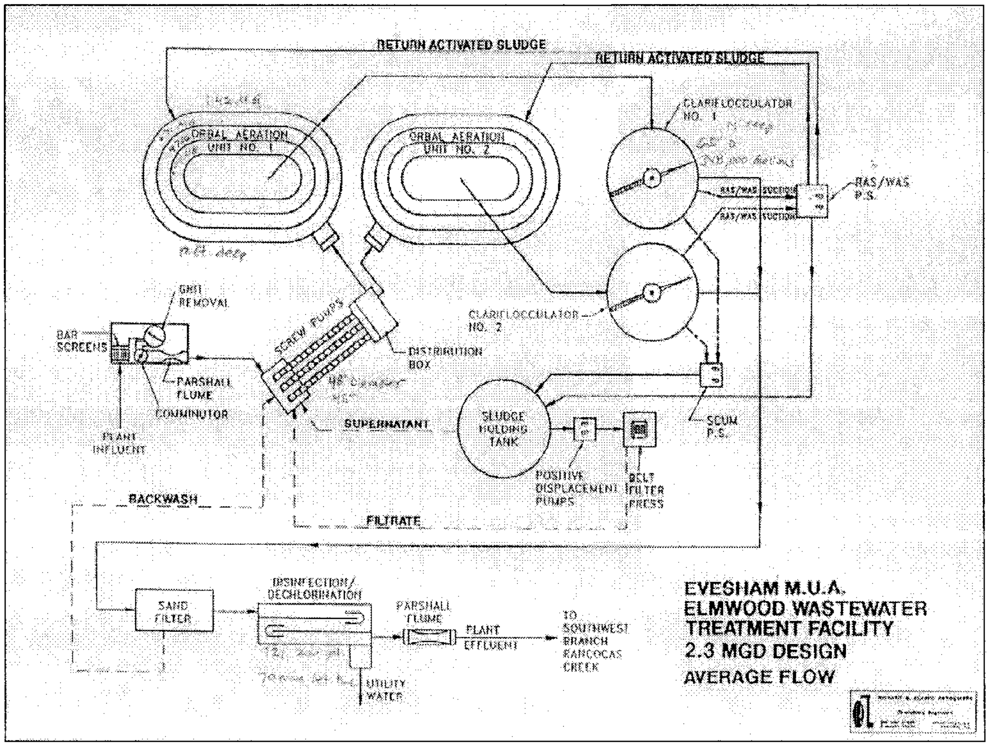


**Figure 42: Process Train of the Elmwood Wastewater Treatment Facility Located in Evesham Township, New Jersey (Maiellano, 2003)**

To facilitate the irrigation of the golf course with reclaimed water, the MUA had constructed a 2,700 linear foot force main and had contracted for the installation of a pump into the EWTF's chlorine contact tank. The pump starter was interlocked with an on-line chlorine residual analyzer and an on-line turbidimeter. These instruments ensured that the reclaimed water is adequately disinfected prior to transmission to the golf course, Evesham Township and the Evesham MUA constructed a new pond on the golf course to receive the reclaimed water exclusively. New irrigation pumps supply the irrigation system from the pond and were incorporated into an upgrade of the golf course's irrigation system (Maiellano, 2003).

The EWTF is permitted by the NJDEP to provide a maximum of 300,000 gallons per day of treated effluent to the Indian Springs Golf Course during the months of May through October. The treated effluent supplies water for irrigation of the course's tees, greens, and fairways. The operators of the EWTF monitor the effluent diverted to Indian Springs Golf Course for fecal coliform, total suspended solids, and turbidity as part of an Operations Protocol mandated by the NJDEP Technical Manual for Reclaimed Water for Beneficial Reuse. Other parameters, such as nitrate-nitrogen, total phosphorus, $BOD_5$, dissolved oxygen, and temperature are monitored as required by the EWTF NJPDES permit. Table 15 lists selected monitoring parameters and effluent concentration limits. Raw data, in the form of Monitoring Reports submitted to the NJDEP by the Evesham MUA, is provided in Appendix E.

**Table 17: Evesham MUA Required Monitoring Parameters**

| Parameter | Analysis Frequency | Concentration Limit |
|---|---|---|
| **Influent and Gross Effluent** | | |
| Flow | Continuous | NA |
| $BOD_5$ (Influent) | Weekly | NA |
| $BOD_5$ (Effluent Gross Value) | Weekly | 10 mg/L (Monthly Average), 15 mg/L (Weekly Average) |
| pH (Influent) | Twice Daily | NA |
| pH (Effluent Gross Value) | Twice Daily | Report Minimum & Maximum Values |
| Total Alkalinity (as $CaCO_3$) | Weekly | Report Minimum & Maximum Values |
| TSS (Influent) | Weekly | Report Monthly & Weekly Averages |
| TSS (Effluent Gross Value) | Weekly | 10 mg/L (Monthly Average), 15 mg/L (Weekly Average) |
| Oil and Grease | Monthly | 10 mg/L (Monthly Average), 15 mg/L (Weekly Average) |
| Nitrogen, Ammonia (Effluent Gross Value) | Weekly | 1.6 mg/L (Monthly Average), 4.0 (Daily Maximum) |
| Nitrogen, Kjeldahl (Effluent Gross Value) | Weekly | Report Monthly & Weekly Averages |
| TDS (Effluent Gross Value) | Weekly | Report Monthly & Weekly Averages |
| Total Nitrate (as $NO_3$) | Weekly | 2 mg/L (Monthly Average), Report Weekly Average |
| Fecal Coliform (Effluent Gross Value) | Weekly | 200 CFU/100 mL, 400 CFU/100 mL (Monthly Maximum) |
| Temperature (Influent) | Twice Daily | Report Monthly Average & Minimum & Maximum Values |
| Temperature (Gross Effluent Value) | Twice Daily | Report Monthly Average & Minimum & Maximum Values |
| Dissolved Oxygen (Effluent Gross Value) | Weekly | 5 mg/L (Daily Minimum), 6.5 mg/L (Minimum Weekly Average) |
| Total Phosphorus (Effluent Gross Value) | Weekly | 1 mg/L (Monthly Average), Report Weekly Average |
| **Beneficial Reuse** | | |
| TSS (Beneficial Reuse) | Weekly | 5 mg/L (Instantaneous Maximum During Reporting Period) |
| Fecal Coliform (Beneficial Reuse) | Biweekly | 2.2 CFU/100 mL, 14 CFU 100/mL (Reporting Period Maximum) |
| Turbidity (Beneficial Reuse) | Continuous | Report Monthly Instantaneous Maximum |

All water not meeting the effluent limits required per the NPDES permit for beneficial reuse is required to be diverted for discharge to surface waters (Alaimo, 2001). The EWTF is not required to monitor the diverted effluent for nitrate-nitrogen and phosphorus. As such, the nutrient concentrations detected in the gross effluent are assumed to be equal to those in the diverted effluent. Plots containing monitoring data relevant to beneficial reuse applications from March 2003 through March 2005 are shown in Figure 43 through Figure 45. Plots containing monitoring data relevant to gross effluent discharge from March 2003 through March 2005 are shown in Figure 46 through Figure 49. The monitoring data indicates that the EWTF is operating within their permitted limits for all parameters except fecal coliform and nitrate-nitrogen. Fecal coliform detections were consistently in excess of the 2.2 CFU/100 mL permit limit for wastewater reuse. Nitrate-nitrogen concentrations were detected in excess of the 2.0 mg/L permit limit during the months of September 2003 and October 2003. Nitrate-nitrogen concentrations otherwise met the limitations of the NPDES permit throughout the length of this study.

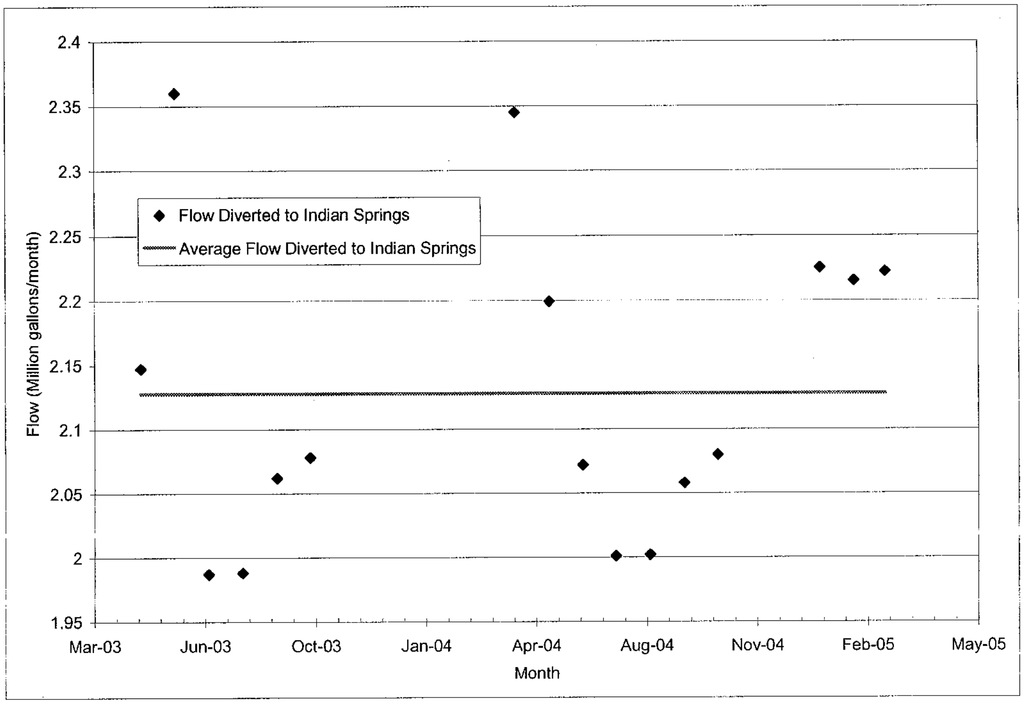


Figure 43: Monthly Effluent Flow Diverted from EWTF to Indian Springs Golf Course

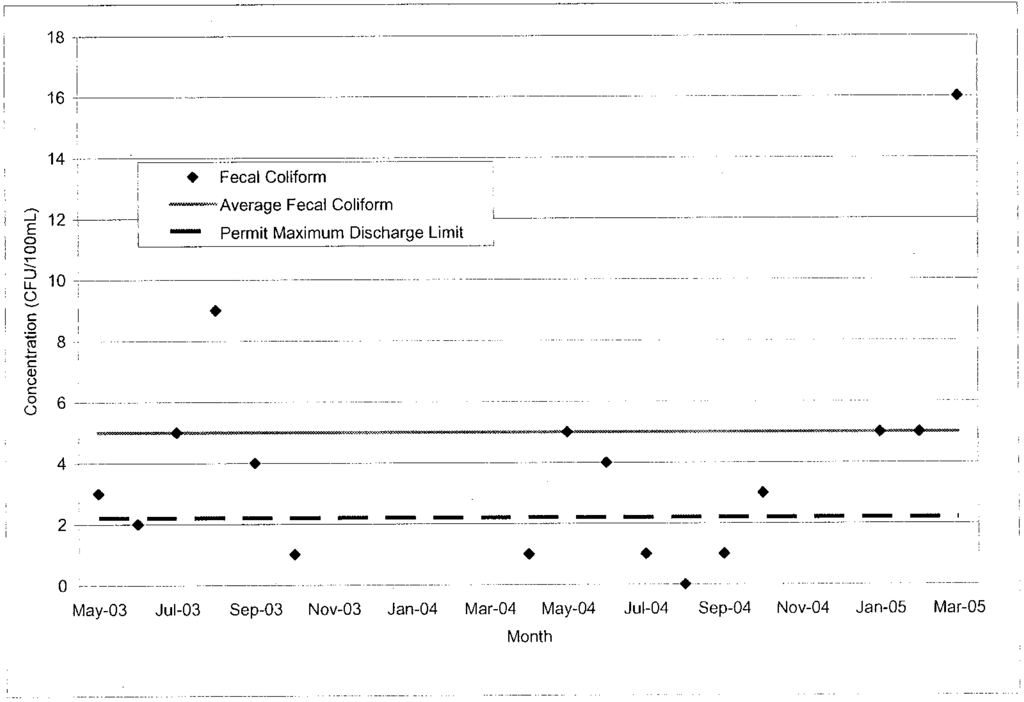


Figure 44: Fecal Coliform Bacteria Detected in EWTF Effluent Discharged to Indian Springs Golf Course for Beneficial Reuse

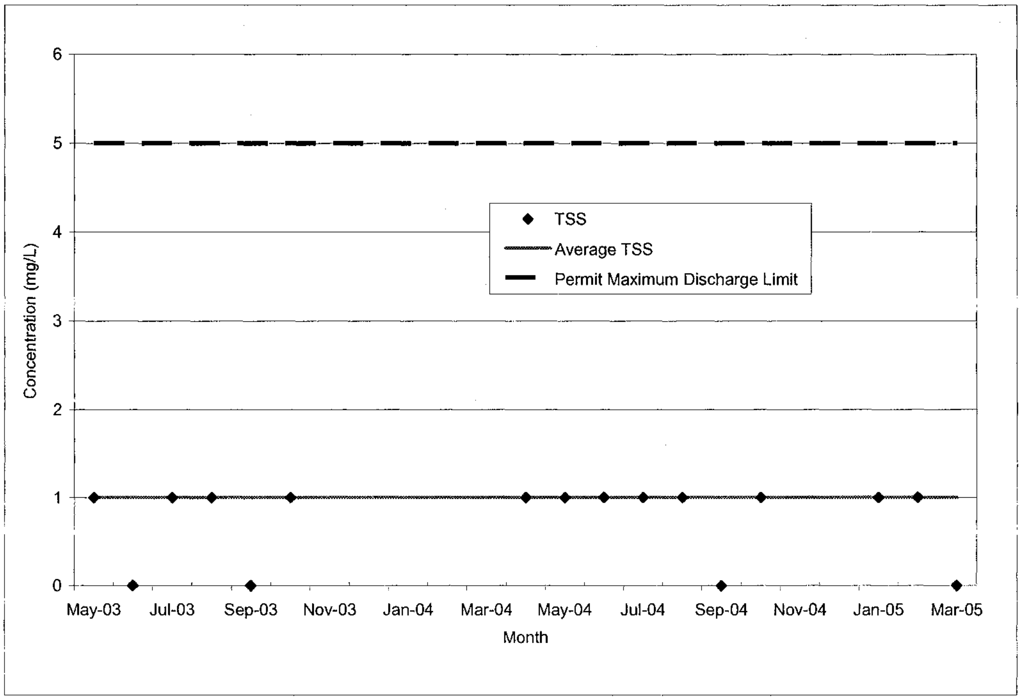


Figure 45: Total Suspended Solids (TSS) Concentrations Detected in EWTF Effluent Discharged to Indian Springs Golf Course for Beneficial Reuse

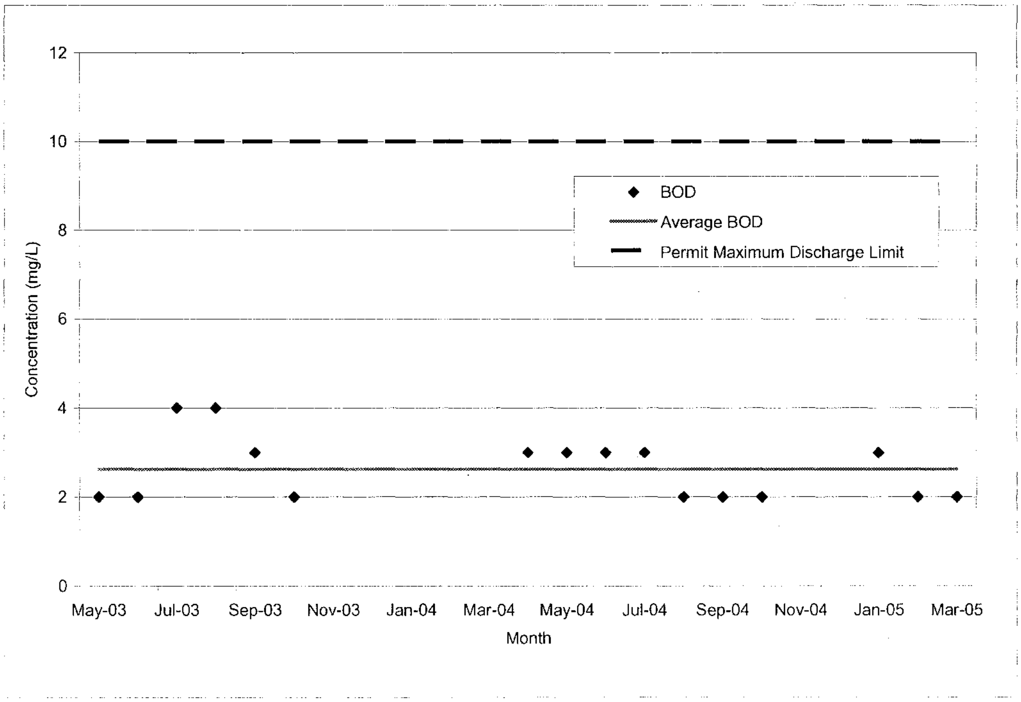


Figure 46: Biological Oxygen Demand (BOD) Concentrations Detected in EWTF Effluent

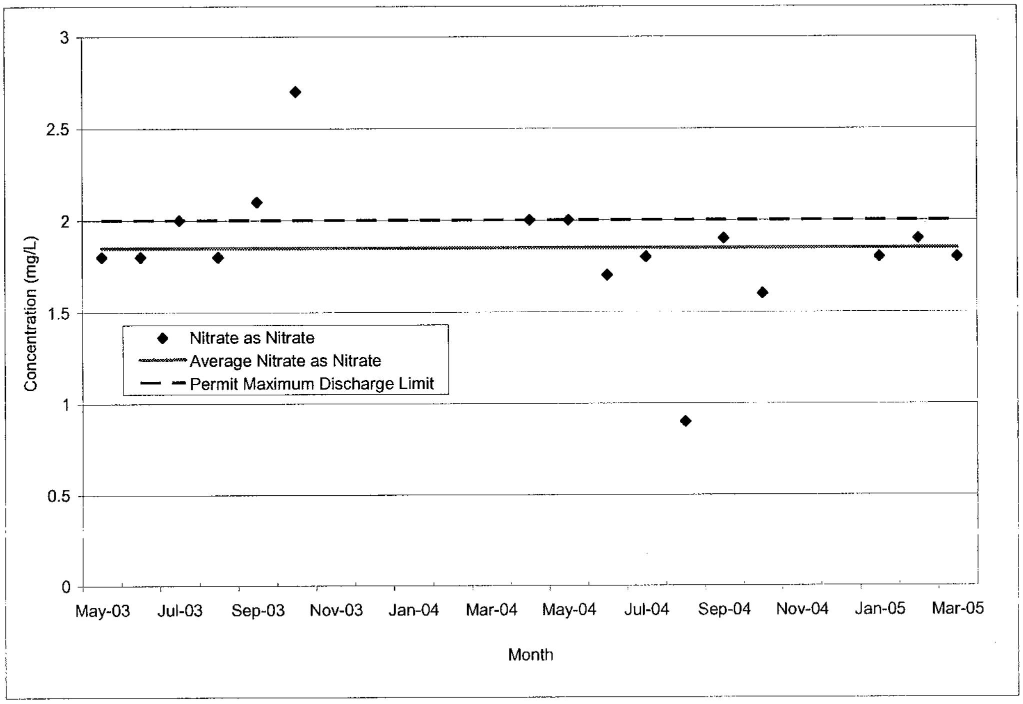


**Figure 47: Total Nitrate-nitrogen Concentrations Detected in EWTF Effluent**

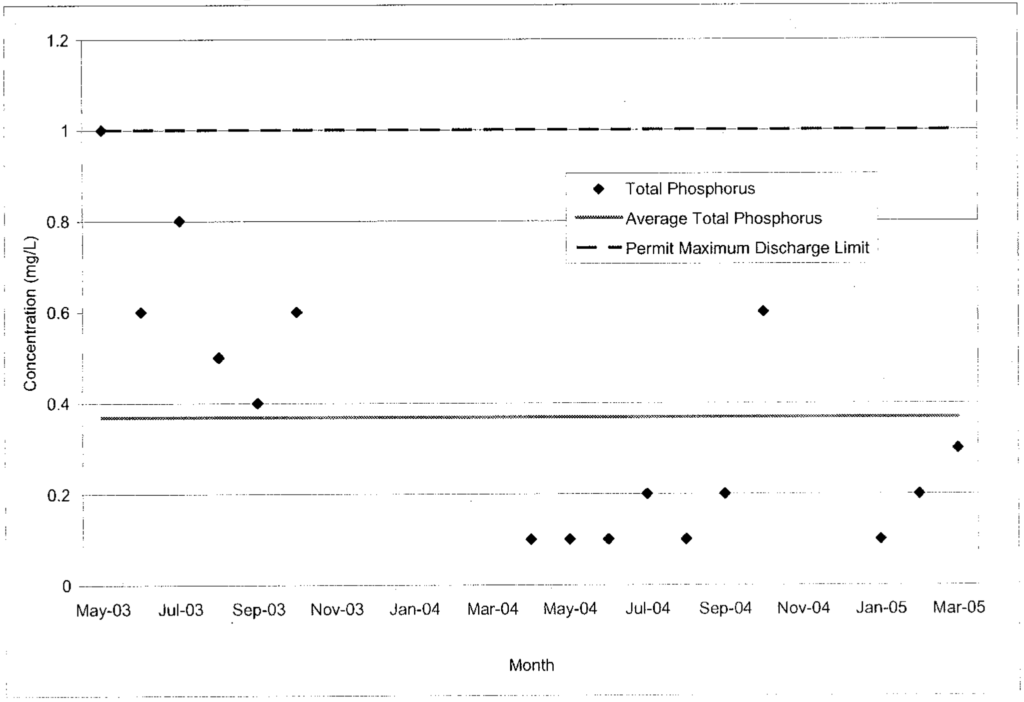


**Figure 48: Total Phosphorus Concentrations Detected in EWTF Effluent**

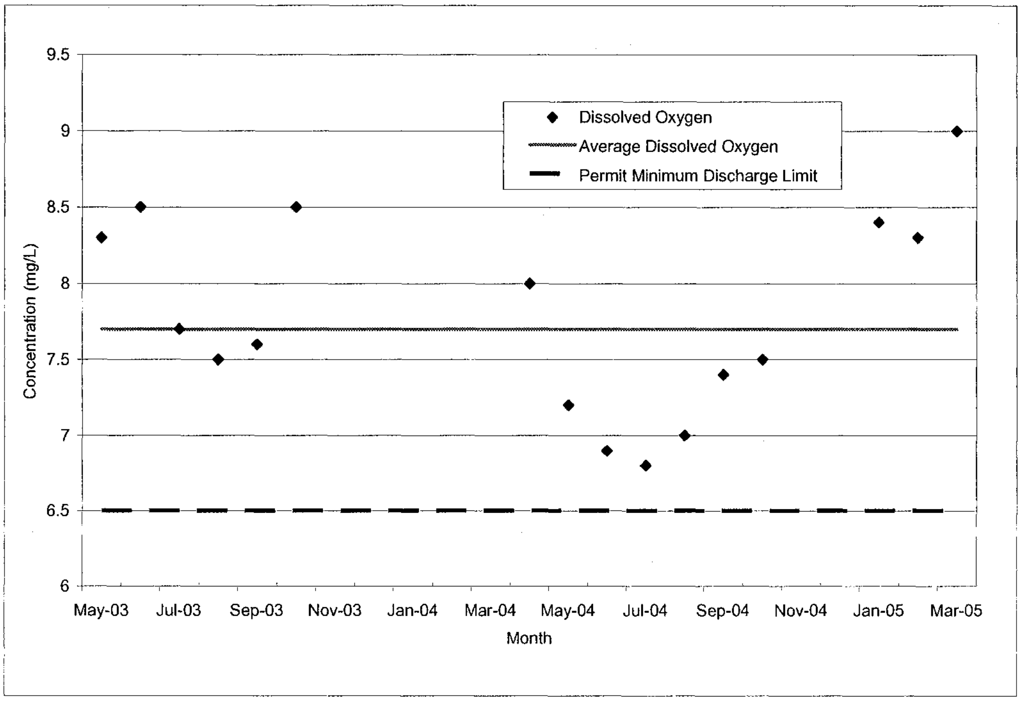


**Figure 49: Dissolved Oxygen Concentrations Detected in EWTF Effluent**

*Water Quality Parameters*

Four wastewater quality parameters were identified and monitored at select sites within each golf course to study the impact of treated wastewater on adjacent surface water bodies. Samples were collected on a bi-monthly basis over the course of one (1) year, for a total of seven (7) surface water sampling events. Grab surface water samples were collected in one (1) liter sterilized unpreserved plastic sample bottles from irrigation ponds and wetland areas within each golf course. The sample bottles were stored at 4° C in a cooler containing ice and transported to the Environmental Engineering Laboratory in Henry M. Rowan Hall at Rowan University's Glassboro, New Jersey campus and analyzed for chemical oxygen demand (COD), nitrate-nitrogen, total phosphorus, and bacteria (total and fecal coliform). Details of Quality Assurance and Quality Control procedures followed can be found in Appendix E (Jahan, 2004).

Sampling locations were selected at each site based on their elevation and proximity to wetlands. The sample locations were recorded using global positioning system technology during the first sampling event for consistency in location during future sampling events. The sample locations at each monitoring location are shown in Figure 52 and Figure 53 below.

All samples were collected from retention ponds located at the monitoring sites. Sample IS P1 was collected from a retention pond located proximal to a large parking area near the Indian Springs Golf Course club house. Sample IS P2 was collected from the retention pond that directly receives treated wastewater effluent from the EWTF. Sample locations IS 3A and IS 3B are located on the down gradient side of the golf course. Sample location IS 3A was selected due to its location near the beginning of a wetland area.

Sample ML P1 was collected from a pond centrally located at the Medford Lakes Country Club. This pond discharges to a wetland area and a sample was collected from the wetland area and is identified as ML WT. Sample location ML P2 is located at the extreme northern boundary of the golf course and is adjacent to a large, straight stretch of fairway.

### *Geographic Position of Sample Locations*

A Trimble® GeoXT™ handheld global positioning system (GPS) was used to obtain the geographic positions of the sample locations. All sample locations were taken in the geographic coordinate system, which defines places in latitude and longitude coordinates. The coordinates were later changed to the New Jersey State Plane coordinate system in ArcMap.

GeoPathfinder Office 2.90 was used to create data dictionaries in the field for subsequent transfer to a PC. A data dictionary is a custom list of features and attributes that the user creates while collecting data. The GPS unit prompts the user to enter information that helps to ensure all the necessary data is collected for each feature.

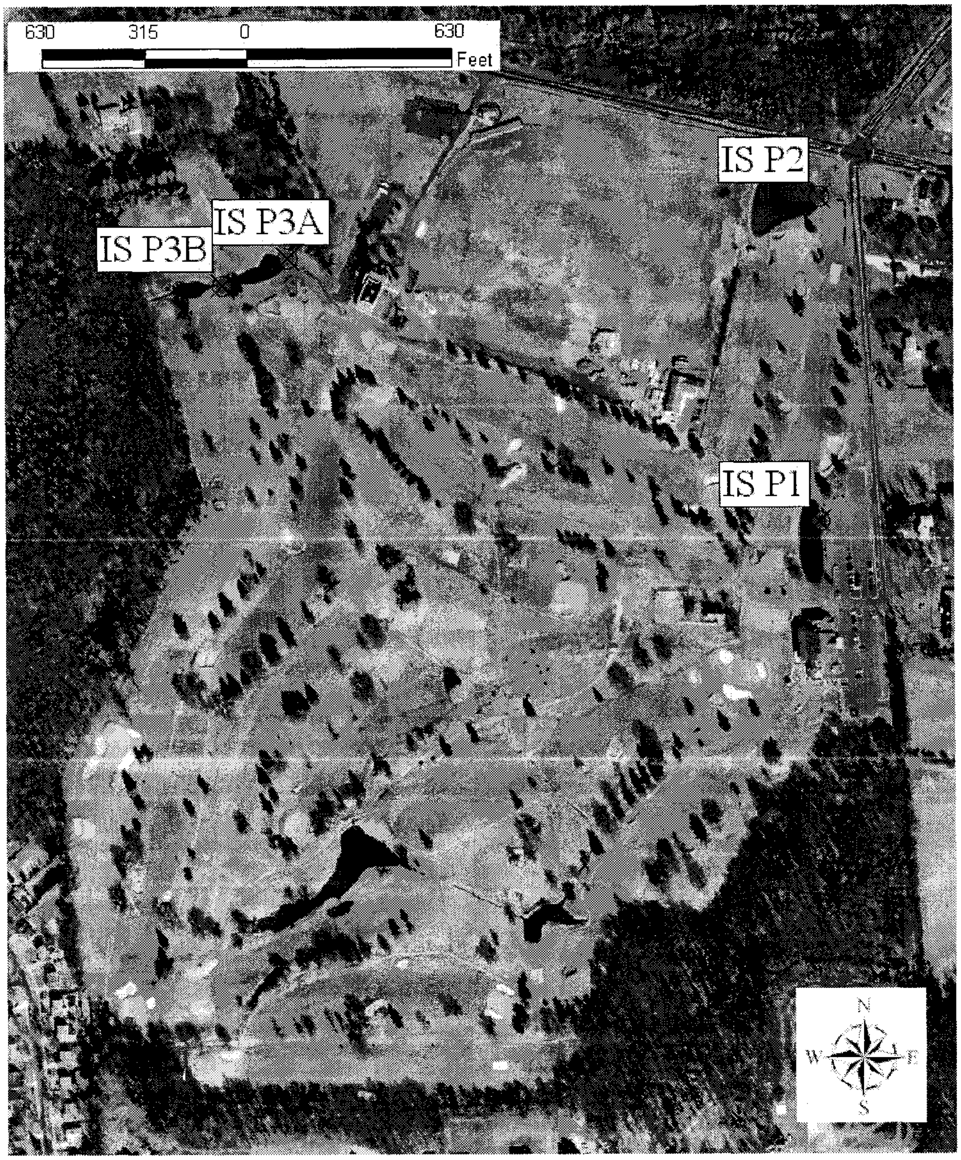


**Figure 50: Surface Water Sample Locations at Indian Springs Golf Course**

**Figure 51: Surface Water Sample Locations at Medford Lakes Golf Course**

The information collected using the GeoXT$^{TM}$ was downloaded to a PC using GeoPathfinder Office 2.90 and differentially corrected. Differential correction is used to improve the accuracy of a GPS location measurement by correcting errors caused by satellite geometry, atmospheric delay, multipaths, and clocks (Trimble, 2004). The differential correction file was downloaded from the New Jersey Department of Environmental Protection's base station located in Trenton, New Jersey. A geographic information system (GIS) shape file was created from the corrected

GPS points. The shape file includes the geographic located and an attribute table containing the data dictionary information for the sample locations. ESRI ArcMap 9.0 was used to create the project maps provided in Appendix A. The New Jersey State Plane Coordinates for each sample location are listed in Table 18 below.

**Table 18: Geographic Sample Locations in New Jersey State Plane Coordinates**

| | U.S. Survey Feet | | NAD 83 | |
|---|---|---|---|---|
| **Sample Location** | **Northing** | **Easting** | **Latitude** | **Longitude** |
| IS P1 | 383,565 | 383,099 | 39°53’09” | 74°53’19” |
| IS P2 | 383,565 | 383,147 | 39°53’09” | 74°53’18” |
| IS P3A | 381,953 | 383,066 | 39°52’53” | 74°53’19” |
| IS P3B | 381,745 | 382,908 | 39°52’50” | 74°53’21” |
| ML P1 | 410,541 | 373,978 | 39°57’35” | 74°55’17” |
| ML P2 | 409,656 | 375,660 | 39°57’26” | 74°54’55” |
| ML WT | 410,680 | 373,871 | 39°57’37” | 74°55’19” |

Geographic data sets for New Jersey, Burlington County, and associated Watershed Management Areas were obtained from the NJDEP Bureau of Geographic Information Systems and the New Jersey Geological Survey. Table B-1 in Appendix B lists the data sets obtained, data type, source, and content of the data. Data descriptions shown in Table B-1 were incorporated from metadata information supplied by the NJDEP Bureau of Geographic Information Systems and the New Jersey Geological Survey.

2002 aerial orthophotographs of each of the golf courses were downloaded from the New Jersey Office of Geographic Information Systems in MrSID format and imported into ESRI ArcMap 9.0. The aerial photographs were captured using the digital color infrared (CIR) orthophotography technique and were projected into New Jersey State Plane NAD83 Coordinates. The digital orthophotography was produced at a scale of 1:2400 (1"=200') with a 1 foot pixel resolution. Digital orthophotography combines the image characteristics of a photograph with the geometric qualities of a map. Digital orthophotography is a process which converts aerial photography from an original photo negative to a digital product that has been positionally corrected for camera lens distortion, vertical displacement and variations in aircraft altitude and orientation (NJGIS, 2004).

### *Water Sample Analysis Methods*

Nitrate-nitrogen was analyzed using a HACH DR 4000 Spectrophotometer and HACH method 8171 for mid-range nitrate-nitrogen concentrations. Approximately 40 mL of each sample was collected in a HACH NitraVer 5 Nitrate AccuVac Ampul and repeatedly inverted for one (1) minute. After the inversion period, the Ampul was allowed to rest for a five (5) minute reaction period. During sample preparation, cadmium metal contained in the Ampul reduces nitrates in the sample to nitrite. The nitrite ion then reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt. The salt couples with gentisic acid to form an amber colored solution (HACH, 2003a). Samples were placed in the spectrophotometer and analyzed at a wavelength of 400 nanometers (nm) using HACH Program 2525. When the sample is placed in the spectrophotometer, light is directed through the sample. The amount of light that is absorbed by the sample is translated to a concentration dependent on what wavelength and HACH program is used. All samples were analyzed in duplicate and the average is reported.

Total phosphorus was analyzed using a HACH DR 4000 Spectrophotometer and HACH method 8190. Phosphates present in the sample in organic and condensed inorganic forms (meta-, pyro-, or other polyphosphates) must be converted to reactive orthophosphate before analysis. Pretreatment of the sample with 1.54 N sodium hydroxide acid solution and heat provides the conditions for hydrolysis of the condensed inorganic forms. Organic phosphates are converted to orthophosphates by heating with acid and persulfate. Orthophosphate reacts with molybdate in an acid medium to produce a mixed phosphate/molybdate complex. Ascorbic acid then reduces the complex, giving an intense molybdenum blue color (HACH, 2003b). Samples were placed in the spectrophotometer and analyzed at a wavelength of 880 nm using HACH Program 536. All samples were analyzed in duplicate and the average is reported.

Chemical oxygen demand (COD) was analyzed using a HACH DR 4000 Spectrophotometer and USEPA approved HACH method 8000. The mg/L COD results are defined as the mg of $O_2$ consumed per liter of sample under conditions of the procedure. In the procedure, the sample is heated for two hours with a strong oxidizing agent, potassium dichromate. Oxidizable organic compounds present in the sample react with the potassium dichromate, reducing the dichromate ion ($Cr_2O_7^{2-}$) to green chromic ion ($Cr^{3+}$). HACH program 2710 was used to determine the amount of $Cr^{6+}$ remaining in the sample vial. The COD reagent also contains silver and mercury ions. Silver is a catalyst and mercury is used to control chloride interferences (HACH, 2003c). All samples were analyzed in duplicate and the average is reported.

Membrane filtration was used for microbiological sample analysis. A USEPA approved HACH method (10029) for the simultaneous detection of total coliform bacteria and *Escherichia coli* (*E. coli*) bacteria was used to determine the amount of bacteria present in the samples. Sterilized absorbent pads were placed in a Petri dish and an ampule of HACH m-ColiBlue24 Broth was added to the dish. Samples were vacuum filtered at varying dilution rates through 45 μm filters. The filters were placed into the Petri dish containing the absorbent pad and m-ColiBlue24 Broth, inverted, and incubated at 35 $\pm$ 0.5 C for 24 hours. The Petri dishes were examined after the incubation period and coliform density, reported as colony forming units (CFU) per 100 mL, was calculated using the following equation (HACH, 2003d):

$$\text{Coliform colonies per 100 mL} = \frac{\text{Coliform colonies counted}}{\text{mL of original sample filtered}} \times 100$$

All samples were analyzed in duplicate and the average is reported.

# Chapter Five

## Results and Discussion

This study focused on the impacts to surface water quality and adjacent wetlands as a result of the use of treated wastewater effluent for golf course irrigation in Burlington County, New Jersey. Investigations were conducted to identify current suppliers and end users of treated wastewater effluent within the County. It was determined that one (1) site, the Indian Springs Golf Course, had been using reclaimed wastewater for irrigational purposes since 1999. In order to assess the ecological impacts from nearby application of treated wastewater effluent, water quality in retention ponds and wetland areas located at the monitoring sites was evaluated. The selected water quality parameters were analyzed in the laboratory in duplicate and the average results are presented in the following sections. Tabular analytical results are presented in Appendix C.

### *Nitrate-Nitrogen*

Nitrate acts as a nutrient for plants and plankton. High loading of nitrate can cause excessive growth of algae and other aquatic organisms. Large algal blooms prevent atmospheric oxygen exchange at the air-water interface and oxygen is not replenished. Aquatic organisms, such as fish, deplete the available oxygen within the aquatic system during normal biological activities. Once the available oxygen supply is exhausted, fish and other oxygen dependent organisms will begin to die. The NJDEP WAT (2004) compiled a list of nitrate impaired waters throughout the State, of which a significant number are located within the WMAs that encompass Burlington County.

Grab samples collected from irrigation ponds located on each golf course were laboratory analyzed for nitrate-nitrogen after each sampling event. A time series graph of average concentrations of nitrate-nitrogen detected at each of the Indian Springs sampling locations and the average monthly precipitation collected by the ONJSC (2004) for Division 2 (southern New Jersey) are presented in Figure 52. The concentrations of nitrate-nitrogen detected at Indian Springs were below the USEPA drinking water maximum contaminant level of 10 mg/L for nitrate-nitrogen.

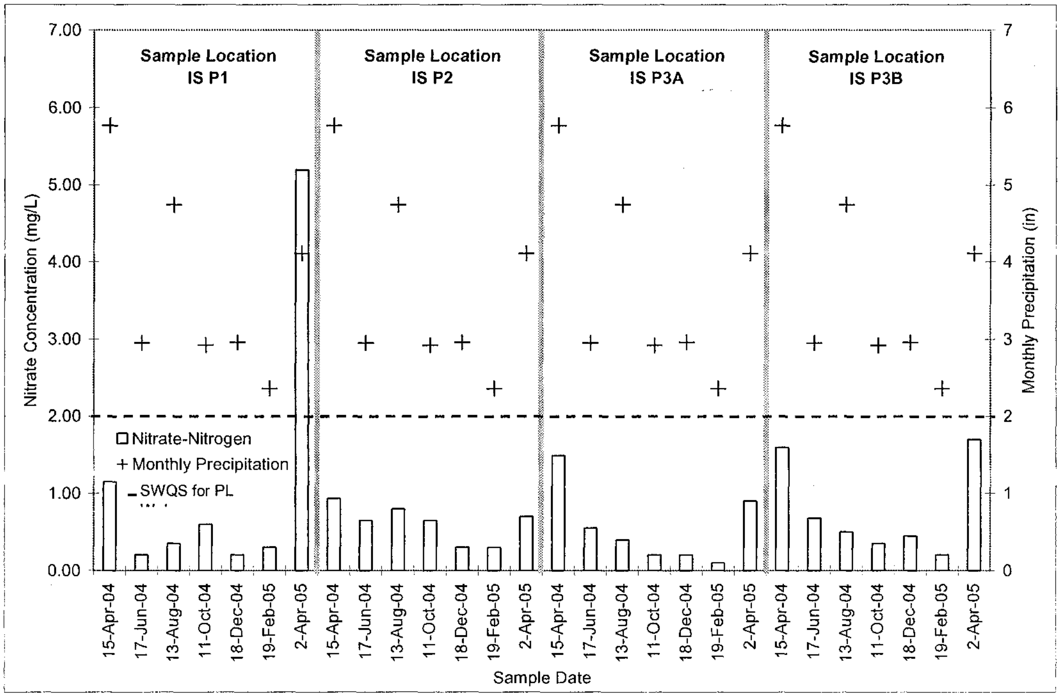


**Figure 52: Seasonal Nitrate-nitrogen Concentrations at Indian Springs Golf Course**

Some seasonal variation in nitrate-nitrogen concentrations can be observed at sample locations IS P1 and IS P2 from the analytical results presented in Figure 52. Overall it is observed that when the amount of monthly precipitation recorded increases the concentrations of nitrate-nitrogen detected increase and vice versa. Similar nitrate-nitrogen concentrations were observed at all of the Indian Springs sampling locations. The highest nitrate-nitrogen concentrations were typically seen at sample locations IS P3A and IS P3B. These sampling sites are located on the down gradient side of the golf course and higher nitrate-nitrogen concentrations can be attributed to nitrate-nitrogen transport in surface water runoff as a result of topographic influences.

The nitrate-nitrogen concentrations observed at the Indian Springs Golf Course were compared to the NJDEP Surface Water Quality Standards (SWQS) (N.J.A.C. 7.9B et. seq.), dated June 2005, for surface waters classified as either PL or FW2. A PL surface water designation is the general surface water classification applied to waters within the boundaries of the Pinelands National Reserve. A FW2 surface water designation is the general surface water classification applied to fresh waters not designated as PL waters (NJDEP DWQ, 2005). A nitrate-nitrogen concentration of 5.20 mg/L was detected in sample IP 1, collected on April 2, 2005. The concentration detected was below the NJDEP SWQS of 10 mg/L of nitrate-nitrogen for FW2 waters, however the concentration of nitrate-nitrogen detected is in excess of the NJDEP SWQS of 2 mg/L for nitrate-nitrogen in PL waters. No additional concentrations of nitrate-nitrogen in excess of the NJDEP SWQS for nitrate-nitrogen in PL and/or FW2 designated waters were detected during the course of the study.

A time series graph of average concentrations of nitrate-nitrogen detected at each of the Medford Lakes sampling locations and the average monthly precipitation collected by the ONJSC (2004) for Division 2 are presented in Figure 53. The concentrations of nitrate-nitrogen detected at Medford Lakes were below the USEPA drinking water maximum contaminant level of 10 mg/L for nitrate-nitrogen.

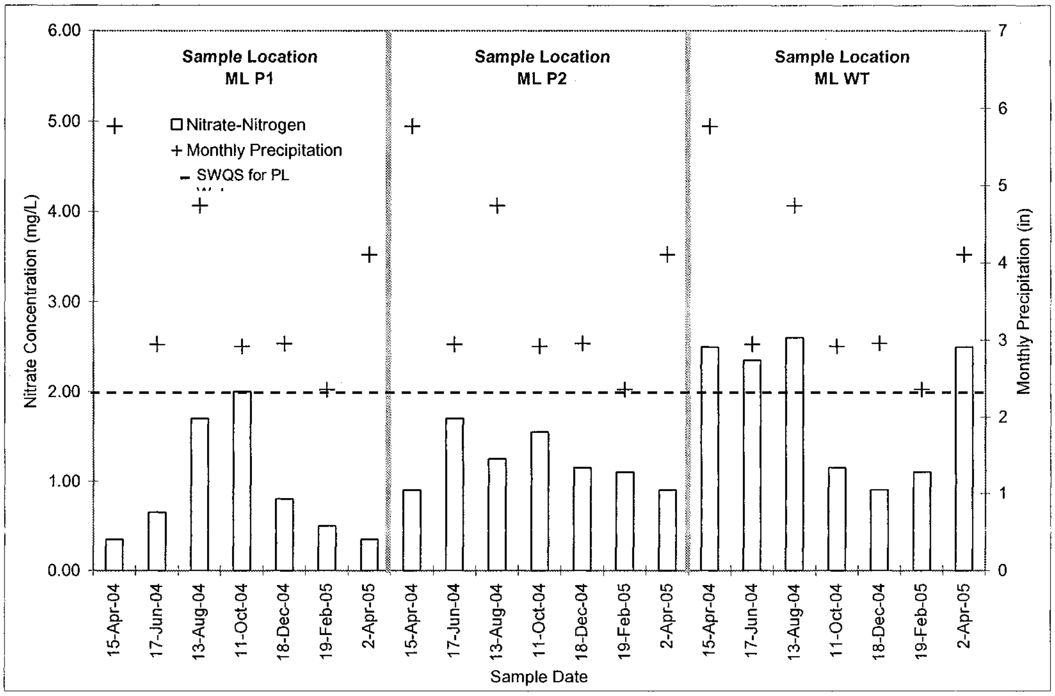


**Figure 53: Seasonal Nitrate-nitrogen Concentrations at Medford Lakes Country Club**

Seasonal variation in nitrate-nitrogen concentrations at sample locations ML P1, ML P2, and ML WT are presented in Figure 53. Contrary to the Indian Springs Golf Course, there is no apparent relationship between precipitation amounts and nitrate-nitrogen concentrations detected at the sampling locations. This does not necessarily mean that they are not interrelated. Fertilizer application schedules vary throughout the course of a year and the monthly precipitation amounts are not wholly representative of rainfall patterns prior to the sampling date. Records of fertilizer application schedules were not available from the maintenance staff at Medford Lakes, making it difficult to interpret the effects of fertilizer application on nitrate-nitrogen concentrations detected at the sampling locations.

Similar nitrate-nitrogen concentrations were detected at all of Medford Lakes sample locations, with the highest concentrations typically observed at sampling location ML WT. Sample location ML WT is located down gradient of sample location ML P1 and higher concentrations of nitrate-nitrogen appear to be influenced by the nitrate-nitrogen concentrations observed at ML P1 in addition to inputs from non-point source runoff contributions surrounding sample location ML WT.

The nitrate-nitrogen concentrations observed at the Medford Lakes Country Club were compared to the NJDEP SWQS, for surface waters classified as either PL or FW2. Nitrate-nitrogen concentrations were detected in sample ML WT during the April, June, and August 2004 and April 2005 sampling events at concentrations of 2.50 mg/L, 2.35 mg/L, 2.60 mg/L, and 2.50 mg/L, respectively. Nitrate-nitrogen was also detected in sample ML P1 at a concentration of 2.00 mg/L during the October 2004 sampling event. The concentrations detected were below the NJDEP SWQS of 10 mg/L of nitrate-nitrogen for FW2 waters, however the concentrations of nitrate-nitrogen detected are in excess of the NJDEP SWQS of 2 mg/L for nitrate-nitrogen in PL waters. No additional concentrations of nitrate-nitrogen in excess of the NJDEP SWQS for nitrate-nitrogen in PL and/or FW2 designated surface waters were detected during the course of the study.

A mass balance of nitrate-nitrogen for the retention pond (IS P2) at the Indian Springs Golf Course directly receiving treated wastewater effluent was completed to determine the main source of nitrate-nitrogen loading. The mass balance equation formulated is as follows:

$$N_{pond} = N_{effluent} + N_{nps} + N_{atm} - N_{asm}$$

Where:

$\mathrm{N}_{\mathrm{pond}}$ = Nitrate loading leaving pond via irrigation (kg/day)

$\mathrm{N}_{\mathrm{effluent}}$ = Nitrate loading from EWTF (kg/day)

$\mathrm{N}_{\mathrm{nps}}$ = Nitrate loading from non - point sources (fertilizer runoff and waterfowl) (kg/day)

$\mathrm{N}_{\mathrm{atm}}$ = Nitrate loading as a result of atmospheric deposition (kg/day)

$\mathrm{N}_{\mathrm{asm}}$ = Nitrate assimilated by microorganisms in pond (kg/day)

The surface area of the pond was calculated to be approximately 1,012 $m^2$ with a depth of approximately 2 meters. The approximate volume of the pond was calculated to be $2.02 \times 10^6$ L.

The average daily flow of treated effluent discharged into pond IS P2 was estimated to be 265 cubic meters per day, as determined from Monitoring Reports submitted to the NJDEP by the Evesham MUA. The highest observed nitrate-nitrogen concentration within pond IS P2 was 0.94 mg/L and assuming that the flow of water exiting the pond for irrigation is equal to the amount entering; approximately 0.25 kg/day ($N_{pond}$) of nitrate-nitrogen leaves the pond as a result of irrigation. The average loading rate of nitrate-nitrogen introduced into pond IS P2 from the EWTF was determined, from Monitoring Reports submitted to the NJDEP by the Evesham MUA, to be 0.49 kg/day ($N_{effluent}$).

Kunimatsu, et. al. (1999) investigated the amount of nitrate-nitrogen removed from the surface of golf courses in Japan due to rainfall events. The results of the study indicated that 3.66 kg/ha-yr of nitrate-nitrogen was removed from the golf courses through surface water runoff. There are three (3) surface water ponds located on the Indian Springs Golf Course. Assuming that surface water runoff over the entire area of the golf course (~100 acres) is equally distributed to each of the three (3) ponds, approximately 0.14 kg/day of nitrate-nitrogen is introduced into pond IS P2 from the golf course via surface water runoff.

Purcell and Goldsborough (1996) investigated the role of waterfowl in regulating wetland algal growth. Experiments were conducted using waterfowl feces over an eight (8) week period. The total feces loading during the study was 480 $g/m^2$ with a total nitrogen load of 5.78 $g/m^2$. The study reported that natural feces loading was 0.80 $g/m^2$ over eight (8) weeks. Natural nitrogen loading is estimated to be 0.01 $g/m^2$. Assuming that surface water runoff collecting waterfowl feces over the entire area of the golf course (~100 acres) is equally distributed to each of the three (3) ponds, approximately 13.92 kg/day of nitrate-nitrogen is introduced into pond IS

P2 from the golf course. Therefore, the approximate amount of nitrate-nitrogen introduced into the pond fertilizer runoff and waterfowl feces ($N_{nps}$) is 14.06 kg/day.

Atmospheric deposition of nitrate-nitrogen in the forests of New Jersey was studied by Dighton et al. (2003) to track nitrate-nitrogen deposition trends and its effects over time. The researchers collected precipitation samples from locations in the Pinelands Protection Area over a six (6) month period in 2002 for nitrate-nitrogen analysis. The greatest total nitrate-nitrogen concentration detected at the three sites during the summer months of 2002 was reported to be 3.0 mg/m$^2$. Assuming that precipitation was collected every day for six months, and that one month is equal to thirty (30) days, atmospheric nitrate-nitrogen flux was calculated to be 0.017 mg/m$^2$-day. Approximately 1.72 x 10$^{-5}$ kg/day of nitrate-nitrogen is estimated to fall over the surface area of the pond ($N_{atm}$) which is considered to be negligible when compared to other inputs considered.

Horne (1995) conducted a study to determine denitrification rates of effluent from wastewater stabilization ponds. Results of the study indicate that nitrogen removal can occur at rates ranging from 200 - 5000 mg N /m$^2$-day. Using the rates observed by Horne, nitrate-nitrogen removal ($N_{asm}$) in pond IS P2 is estimated to range from approximately 0.91 to 22.68 kg/day.

The nitrate-nitrogen balance in pond IS P2, using an average estimated $N_{asm}$ of 11.8 kg/day, closes to approximately 120% using the following formula:

$$\text{Nitrate Closure} = \frac{\text{Nitrate In}}{\text{Nitrate Out}} \text{ x } 100\%$$

The results of the mass balance indicate that nitrate-nitrogen is being introduced into the pond at a higher rate that can be assimilated by microorganisms and/or removed for irrigation purposes. A major contributor to the nitrate-nitrogen inputs to pond IS P2, based on the above assumptions, is the presence of waterfowl. Implementation of waterfowl control measures and construction of buffer areas between greens, fairways, and ponds can reduce the amount of nitrate-nitrogen input into surface water bodies on the golf course.

### *Total Phosphorus*

Phosphorus is an essential nutrient for plants and algae, but can be considered a pollutant because it can stimulate excessive growth and lead to eutrophication. Phosphorus is most often the limiting nutrient relative to the nutritional requirements of primary producers in freshwater systems. Consequently, phosphorus is frequently a prime determinant of algal activity in a stream or lake. Signs of eutrophication include oxygen super-saturation during the day, oxygen depletion during the night, and high sedimentation rate. Algae and aquatic plants are the catalysts for these processes. Secondary biological impacts can include loss of biodiversity and structural changes to communities (NJDEP DWM, 2004). The NJDEP WAT (2004) compiled a list of phosphorus impaired water bodies (i.e., lakes and streams) throughout the State, of which a significant number are located within the WMAs that encompass Burlington County.

Grab samples collected from irrigation ponds located on each golf course were laboratory analyzed for total phosphorus after each sampling event. A time series graph of average concentrations of total phosphorus detected at each of the Indian Springs sampling locations and the average monthly precipitation collected by the ONJSC (2004) for Division 2 (southern New Jersey) are presented in Figure 54. Seasonal variation in total phosphorus concentrations is readily observed at all of the Indian Springs sample locations.

The phosphorus concentrations observed at the Indian Springs Golf Course were compared to the NJDEP SWQS for surface waters classified as FW2. No total phosphorus NJDEP SWQS is currently in place for surface waters with a PL designation. Allowable total phosphorus limits in fresh waters with a FW2 designation is 0.05 mg/L. All of the total phosphorus concentrations detected during each sampling event at the Indian Springs Golf Course during the course of the study were found to be in excess of the NJDEP SWQS for surface waters with a FW2 designation.

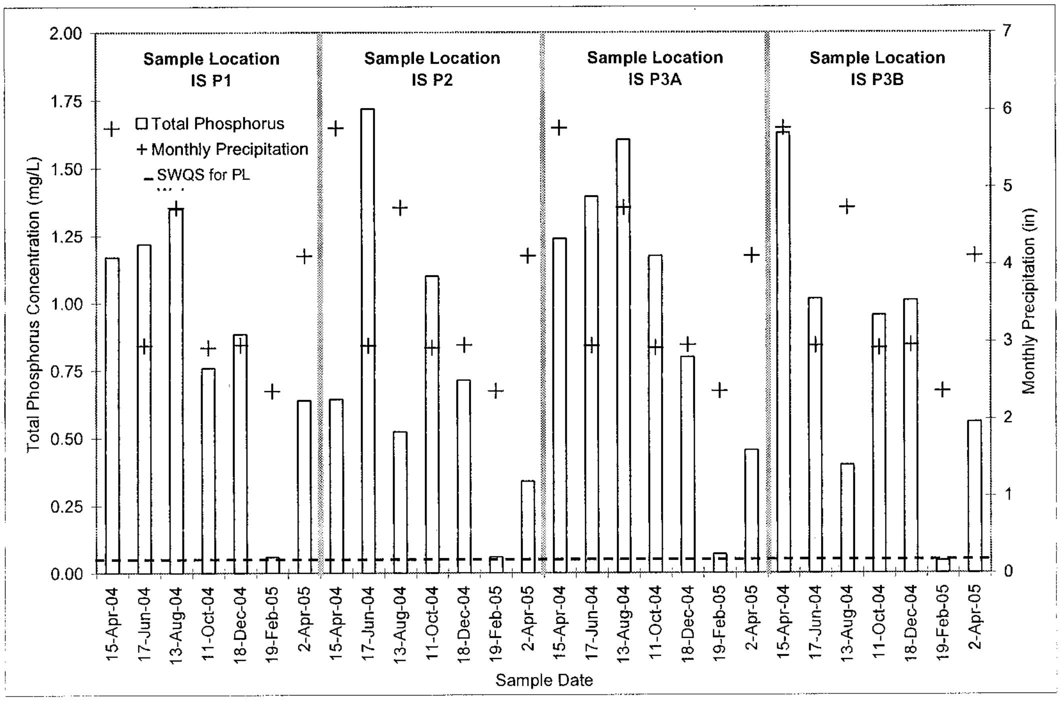


Figure 54: Seasonal Total Phosphorus Concentrations at Indian Springs Golf Course

A time series graph of average concentrations of total phosphorus detected at each of the Medford Lakes sampling locations and the average monthly precipitation collected by the ONJSC (2004) for Division 2 (southern New Jersey) are presented in Figure 55.

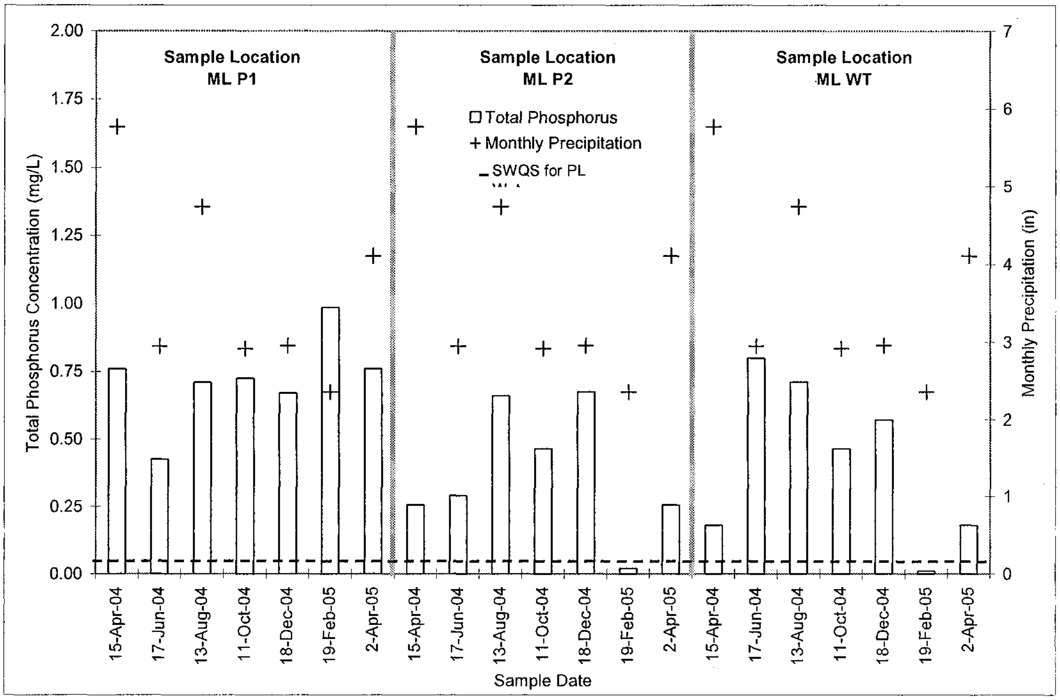


**Figure 55: Seasonal Total Phosphorus Concentrations at Medford Lakes Country Club**

There is no apparent relationship between precipitation amounts and total phosphorus concentrations detected at the sampling locations. Overall, total phosphorus concentrations detected at the Medford Lakes sampling locations were observed to be similar. The highest concentrations of total phosphorus were consistently detected at sample location ML P1. Sample location ML P1 is surrounded by fairways and greens and receives a high amount of surface water runoff.

The phosphorus concentrations observed at the Medford Lakes were compared to the NJDEP SWQS for surface waters classified as FW2. All of the total phosphorus concentrations detected at each sampling location during all of the sampling events at Medford Lakes during the course of the study were found to be in excess of the NJDEP SWQS for surface waters with a FW2 designation, with the exception of sampling locations ML P2 and ML WT during the February 2005 sampling event.

A mass balance of total phosphorus for pond IS P2 was completed to determine the main source of total phosphorus loading. The mass balance equation formulated is as follows:

$$P_{pond} = P_{effluent} + P_{nps} + P_{atm} - P_{rem}$$

Where:

$P_{pond}$ = Phosphorus loading leaving pond via irrigation (kg/day)
$P_{effluent}$ = Phosphorus loading from EWTF (kg/day)
$P_{nps}$ = Phosphorus loading from non - point sources (fertilizer runoff and waterfowl) (kg/day)
$P_{atm}$ = Phosphorus loading as a result of atmospheric deposition (kg/day)
$P_{rem}$ = Phosphorus removed in pond (kg/day)

The highest observed total phosphorus concentration within pond IS P2 was 1.72 mg/L. Assuming that the flow of water exiting the pond for irrigation is equal to the amount entering, approximately 0.46 kg/day ($P_{pond}$) of total phosphorus leaves the pond as a result of irrigation. The average loading rate of total phosphorus introduced into pond IS P2 from the EWTF was determined from monitoring reports submitted to the NJDEP by the Evesham MUA. The total phosphorus loading was reported to be 0.10 kg/day ($P_{effluent}$).

Kunimatsu et al. (1999) investigated the amount of total phosphorus removed from the surface of golf courses in Japan due to rainfall events. The results of the study estimated that about 3.04 kg/ha-yr of total phosphorus was removed from the golf courses through surface water runoff. Assuming that surface water runoff over the entire area of the golf course (~100 acres) is equally distributed to each of the three (3) ponds, approximately 0.11 kg/day of total phosphorus is introduced into pond IS P2 from the golf course via surface water runoff.

Purcell and Goldsborough (1996) also investigated the effects of phosphorus additions on algal growth. The total feces loading during the study was 480 g/m$^2$ with a total phosphorus load of 1.92 g/m$^2$. Natural phosphorus loading is estimated to be 0.0032 g/m$^2$. Assuming that surface water runoff collecting waterfowl feces over the entire area of the golf course (~100 acres) is equally distributed to each of the three (3) ponds, approximately 4.62 kg/day of total phosphorus is introduced into pond IS P2 from the golf course. Therefore, the approximate amount of total phosphorus introduced into the pond fertilizer runoff and waterfowl feces ($P_{nps}$) is 4.73 kg/day.

Atmospheric deposition of total phosphorus in New Jersey was studied by Koelliker et al. (2004). The researchers collected precipitation samples from locations throughout the State from July 1999 through June 2001 for total phosphorus analysis. The greatest total phosphorus flux detected at the location closest to the Indian Springs Golf Course the study was reported to be 8.1 $mg/m^2$-year (Koelliker et al., 2004). Assuming that precipitation was collected every day for 365 days, atmospheric total phosphorus flux was calculated to be 0.022 $mg/m^2$-day. Approximately $2.22 \times 10^{-5}$ kg/day of total phosphorus is estimated to fall over the surface area of the pond ($P_{atm}$) and this amount is considered to be negligible.

Comings et al. (1997) conducted a study to determine storm water pollutant removal rates in wet ponds. Results of the study indicate that total phosphorus removal can occur at rates ranging from 0.13 - 0.56 kg/ha-yr. Using the rates observed and the approximate surface area of the pond IS P2, total phosphorus removal ($P_{rem}$) is estimated to range from approximately $3.6 \times 10^{-5}$ - 0.001 kg/day.

The results of the total phosphorus mass balance indicate that total phosphorus is being introduced into the pond at a much higher rate that can be removed. A major contributor to the total phosphorus inputs to pond IS P2, based on the above assumptions, is the presence of waterfowl. Implementation of waterfowl control measures and construction of buffer areas between greens, fairways, and ponds can reduce the amount of total phosphorus input into surface water bodies on the golf course.

### *Chemical Oxygen Demand (COD)*

COD analysis is a reliable measurement of the oxygen equivalent of organic matter that can be chemically oxidized using dichromate in an acid solution (Metcalf & Eddy, 2003). EWTF does not monitor its diverted effluent for COD. Grab samples collected from irrigation ponds located on each golf course were laboratory analyzed for COD after each sampling event. A time series graph of average concentrations of COD detected at each of the Indian Springs and Medford Lakes sampling locations and the average monthly precipitation collected by the ONJSC (2004) for Division 2 (southern New Jersey) are presented in Figure 56 and Figure 57, respectively.

The concentrations of COD detected at the Indian Springs sampling locations indicate that there may be other inputs of organics into the ponds other than the wastewater effluent for reuse. The COD concentrations detected at Medford Lakes were generally found to be higher than those at Indian Springs.

The concentrations of COD detected at both sampling locations are representative of all oxidizable organic matter contained in the sample. As the samples were collected from retention ponds located at the monitoring locations, layers of leaves and other dead vegetation have collected at the bottom of the ponds from the natural processes that occur during the autumn season. The detritus located at the bottom of the pond releases organic matter into the water of the retention ponds as it decomposes, contributing to the results of the COD analysis.

Other inputs of organic material into the ponds located at the monitoring sites may be attributed to the presence of migratory waterfowl, particularly the Canada goose (*Branta canadensis*). This type of goose is prevalent throughout Canada and the United States and subsists on vegetation such as short grasses. The amount of grassed areas located on a golf course creates an ideal feeding ground for the Canada goose. As a result, many geese have been seen at the monitoring locations during the migratory season.

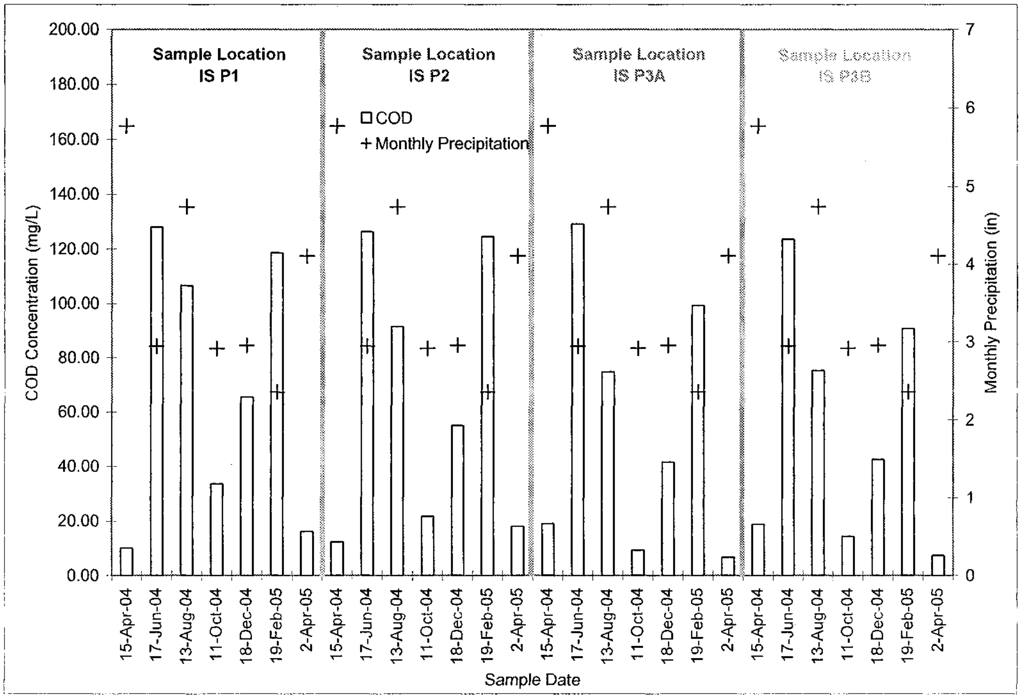


Figure 56: Seasonal COD Concentrations at Indian Springs Golf Course

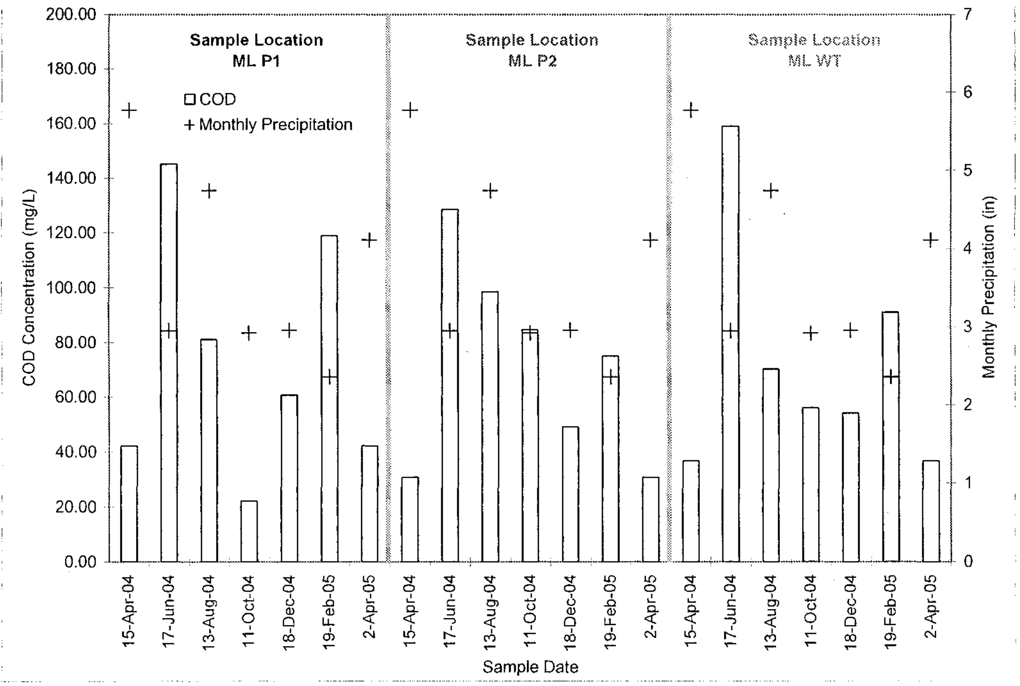


Figure 57: Seasonal COD Concentrations at Medford Lakes Country Club

Geese produce large amounts of excreta, a good majority of which contains indigestible organic material, which is deposited on the ground surface. Rain events carry the decomposing excreta over land and deposit it into low lying areas and the retention ponds located at the monitoring locations. The residual organic material decomposes in a similar fashion to that of the detritus mentioned previous, contributing to the results of the COD analysis.

As discussed previously, the EWTF does not monitor the effluent diverted for beneficial reuse applications for COD. The EWTF monitors effluent discharged to Rancocas Creek for biological oxygen demand (BOD), which is a measure of the amount of dissolved oxygen consumed by microorganisms during the biodegradation of organic material contained in a wastewater sample (Metcalf & Eddy, 2003). The State of Florida requires all treated wastewater effluent to be used for beneficial applications meet an average total organic carbon (TOC) limit of 3.0 mg/L on a monthly basis (FAC, 1999). This limit was introduced in response to increased detection rates of organic compounds in the wastewater stream for the protection of human health and the sensitive ecosystems found in Florida.

BOD, COD, and TOC concentrations in municipal wastewater are interrelated and ratios between BOD and COD and BOD and TOC are used to characterize the treatability of wastewater (Metcalf & Eddy, 2003). A comparison of the ratios of BOD/COD and BOD/TOC found at various treatment levels is shown in Table 17.

**Table 19: Comparison of Ratios of Various Parameters Used to Characterize Wastewater (Metcalf & Eddy, 2003)**

| **Type of Wastewater** | **BOD/COD** | **BOD/TOC** |
|---|---|---|
| Untreated | 0.3 - 0.8 | 1.2 - 2.0 |
| After primary settling | 0.4 - 0.6 | 0.8 - 1.2 |
| Final effluent | 0.1 - 0.3 | 0.2 - 0.5 |

Characterizing the water contained within the pond directly receiving the treated effluent at Indian Springs as being of final effluent quality, the average BOD/COD ratio from Table 17 is 0.2. Using the highest COD concentration detected at sample location IS P2 (128.8 mg/L) the theoretical BOD concentration of the sample was calculated to be 25.76 mg/L. The theoretical TOC concentration of the sample, using a BOD/TOC ratio of 0.35, was calculated to be 73.6 mg/L. The theoretical TOC concentration detected at sample location IS P2 is over 24 times higher than the allowable 3.0 mg/L TOC concentration in the State of Florida. The State of New Jersey currently has no requirement for TOC monitoring of effluent reclaimed for beneficial reuse.

In light of recent detections of potentially harmful organic compounds such as endocrine disruptors in wastewater effluent, the development of a TOC concentration limit by the NJDEP for beneficial reuse applications will significantly reduce the risk to human health from these compounds. Additionally, low TOC concentration limits will reduce the organic material available to pathogenic microorganisms for use as a growth substrate.

### *Total Coliform Bacteria and Escherichia Coli*

Coliform bacteria have traditionally been used as indicator organisms in the determination of the potential for pathogenic organisms to be present in water. Coliform bacteria are common to the intestinal tract of humans and the potential exists to shed 100 million to 400 million coliform bacteria daily (Metcalf & Eddy, 2003).

*Escherichia coli* (*E. coli*) is a type of coliform bacteria most commonly found in the intestinal tract of warm-blooded animals and has historically been the target organism measured with the total coliform bacteria test. It was determined early on that the total coliform test was not specific to *E. coli*, resulting in a variety of coliform organisms being included in the test results. More recently, coliform bacteria tests have been developed to distinguish between total coliform, fecal coliform, and *E. coli* bacteria (Metcalf & Eddy, 2003).

*E. coli* is now easily identifiable by conducting the coliform test at elevated temperatures in a specific growth media. The presence of a bright blue fluorescence at the conclusion of the test is taken as a positive indication for *E. coli* presence. The occurrence of *E. coli* is taken as a specific indicator of fecal contamination and the possible presence of enteric pathogens (USEPA, 1988).

To determine the presence of fecal contamination due to the use of treated effluent for irrigation, total coliform bacteria and *E. coli* were monitored in the samples taken from the monitoring sites. A time series graph of average concentrations of *E. coli* and total coliform bacteria detected in each of the sampling locations at Indian Springs and the average monthly precipitation collected by the ONJSC (2004) for Division 2 (southern New Jersey) are presented in Figure 58.

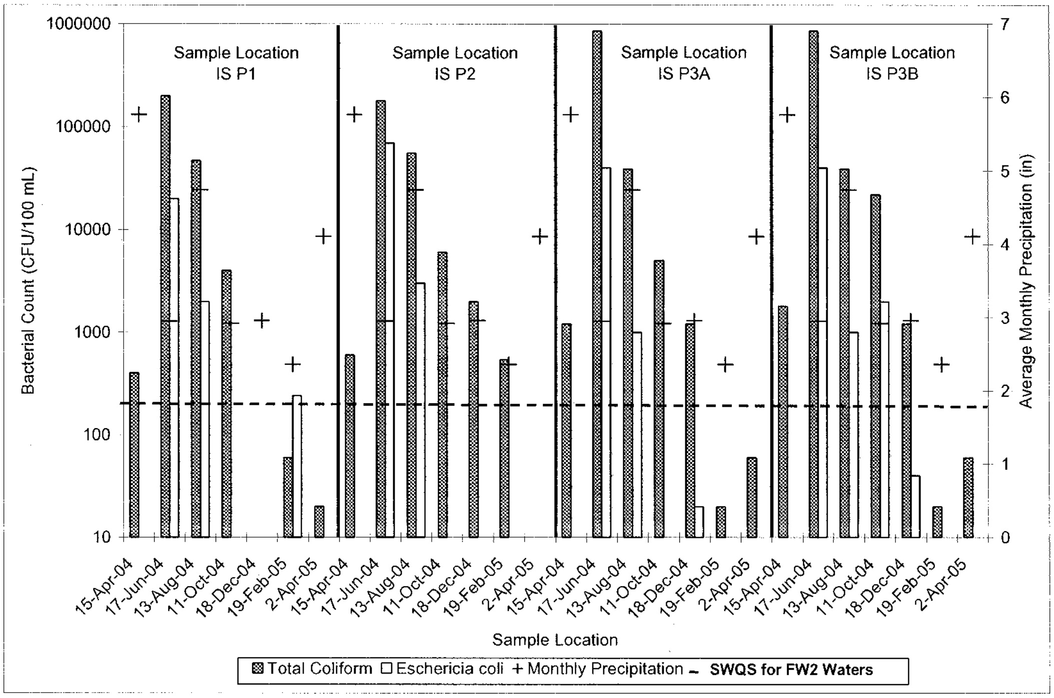


**Figure 58:** ***Escherichia coli*** **and Total Coliform Bacteria Detected at Indian Springs Golf Course**

Concentrations of *E. coli* at Indian Springs were consistently found to be the highest at sample location IS P2. The pond from which sample IS P2 was collected directly receives treated effluent from the EWTF, however the levels of bacteria detected cannot be attributed to inputs from the EWTF. The EWTF is limited to a fecal coliform concentration of 2.2 CFU/100 mL for beneficial reuse applications. Inputs of *E. coli* bacteria can be attributed to the presence of Canada geese and other waterfowl observed during sampling events.

The results of the bacterial analysis at the Indian Springs Golf Course were compared to the NJDEP SWQS for surface waters classified as FW2. No fecal coliform NJDEP SWQS is currently in place for surface waters with a PL designation. Allowable fecal coliform limits in fresh waters with a FW2 designation is 200 CFU/100 mL. Bacteria counts were in excess of the NJDEP SWQS at all Indian Springs Golf Course sampling locations during the June and August 2004 sampling events, at sample location IP 3B during the October 2004 sampling event, and at sample location IP 1 during the February 2005 sampling event. No additional bacterial counts in excess of the NJDEP SWQS for fecal coliform in FW2 waters were detected at the Indian Springs Golf Course during the course of the study.

A time series graph of average concentrations of *E. coli* and total coliform bacteria detected in each of the sampling locations at Medford Lakes and the average monthly precipitation collected by the ONJSC (2004) for Division 2 (southern New Jersey) are presented in Figure 59. The highest concentration throughout the study of *E. coli* at Medford Lakes was detected at sample location ML WT during the June 2004 sampling event. It reasonable to infer that the levels of bacteria found during the June 2004 sampling event were the result of severe rainstorms and subsequent flooding in the days prior to sampling.

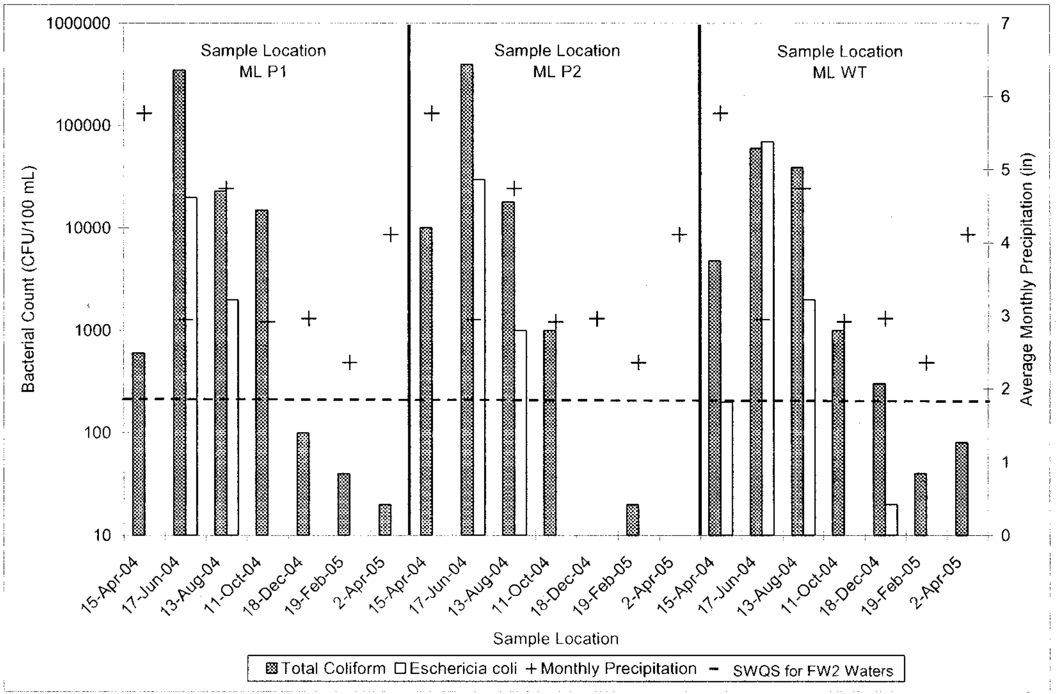


**Figure 59:** ***Escherichia coli*** **and Total Coliform Bacteria Detected at Medford Lakes Country Club**

The results of the bacterial analysis at Medford Lakes were compared to the NJDEP SWQS for surface waters classified as FW2. Bacteria counts were in excess of the NJDEP SWQS at sample location ML WT during the April 2004 sampling and at all of the Medford Lakes sampling locations during the June and August 2004 sampling events. No additional bacterial counts in excess of the NJDEP SWQS for fecal coliform in FW2 waters were detected at Medford Lakes during the course of the study.

It is obvious that the presence of high levels of *E. coli* detected in the sample identified as ML WT is attributable to the presence of Canada geese and other waterfowl. The area of the Medford Lakes monitoring site draining into the wetland area covers a large area of the golf course. Any surface water runoff will lose velocity as it enters the wetland area, causing any suspended colloidal and suspended particulates in the water to settle out under the effects of gravity. Bacteria adsorbed to these particles are deposited along with the particulates, accumulating after each rain event large enough to result in runoff.

The results of the monitoring plan implemented at the Burlington County locations indicate that the use of treated wastewater effluent for irrigation has had minimal, if any, impact to surface water quality. The high nutrient loading calculated for the retention pond from which sample IS P2 was obtained should provide incentive for the incorporation of best management practices on behalf of the Medford Lakes Country Club and the Indian Springs Golf Course management and maintenance staff to reduce unnecessary fertilization of landscaped areas of the golf courses. The development of a fertilization schedule considerate of nutrients introduced by the EWTF effluent will help to decrease costs associated with the purchase and application of fertilizer while helping to improve the water quality of surface water bodies adjacent to areas irrigated with treated wastewater effluent.

# Chapter Six
## Conclusions

The use of reclaimed wastewater has become a valued resource for the protection of drinking water supplies and surface water quality. Reclaimed wastewater can be used for irrigation purposes, greatly reducing the strain on freshwater supplies that are concurrently needed for drinking water. Diverting treated effluent for irrigation can improve the quality of streams and lakes by reducing the concentration of point source nutrients and oxygen consuming organics. In addition to irrigation, wastewater may be reclaimed and reused to recharge dwindling groundwater supplies or for recreational purposes.

The importance of reclaimed wastewater for beneficial reuse (RWBR) became significant in New Jersey during the drought of 1999. During that time many wastewater treatment facilities received authorization to reuse their treated effluent for various beneficial reuse applications, successfully increasing the amount of freshwater available for potable use.

The results of the monitoring plan implemented at the Burlington County locations indicate that the use of treated wastewater effluent for irrigation has had non-detectable impacts to surface water quality when compared to the impacts of other land management practices on golf courses. Concentrations of nutrients and bacteria at surface water sampling locations were found to be similar and often greater at the Medford Lakes monitoring location, indicating that there are additional factors influencing any effect the treated effluent may be imparting on the surface water ponds. Detections of targeted water quality parameters were compared to the NJDEP SWQS for PL and/or FW2 designated surface waters. The concentrations were found to be in excess of the applicable NJDEP SWQS during the majority of sampling events.

Additional factors identified that may have influence over the effects of the use of treated effluent for irrigation include, but are not limited to:

- Over fertilization of vegetated areas at the sampling locations resulting in collection of excess nutrients in runoff and deposition into the sampling ponds (nitrate-nitrogen and total phosphorus)

- The presence of migratory waterfowl in and around the sampling locations (bacteria and organics)

- Decomposing organic matter (i.e. leaves and grass) at the sampling locations (organics)

Concentrations of nutrients and bacteria detected in samples collected from wetland areas were found to be similar to concentrations detected in the retention ponds. This is not necessarily an indication that the use of treated effluent for irrigation on adjacent areas is negatively impacting wetlands. Nutrient mass balances indicate that the majority of inputs into pond IS P2 at the Indian Springs Golf Course are a result of uncontrolled non-point sources. Negative impact to wetland areas in the future can be prevented by the incorporation of buffer zones between heavily irrigated areas, such as tees and fairways, and natural wetland areas. Buffer zones, comprised of vegetation that acts as a nutrient sink, prevents the accumulation of nutrients in areas that are sensitive to high nutrient loads.

Best management practices should be developed and implemented at both the Medford Lakes Country Club and the Indian Springs Golf Course management and maintenance staff to reduce unnecessary fertilization of landscaped areas of the golf courses. Fertilization schedules considerate of nutrients introduced by the EWTF effluent will help to decrease costs associated with the purchase and application of fertilizer while helping to improve the water quality of surface water bodies adjacent to areas irrigated with treated wastewater effluent.

The use of reclaimed wastewater for irrigation has been practiced around the world and the United States for decades. The state of Florida has successfully been one of the largest users of reclaimed water for irrigation and has one of the most sensitive ecosystems in the country. The results of this study indicate that the use of reclaimed water for irrigation at the Indian Springs Golf Course is not having a detrimental effect on the environment that surrounds the location.

Since the susceptibility of groundwater wells within Burlington County to contamination from nutrients and fecal coliform was predicted to be low, the incorporation of the use of treated wastewater effluent for beneficial reuse into the County's environmental management program holds promise. However, a large percentage of Burlington County surface water bodies are nutrient and/or fecal coliform impaired. As such, the beneficial reuse of wastewater should be tightly linked to the Best Management Practices at the reuse site to prevent further degradation of surface water quality and to prevent the susceptibility of groundwater wells to contamination from increasing.

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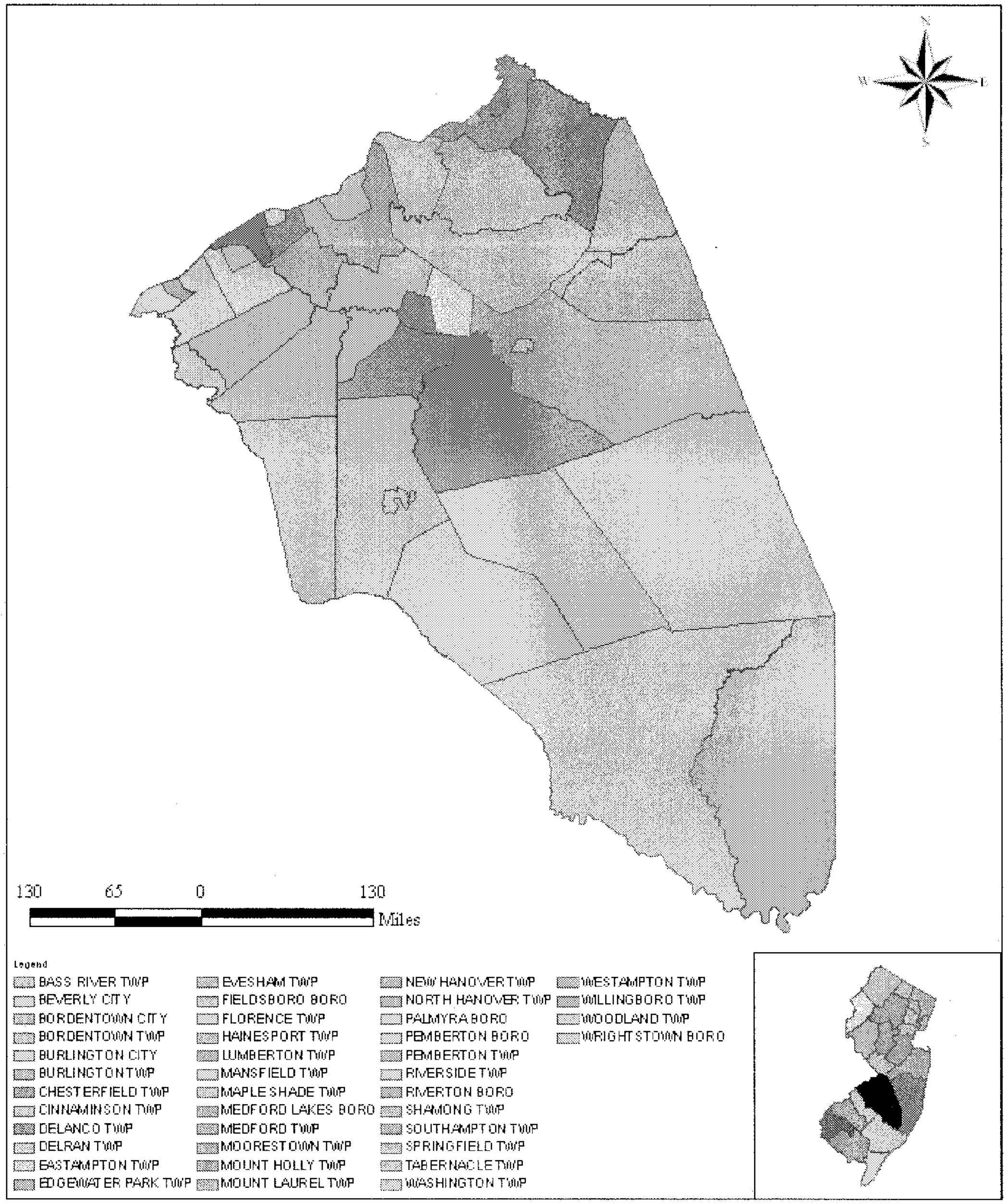
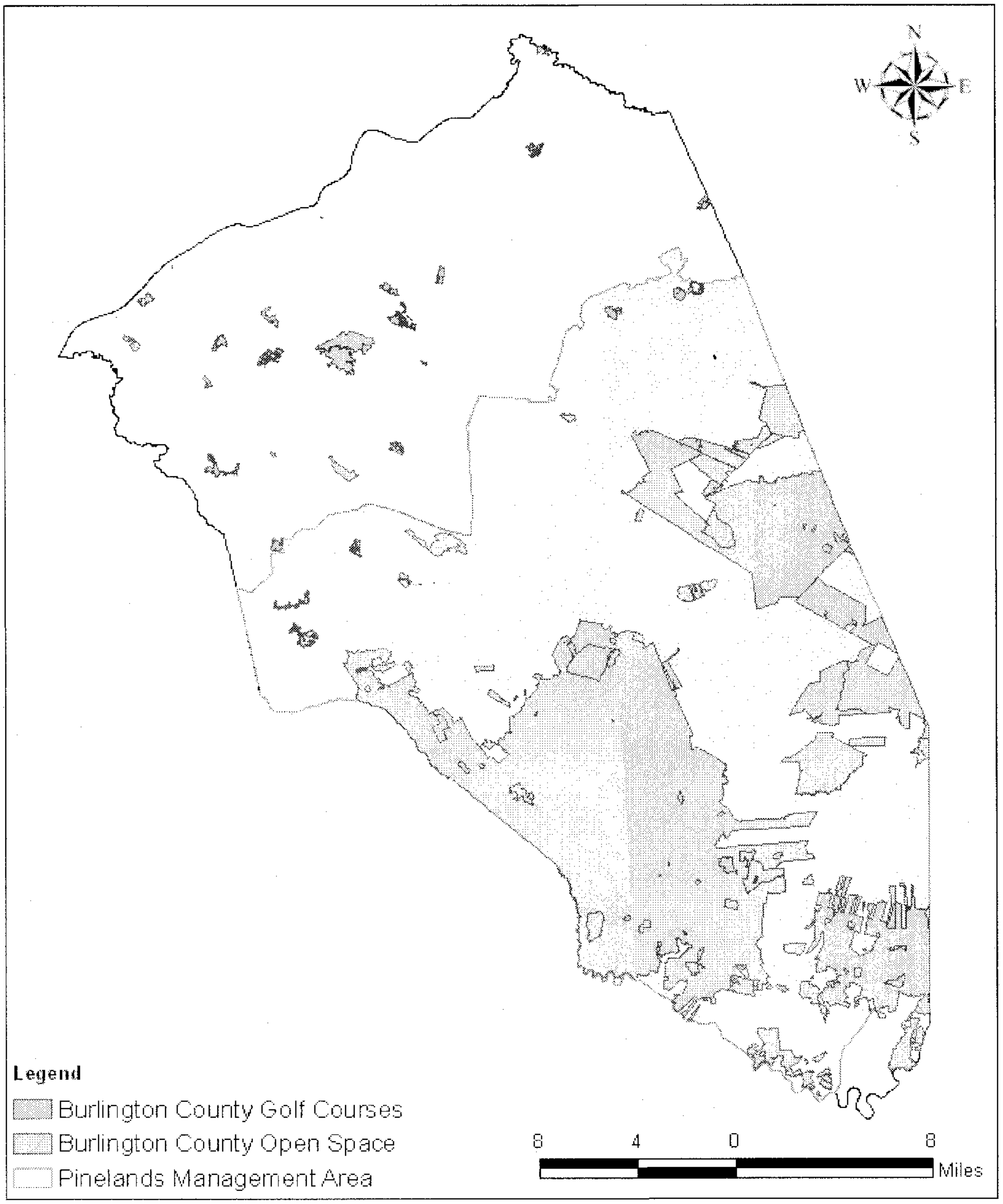
# APPENDIX A

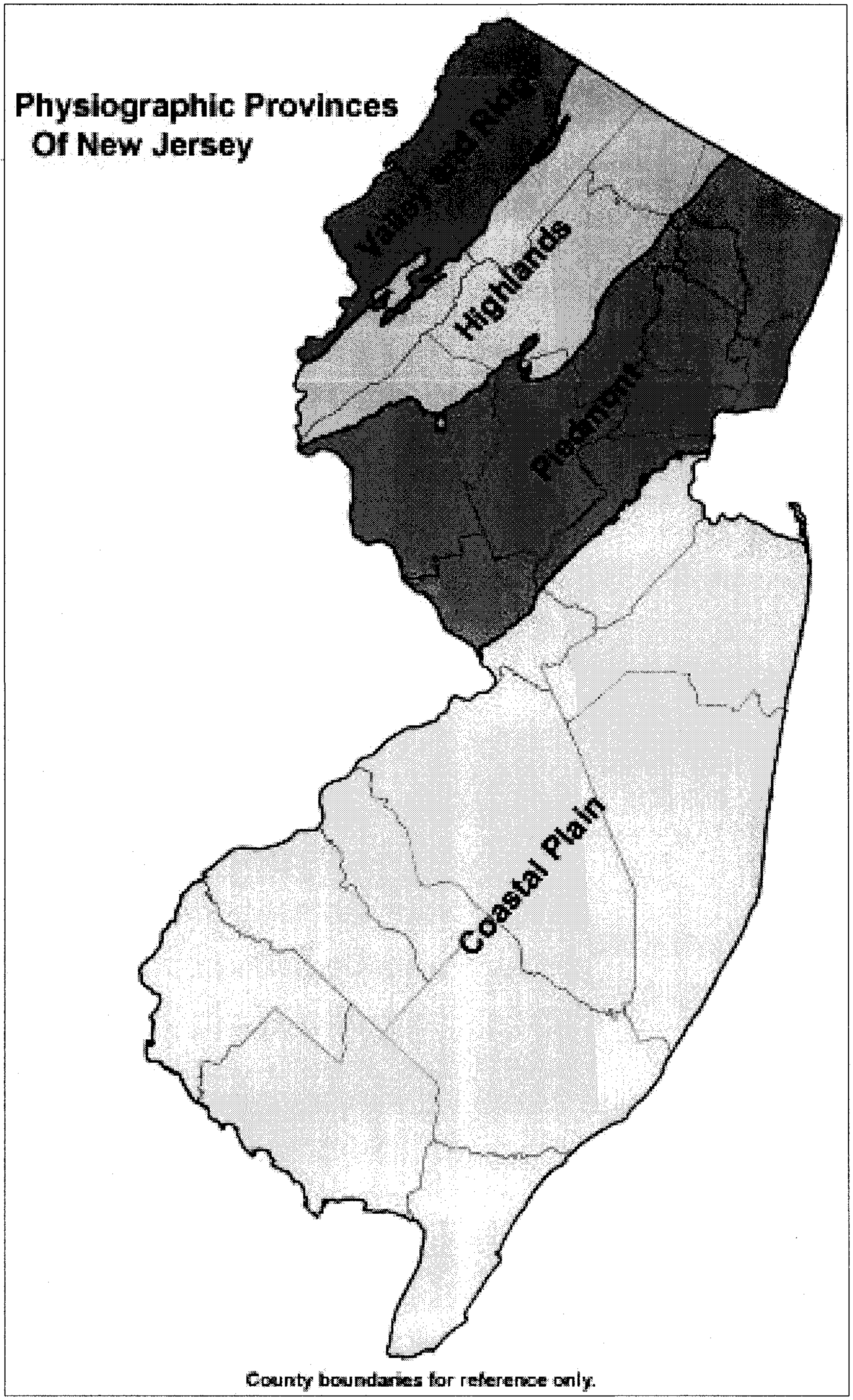
## Project Maps

# BURLINGTON COUNTY MUNICIPALITIES
# (NJDEP, 2003)



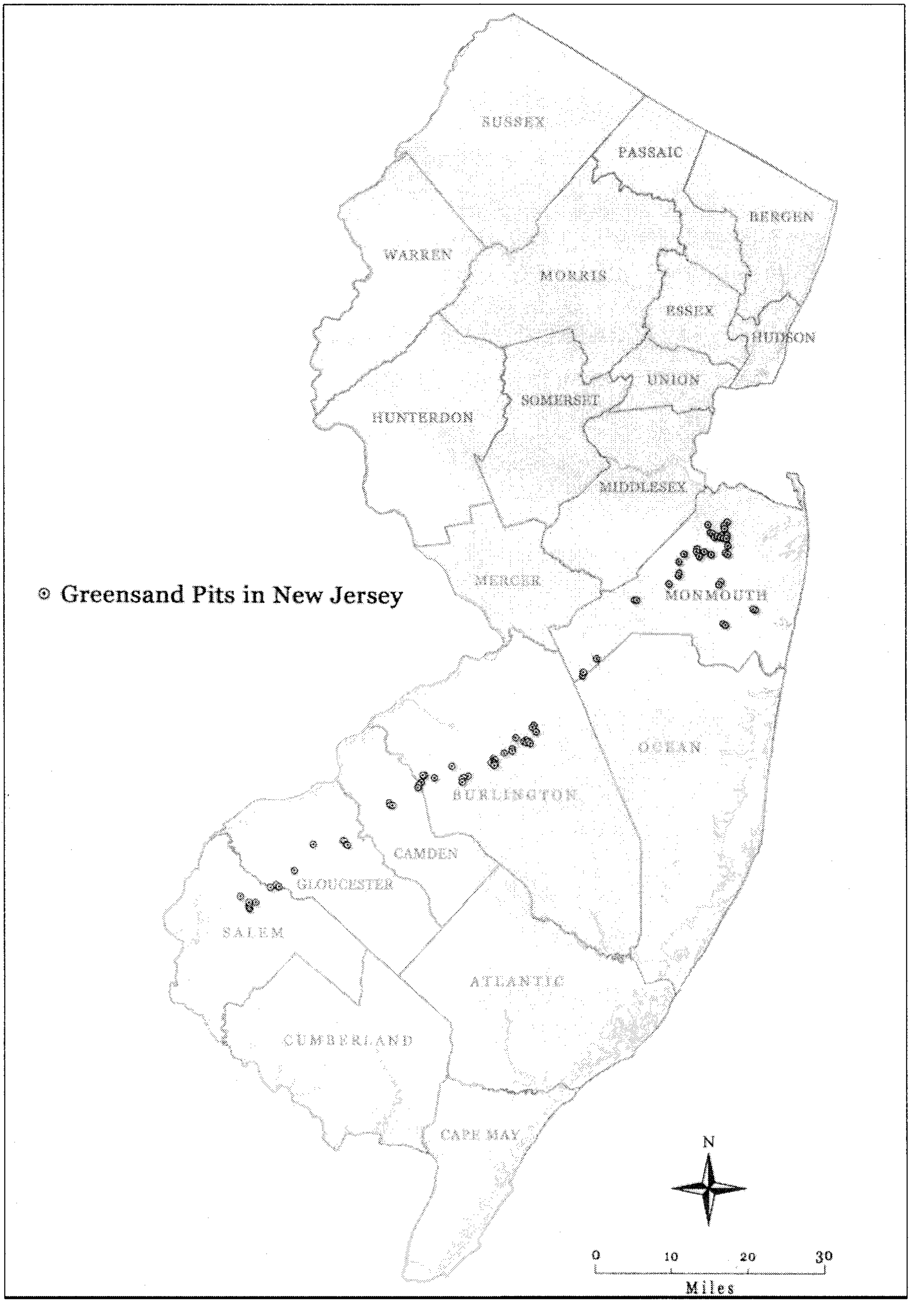
# PRESERVED OPEN SPACES IN BURLINGTON COUNTY



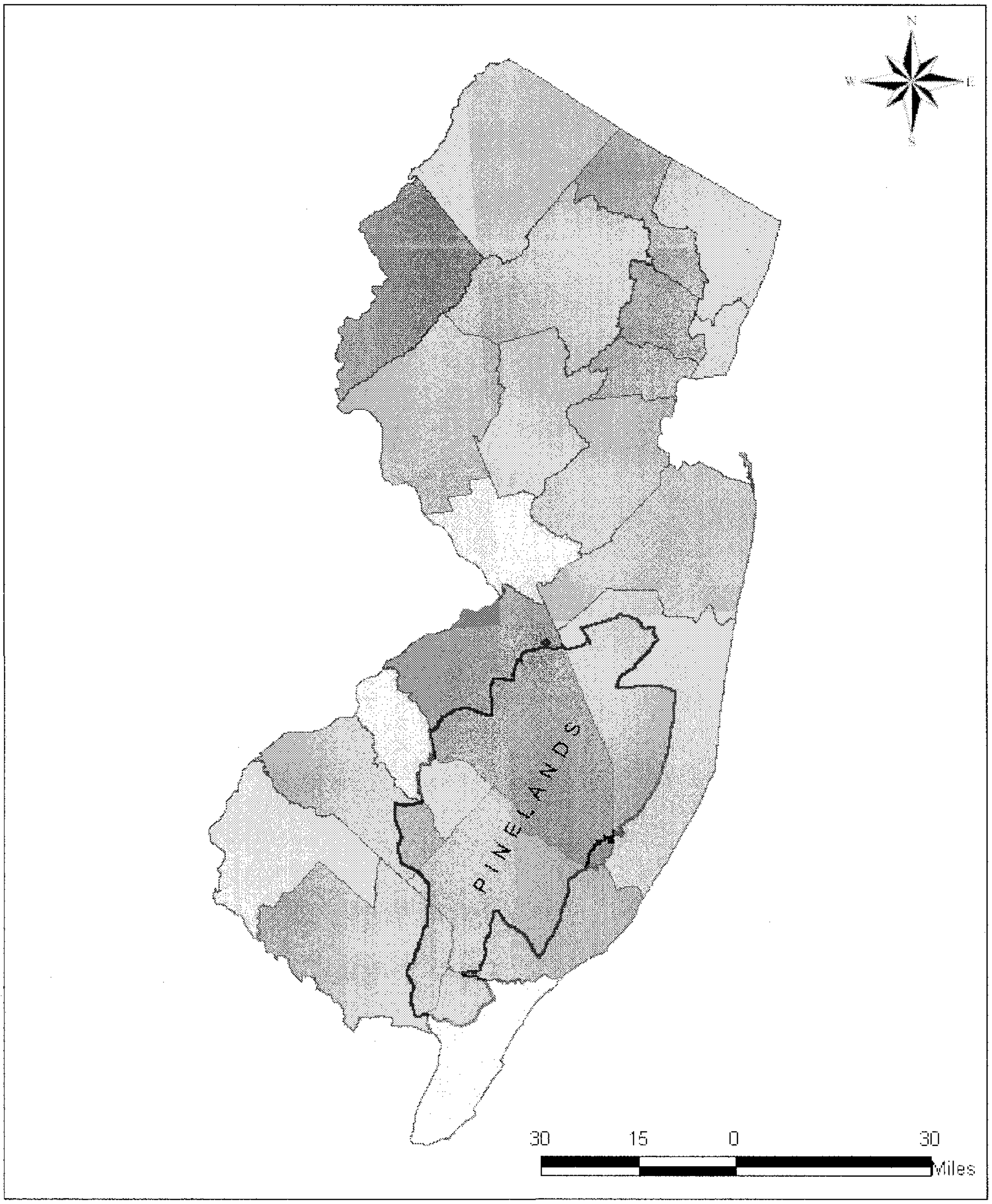


Physiographic Provinces Of New Jersey

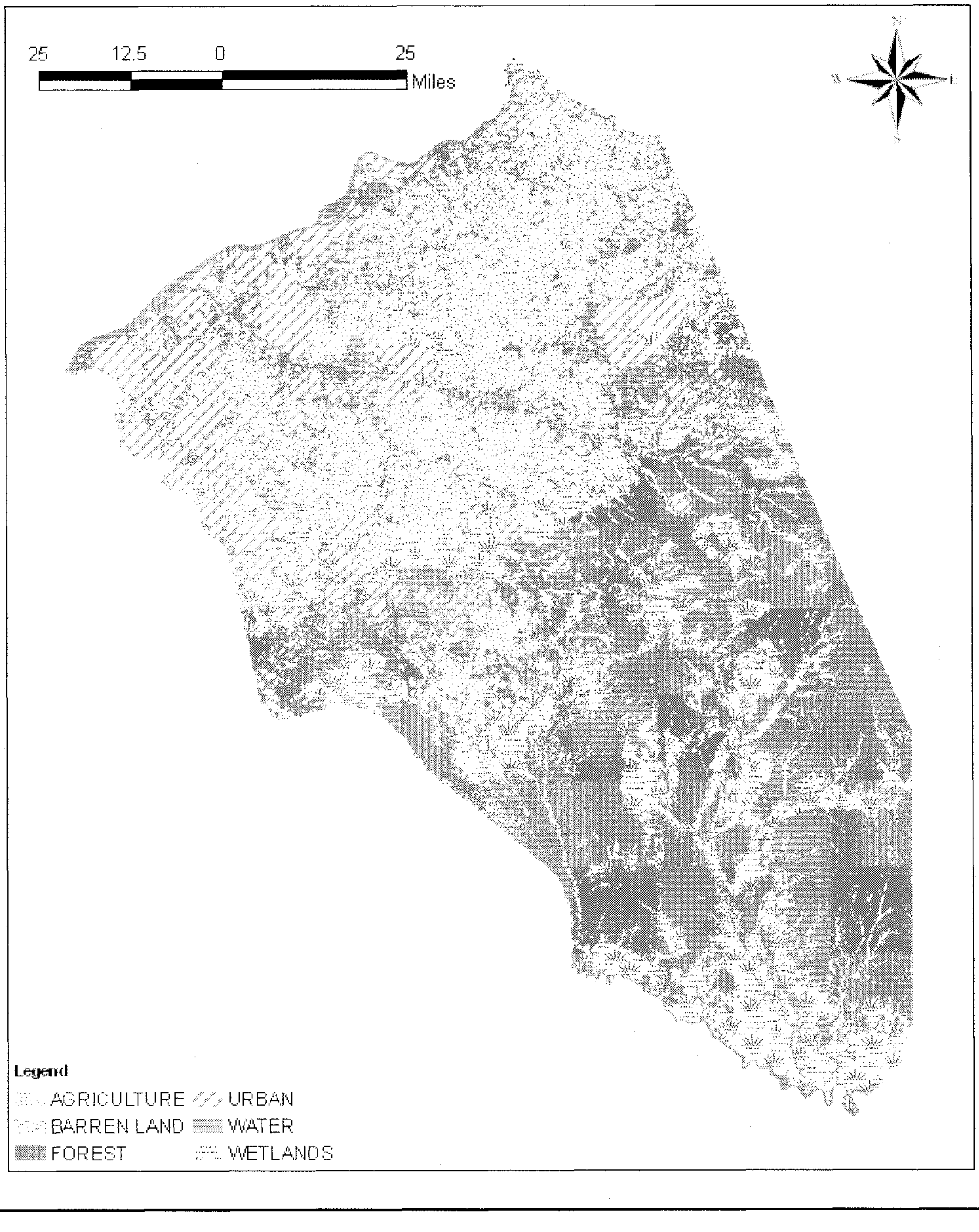
County boundaries for reference only.


⊙ Greensand Pits in New Jersey
SUSSEX
PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
HUDSON
UNION
HUNTERDON
SOMERSET
MIDDLESEX
MERCER
MONMOUTH
OCEAN
BURLINGTON
CAMDEN
GLOUCESTER
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY
N
0
10
20
30
Miles

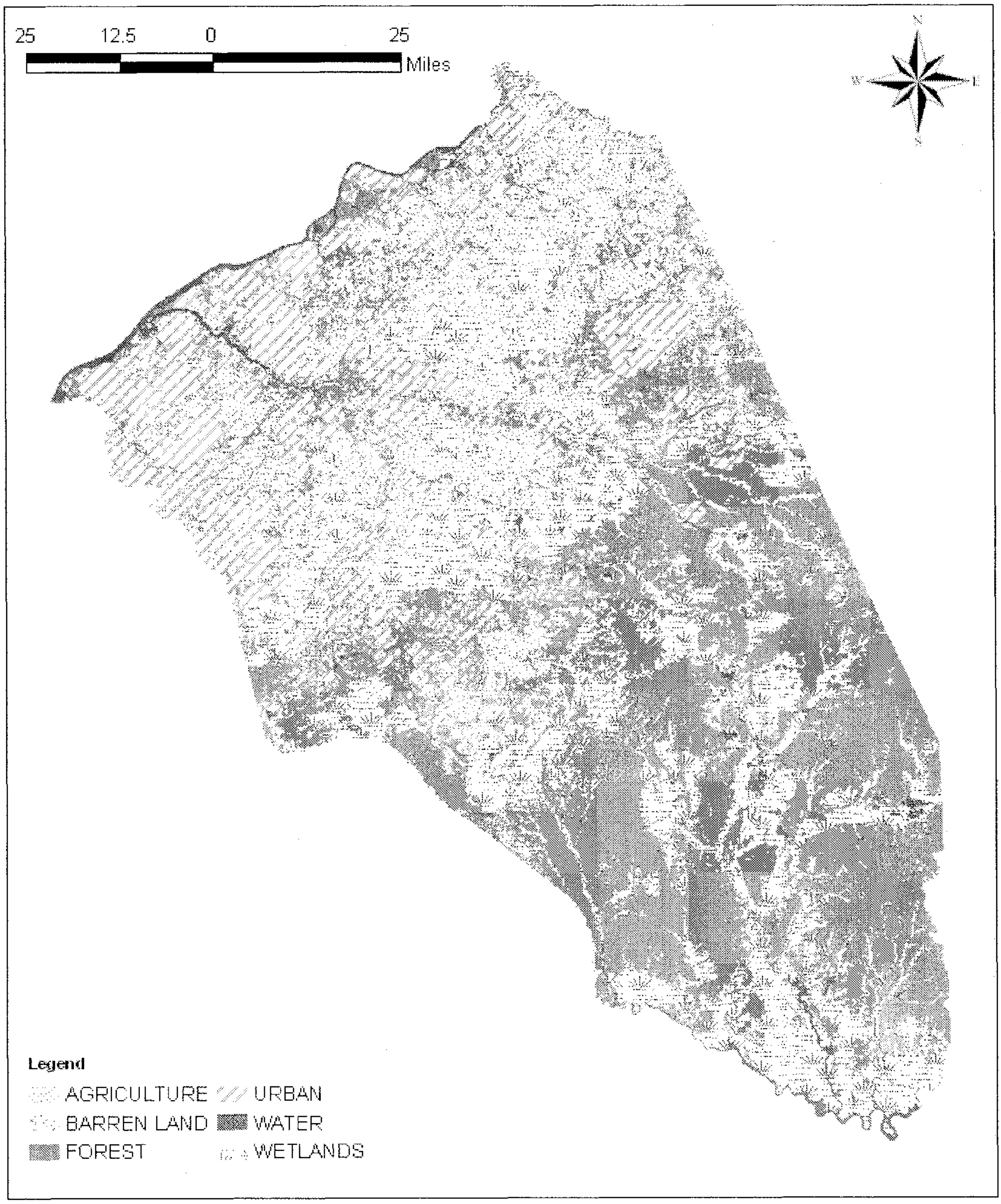
# PINELANDS PROTECTION AREA
# (NJDEP, 2003)



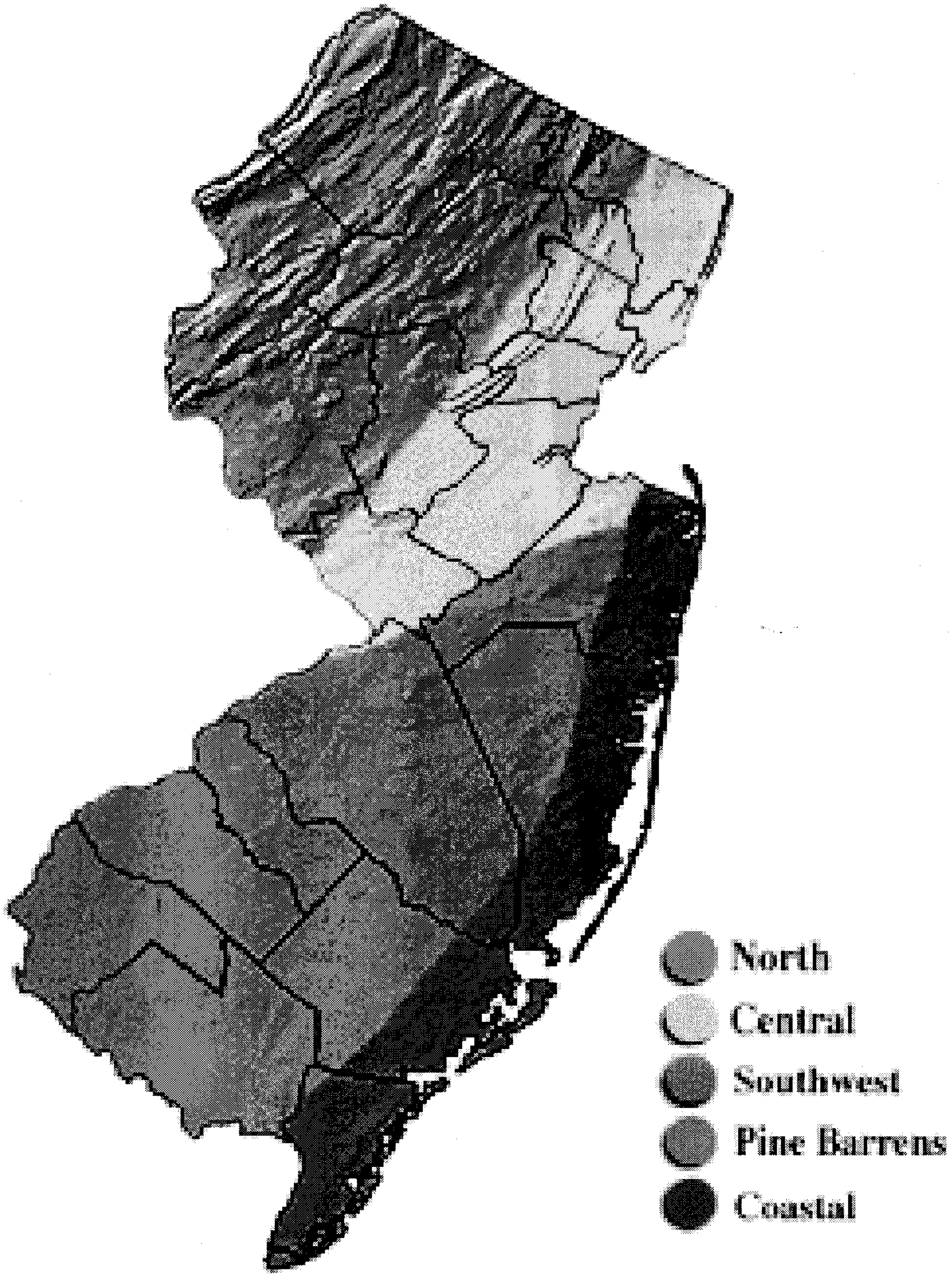
# 1986 BURLINGTON COUNTY LANDUSE
(NJDEP, 2003)



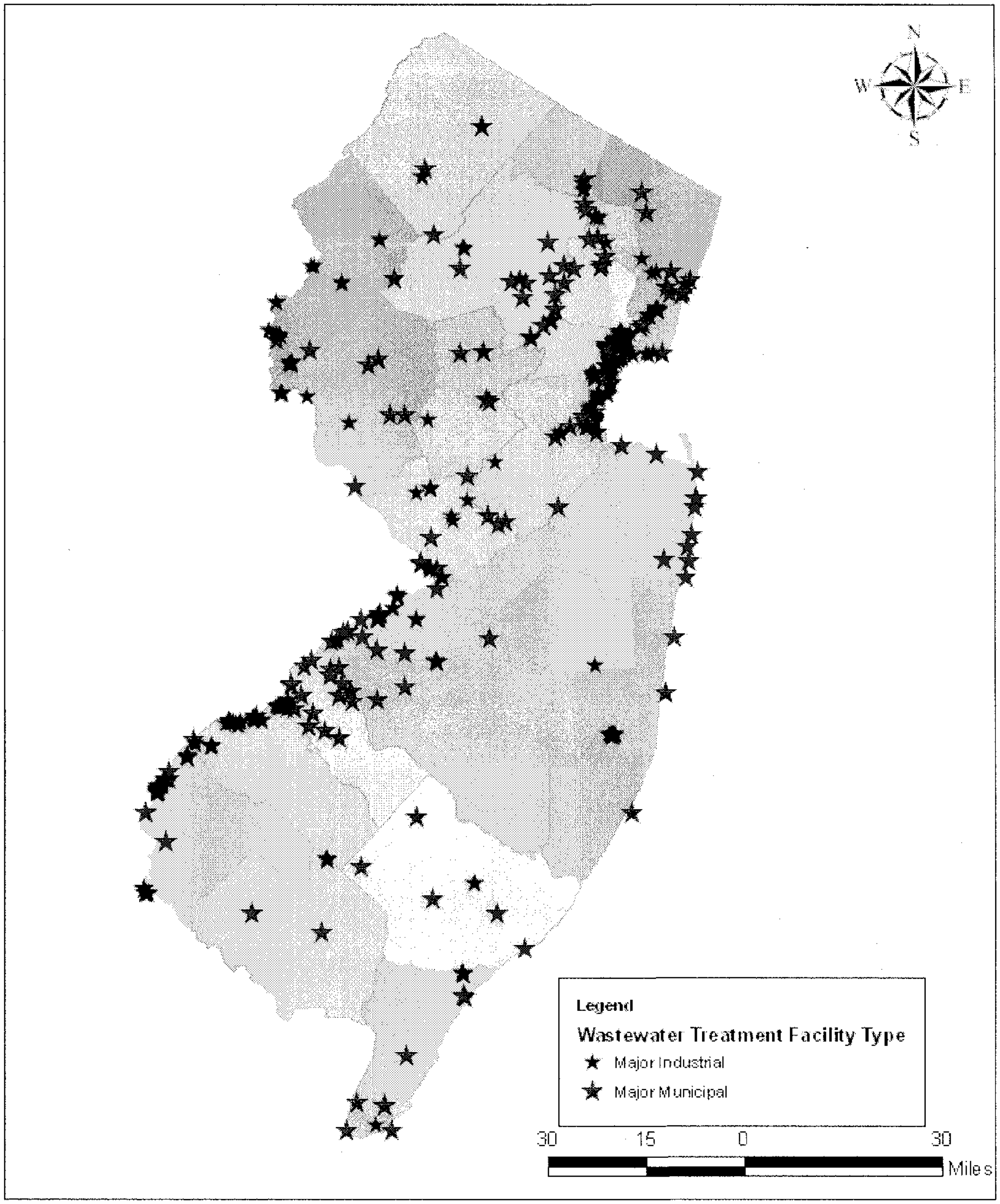
# 1995 BURLINGTON COUNTY LANDUSE
# (NJDEP, 2003)



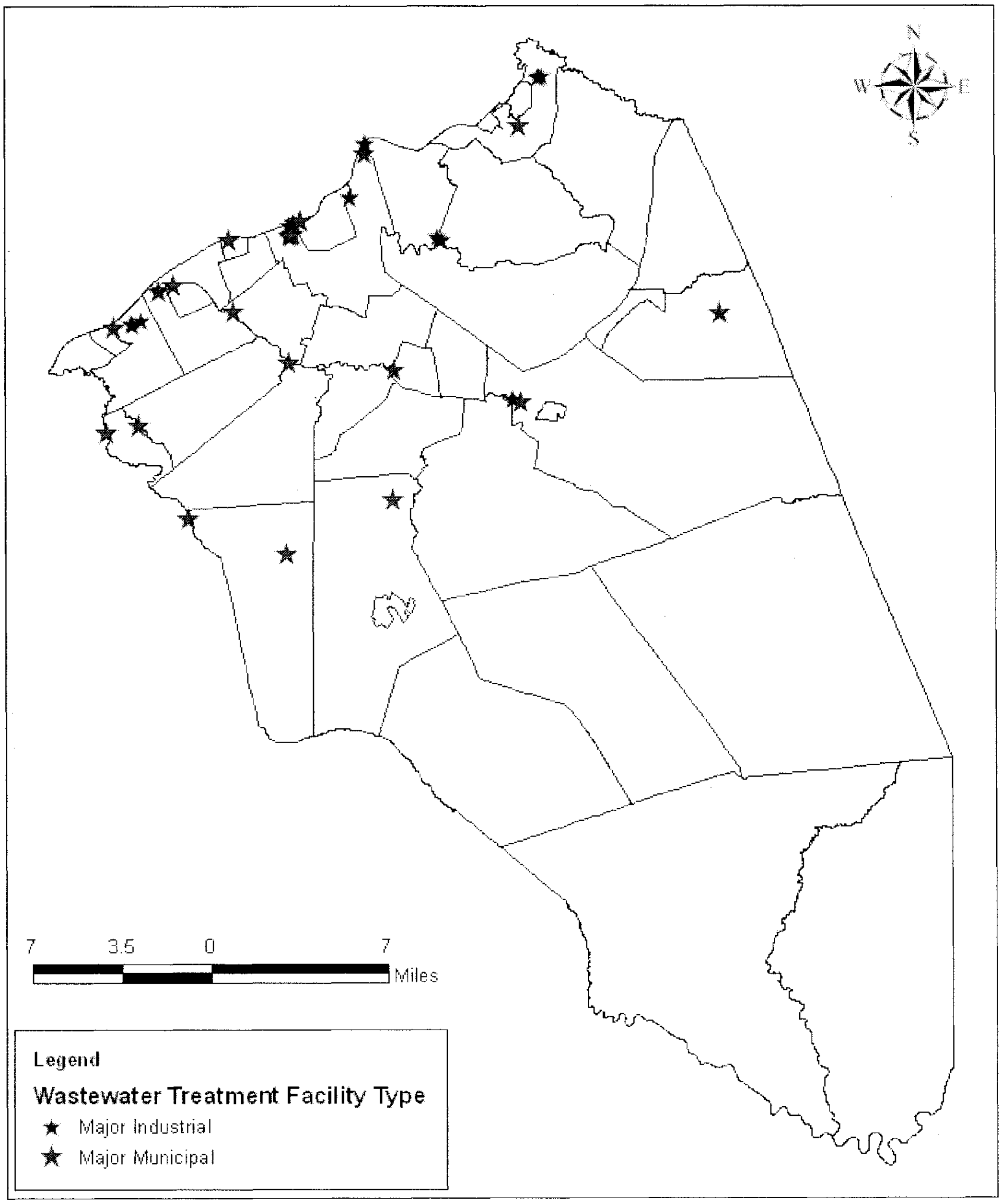
# New Jersey Climate Zones



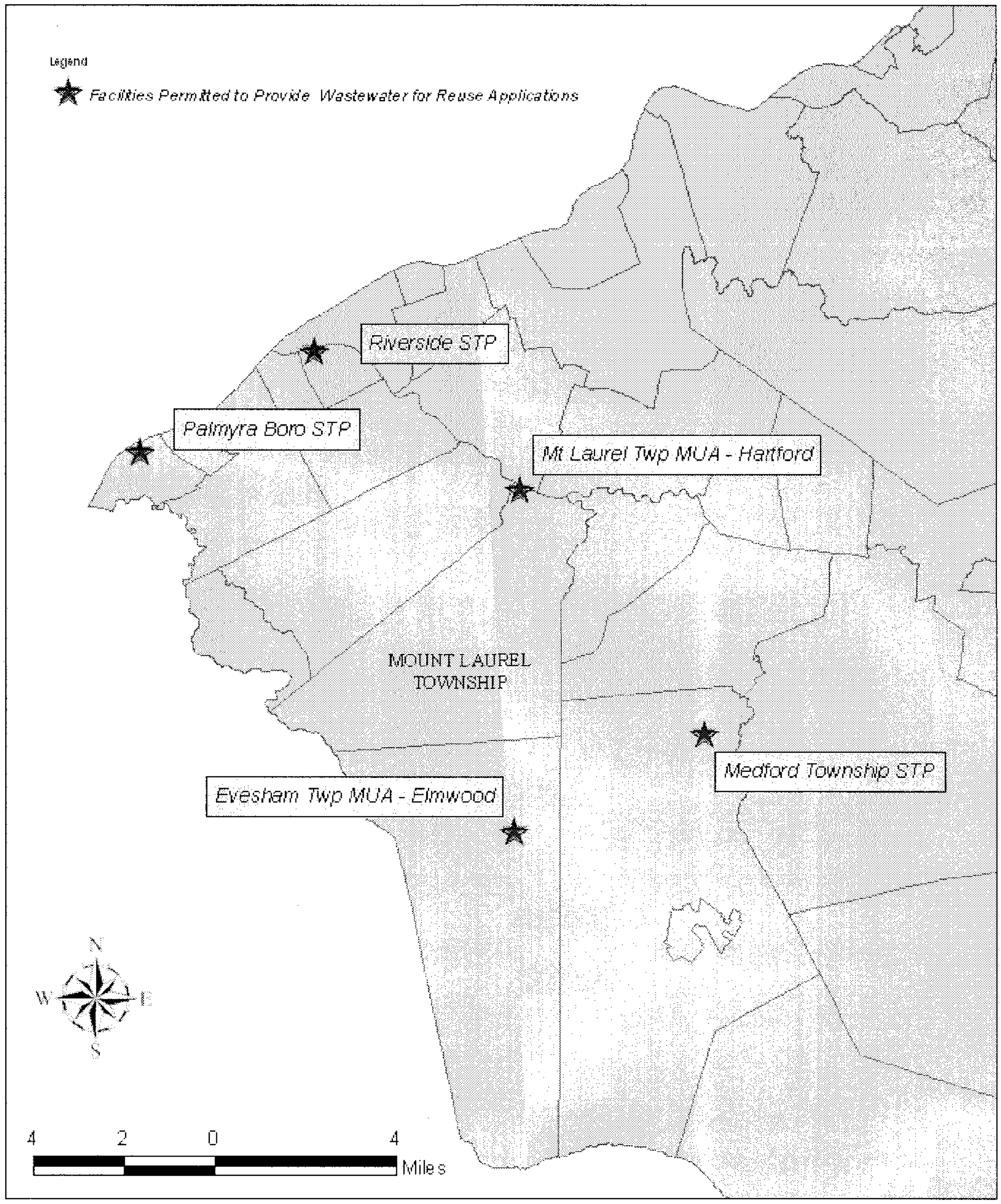
## NJPDES PERMITTED SURFACE WASTEWATER DISCHARGE FACILITIES LOCATED IN NEW JERSEY
## (NJDEP, 2003)



# NJPDES PERMITTED SURFACE WASTEWATER DISCHARGE FACILITIES LOCATED IN BURLINGTON COUNTY, NEW JERSEY (NJDEP, 2003)



# FACILITIES PERMITTED FOR REUSE APPLICATIONS IN BURLINGTON COUNTY, NEW JERSEY



# APPENDIX B

## Digital Data Sources

## Table 1: Sources of Digital Data Utilized for Project Maps

| Data Layer Name | Publication Date | Originator | Contents |
|---|---|---|---|
| *Statewide* | | | |
| NJDEP County Boundaries for the State of New Jersey | 01/23/03 | NJDEP BGIS | County boundaries of New Jersey. Boundary lines were checked against other boundary delineations such as Patton, Hagstrom, and county freeholder maps. In January 2003 the Census 2000 population information was joined to the former stco coverage to create this stco data layer. Additional attributes included population in 1990 and 1980, and population change between each census. |
| NJDEP State Owned, Protected Open Space and Recreation Areas in New Jersey 1:12000 | 1999 | NJDEP, Green Acres Program | Represents state owned, protected open space, and recreation areas in New Jersey. Federal parcels are included within this data set and are represented represented in a separate coverage. |
| NJDEP Statewide Golf Course Shapefile | 11/09/01 | NJDEP, DSRT | The shapefile represents the fairway, green and tee areas of all the golf courses in New Jersey. It was created by selecting all recreation polygons from the 1995/97 NJDEP land use/land cover (LU/LC) file. All recreation polygons were then compared to the 1995 digital aerial photographs to confirm the presence or absence of a golf course. There are 256 courses identified in this data set. |
| NJPDES Ground Water Discharges in New Jersey | 09/12/02 | NJDEP, ER, DWQ, PSP-R1, Thomas Cosmas (ed.) | New Jersey Pollutant Discharge Elimination System (NJPDES) ground water discharge pipe GIS point coverage compiled from GPSed locations, NJPDES databases, and permit applications. This coverage contains the ground water discharge points for the active as well as terminated pipes |
| NJPDES Surface Water Discharges in New Jersey | 09/12/02 | NJDEP, ER, DWQ, PSP-R1, Thomas Cosmas (ed.) | New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge pipe GIS point coverage compiled from GPSed locations, NJPDES databases, and permit applications. This coverage contains the surface water discharge points and the receiving waters coordinates for the active as well as terminated pipes. |
| NJDEP State Boundary of New Jersey | 11/01/98 | NJDEP, OIRM, BGIA | This data represents the New Jersey State Boundary. This data was dissolved from the New Jersey county data (stco), which was in turn dissolved from the New Jersey Municipality data (stmun). |
| NJDEP Total Maximum Daily Loads (TMDLs) for Fecal Streams | 09/29/03 | NJDEP, BEAR | The pollutant of concern for these Stream TMDLs is pathogens, the presence of which is indicated by elevated concentrations of fecal coliform bacteria. Fecal coliform concentrations were found to exceed New Jersey's Surface Water Quality Standards (SWQS), published at N.J.A.C. 7-9B et seq., for the segments identified. |
| Bedrock Geology for New Jersey | 06/30/99 | NJDEP, NJGS, Ronald S. Pristas (ed.) | The Bedrock Geology of New Jersey consists of statewide and countywide data layers (contacts, faults, folds, dikes). The data are provided in: ESRI's ARC/INFO Geographic Information Systems (GIS). The GIS data were scanned and digitized from United States Geological Survey Miscellaneous Investigations and Open-File Series 1:100,000 scale geologic maps compiled from 1984 to 1993. |
| Physiographic Provinces of New Jersey | 06/30/02 | NJDEP, NJGS | New Jersey is divided into the Valley and Ridge, Highlands, Piedmont, and Coastal Plain Physiographic Provinces. Each province defines a region in which relief, landforms, and geology are significantly different from that of the adjoining and nearby regions. The boundary between each province is determined by a major change in topography and geology, and this data set delineates the boundary lines between them. |
| Aquifers of New Jersey | 03/25/98 | NJGS | Data set consists of two ARC/INFO Geographic Information Systems (GIS) coverages of the bedrock and surficial aquifers and confining units in New Jersey. |
| Water withdrawals in New Jersey (1990-1999) | September 2001 | NJDEP BWA | A collection of ten relational data files that document fresh-water withdrawals in New Jersey by county, HUC11 and HUC14 watersheds, watershed management areas, and water regions. Data are compiled for calender year 1999 and for a ten-year period from 1990 to 1999.The withdrawal information is based on a database maintained by the NJDEP BWA. |
| **Data Layer Name** | **Publication Date** | **Originator** | **Contents** |
| *Burlington County* | | | |
| NJDEP County Boundary for Burlington County, New Jersey | January 2003 | NJDEP, OIRM, BGIS | This data contains the county boundaries of New Jersey. Boundary lines were checked against other boundary delineations such as Patton, Hagstrom, and county freeholder maps. |
| NJDEP Open Water Areas of Burlington County, New Jersey 1986 | 11/01/98 | NJDEP, OIRM, BGIA | This data contains all the open water areas for this county as of 1986. Open water areas such as as lakes, ponds, tidal waters, reservoirs, bays, etc., are included. This file was created by reselecting the water series out of its LULC (land use/land cover) data. |
| NJDEP 1986 Land Use/Land Cover for Burlington County, New Jersey | 11/01/98 | NJDEP, OIRM, BGIA | This data was created by combining two separate data sets, the land use/land cover layer from the Integrated Terrain Unit Maps (ITUM) for this county and the freshwater wetlands (FWW) layer generated under the New Jersey Freshwater Wetlands Mapping Program. The ITUM land use/land cover was photo interpreted from 1986 color infrared (CIR) 1:58000 aerial photos, and delineated using a modified Anderson et al. 1976, classification system to 1:24000 rectified photo-basemaps. |
| Soil Survey Geographic (SSURGO) Database for Burlington County, New Jersey | 05/24/99 | USDA, NRCS | This data set is a digital soil survey and generally is the most detailed level of soil geographic data developed by the National Cooperative Soil Survey. The information was prepared by digitizing maps, by compiling information onto a planimetric correct base and digitizing, or by revising digitized maps using remotely |
| NJDEP Streams of Burlington County, New Jersey | 11/01/98 | NJDEP, OIRM, BGIS | This data represents the streams of Burlington County, New Jersey. The hydrography stream network for this county was generated as a line ArcInfo coverage from USGS 1:24,000 Digital Line Graph(DLG) files, |
| **Data Layer Name** | **Publication Date** | **Originator** | **Contents** |
| *Watershed Management Area* | | | |
| NJDEP 1995/97 Land use/Land cover Update, Mullica Watershed Management Area, WMA-14 | 12/01/00 | NJDEP, OIRM, BGIA | This data was created by comparing the 1986 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database to 1995/97 color infrared (CIR) imagery and delineating areas of change. Work for this data set was done by Aerial Information Systems, Inc., Redlands, CA, under direction of the NJDEP, BGIA |
| NJDEP 1995/97 Land use/Land cover Update, Lower Delaware Watershed Management Area, WMA-18 | 12/01/00 | NJDEP, OIRM, BGIA | This data was created by comparing the 1986 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database to 1995/97 color infrared (CIR) imagery and delineating areas of change. Work for this data set was done by Aerial Information Systems, Inc., Redlands, CA, under direction of the NJDEP, BGIA |
| NJDEP 1995/97 Land use/Land cover Update, Rancocas Watershed Management Area, WMA-19 | 12/01/00 | NJDEP, OIRM, BGIA | This data was created by comparing the 1986 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database to 1995/97 color infrared (CIR) imagery and delineating areas of change. Work for this data set was done by Aerial Information Systems, Inc., Redlands, CA, under direction of the NJDEP, BGIA |
| NJDEP 1995/97 Land use/Land cover Update, Assiscunk, Crosswicks and Doctors Watershed Management Area, WMA-20 | 12/01/00 | NJDEP, OIRM, BGIA | This data was created by comparing the 1986 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database to 1995/97 color infrared (CIR) imagery and delineating areas of change. Work for this data set was done by Aerial Information Systems, Inc., Redlands, CA, under direction of the NJDEP, BGIA |

# APPENDIX C

## Water Usage of Watershed Management Areas

# WATER TRANSFER MODEL V 2.5

## April 16, 2007

# Water Transfers by Watershed Management Area

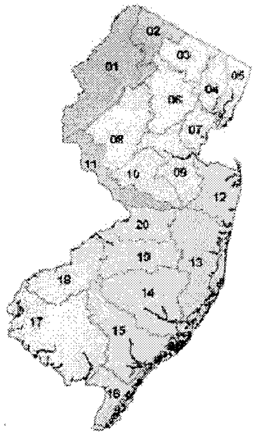
# New Jersey Water Supply Plan - 2005

NJ Department of Environmental Protection, Land Use Management

- New Jersey Geological Survey
- Division of Watershed Management
- Division of Water Supply

Let's protect our earth

NEW JERSEY DEPARTMENT
OF ENVIRONMENTAL PROTECTION



# NEW JERSEY WATER WITHDRAWALS, USES, TRANSFERS & DISCHARGES - Watershed Management Area Summary

V 2.5

**WMA:** *Mullica*

\# 14

*Click on the box to the left and use the pull down menu to select a WMA.*

Subject to Revision

See the 'User's Guide' worksheet for more information.

Subject to revision.

*Table 12. Freshwater Withdrawals, Imports & Exports in WMA 14 (millions of gallons)*

| Withdrawals (Q) | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| surface water | 20,849 | 22,394 | 24,229 | 23,717 | 23,088 | 31,998 | 24,068 | 24,745 | 23,614 | 31,340 | 25,004 |
| ground water | 8,906 | 10,321 | 9,139 | 11,148 | 10,826 | 12,610 | 12,122 | 14,008 | 15,436 | 10,031 | 11,455 |
| total Q | 29,755 | 32,714 | 33,368 | 34,865 | 33,914 | 44,608 | 36,190 | 38,753 | 39,049 | 41,371 | 36,459 |
| imports | 499 | 637 | 635 | 576 | 536 | 614 | 491 | 627 | 647 | 581 | 584 |
| exports | 693 | 1,006 | 995 | 1,138 | 1,128 | 1,205 | 1,016 | 1,083 | 1,228 | 1,270 | 1,076 |
| net | (195) | (369) | (360) | (561) | (592) | (591) | (525) | (456) | (581) | (689) | (492) |

*Table 13. Freshwater Imports to WMA 14 in 1999*

| Source WMA | MG received | % of all water withdrawn in source WMA in 1999 | % of all potable water used in WMA 14 in 1999 |
|---|---|---|---|
| 13 | 34 | 0.1% | 0.9% |
| 15 | 535 | 2.1% | 14.7% |
| 19 | 11 | 0.1% | 0.3% |
| sum: | 581 | | 15.9% |

*Table 14. Freshwater Exports from WMA 14 in 1999*

| Destination WMA | MG sent | % of all water withdrawn in WMA 14 in 1999 | % of all potable water used in destination WMA in 1999 |
|---|---|---|---|
| 13 | 90 | 0.2% | 0.4% |
| 15 | 1,127 | 2.7% | 7.1% |
| 19 | 54 | 0.1% | 0.5% |
| sum: | 1,270 | 3.1% | |

*Table 15. Use of Fresh Water in WMA 14 (millions of gallons) (includes imports, excludes exports)*

| Use Group | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agricultural | 25,579 | 28,730 | 29,267 | 30,329 | 29,119 | 39,845 | 31,783 | 34,236 | 34,045 | 36,640 | 31,997 |
| commercial | 24 | 30 | 21 | 39 | 26 | 78 | 21 | 24 | 29 | 26 | 32 |
| industrial | 122 | 46 | 103 | 212 | 288 | 202 | 133 | 149 | 151 | 157 | 156 |
| irrigation | 7 | 18 | 8 | 28 | 12 | 12 | 11 | 18 | 21 | 47 | 18 |
| mining | 136 | 109 | 275 | 271 | 383 | 401 | 333 | 355 | 786 | 375 | 342 |
| potable supply | 3,292 | 3,413 | 3,335 | 3,425 | 3,494 | 3,480 | 3,383 | 3,516 | 3,611 | 3,642 | 3,459 |
| power generation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total volume | 29,560 | 32,345 | 33,008 | 34,304 | 33,322 | 44,017 | 35,665 | 38,298 | 38,643 | 40,887 | 36,005 |
| consumed volume | 4,482 | 6,598 | 5,577 | 6,779 | 5,711 | 6,640 | 5,394 | 4,795 | 5,145 | 5,476 | 5,660 |
| consumed percent | 15% | 20% | 17% | 20% | 17% | 15% | 15% | 13% | 13% | 13% | 16% |

*Table 16. Sewage Transfers & Reclaimed-Water Discharges in WMA 14 (millions of gallons)*

| Sewage/Reclaimed Water | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| imported to WMA | 87 | 86 | 75 | 85 | 100 | 99 | 110 | 109 | 109 | 102 | 97 |
| exported from WMA | 2,402 | 1,723 | 3,144 | 2,475 | 4,449 | 4,115 | 4,503 | 4,420 | 4,475 | 4,318 | 3,611 |
| generated in WMA | 2,754 | 1,983 | 3,319 | 2,664 | 4,672 | 4,335 | 4,838 | 4,663 | 4,717 | 4,546 | 3,849 |
| discharged in WMA | 440 | 346 | 254 | 275 | 323 | 319 | 354 | 352 | 350 | 329 | 334 |

*Table 17. Destination of Reclaimed-Water Discharges in WMA 14 (millions of gallons)*

| Destination | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| fresh water | 287 | 280 | 254 | 275 | 323 | 319 | 354 | 352 | 350 | 329 | 312 |
| brackish water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| salt water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Table 18. Nonconsumptive Water Returns to WMA 14 (millions of gallons)*

| Water Use | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| potable purveyors | 1,044 | 1,134 | 1,051 | 1,099 | 1,150 | 1,115 | 1,019 | 1,107 | 1,171 | 1,192 | 1,108 |
| domestic wells | 1,853 | 1,861 | 1,880 | 1,900 | 1,918 | 1,937 | 1,954 | 1,972 | 1,991 | 2,009 | 1,928 |
| ind + comm + mining | 244 | 155 | 347 | 451 | 613 | 578 | 426 | 461 | 845 | 487 | 461 |
| ag + irrig | 21,938 | 22,597 | 24,153 | 24,075 | 23,929 | 33,747 | 26,871 | 29,963 | 29,491 | 31,723 | 26,849 |
| power generation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| sum: | 25,078 | 25,747 | 27,431 | 27,524 | 27,611 | 37,377 | 30,271 | 33,503 | 33,498 | 35,410 | 30,345 |

notes.
- Volumes include an estimate of domestic-well withdrawals and their consumptive use
- Consumed refers to water evaporated in the watershed, it does not include exports.
- This does not account for water released from onstream reservoirs for downstream intakes.
- No accounting for intakes or use of salt-water.
- The allocated volume is based on users with allocation permits
- Sewage and reclaimed-water transfers and discharges based on sewer service areas and NJPDES discharge volumes.
- Withdrawals for offstream reservoirs in WMAs 03, 08, and 12 are problematic and complicate Figure 1.
- See the 'User's Guide' worksheet for more information
- Subject to revision.

Figure 12. Freshwater Withdrawals, Use, Imports & Exports

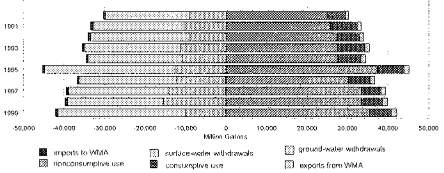


Figure 13. 1999 Freshwater Import & Export Details

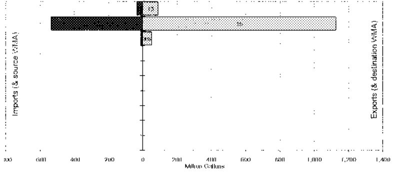


Figure 14. Use of Fresh Water in WMA

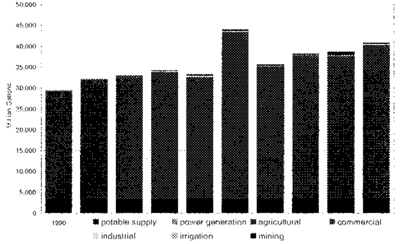


Figure 15. Monthly Consumptive & Nonconsumptive Water Use in WMA

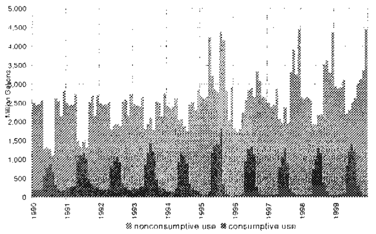


Figure 16. Sewage Generation, Transfers and Reclaimed-Water Discharges

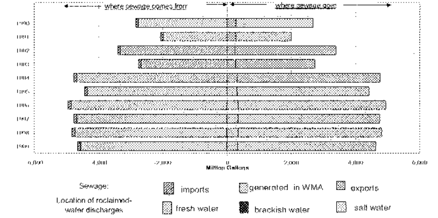


Figure 17. 1999 Sewage Import & Export Details

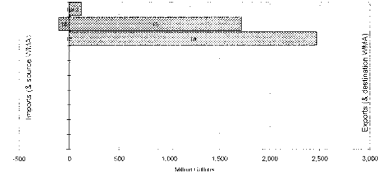
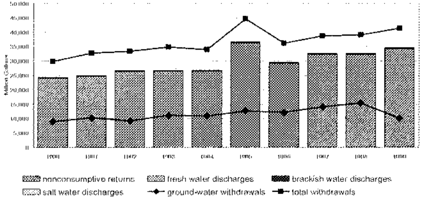


Figure 18. Net Resource Impact to WMA



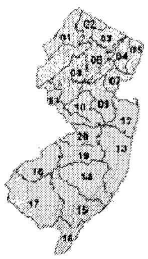


Figure 11. Watershed Management Areas & Counties in New Jersey

WMA boundaries and numbers in black.
County boundaries in white.
Pinelands outer border in green.
Highlands outer border in blue.

See the 'Metadata' worksheet for more information.

***Table 19. Water Allocations in WMA 14 by Water Source***

| Water Source | Million Gallons/Year |
|---|---|
| surface water | 49,130 |
| ground water | 55,283 |
| total | 104,413 |

***Table 20. Water Allocations in WMA 14 by Water Use Group***

| Use Group | Million Gallons/Year |
|---|---|
| agricultural | 98,738 |
| commercial | 186 |
| industrial | 800 |
| irrigation | 210 |
| mining | 953 |
| potable supply | 3,526 |
| power generation | 0 |
| sum | 104,413 |

***Table 21. Descriptive Statistics for WMA 14***

| | | |
|---|---|---|
| ***--- Area:*** | 656.5 | sq mi. |
| ***--- Population:*** | | |
| year | population | change |
| 1940 | 25,228 | -- |
| 1950 | 28,696 | 13.7% |
| 1960 | 39,605 | 38.0% |
| 1970 | 49,704 | 25.5% |
| 1980 | 73,696 | 48.3% |
| 1990 | 99,351 | 34.8% |
| 2000 | 112,311 | 13.0% |
| ***--- Withdrawals per square mile (average):*** | | |
| surface | 38.1 | mg/sq mi |
| ground | 17.4 | mg/sq mi |
| ***--- Land Use:*** | | |
| type | Year | |
| | 1986 | 1995 |
| ag. | 6.4% | 6.1% |
| barren | 0.7% | 0.6% |
| forest | 47.1% | 46.8% |
| water | 6.8% | 6.8% |
| urban | 5.2% | 5.9% |
| wetlands | 33.7% | 33.7% |
| ***--- % of WMA in:*** | | |
| | Pinelands: | 85.2% |
| | Highlands: | 0.0% |

April 16, 2007

*New Jersey Water Supply Plan*

*NJ Department of Environmental Protection - Land Use Management - New Jersey Geological Survey*

**WMA #14**

C:\Documents and Settings\cmattson\Desktop\Unused Desktop Shortcuts\thesis\Sample Data\[wmatransfers25.xls]WMA Details

# WMA: Mullica
# 14

*Change the WMA name on the worksheet "WMA Details"*

V 2.5

## Agricultural Water Use in WMA # 14

*Table 22. Annual Agricultural Water Use by Detailed Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | 269 | 531 | 300 | 331 | 456 | 528 | 525 | 696 | 879 | 961 | 548 |
| christmas trees | 10 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 13 | 11 |
| cranberries | 22,731 | 23,300 | 25,643 | 25,402 | 25,409 | 36,967 | 29,505 | 31,811 | 31,171 | 33,877 | 28,582 |
| field crops | - | - | - | - | - | - | - | - | - | - | - |
| general agriculture | 2,127 | 3,557 | 2,590 | 3,345 | 2,208 | 575 | 707 | 651 | 584 | 756 | 1,710 |
| greenhouse | 60 | 110 | 111 | 68 | 103 | 78 | 39 | 58 | 72 | 122 | 82 |
| sod | 272 | 323 | 30 | 284 | 239 | 379 | 154 | 234 | 141 | 225 | 228 |
| tree fruit | 198 | 344 | 242 | 365 | 296 | 329 | 177 | 207 | 186 | 290 | 263 |
| vegetables, leaf crops | 312 | 555 | 341 | 523 | 398 | 978 | 667 | 568 | 1,001 | 397 | 574 |
| sum | 25,979 | 28,730 | 29,267 | 30,329 | 29,119 | 39,845 | 31,783 | 34,236 | 34,045 | 36,640 | 31,997 |

*Table 23. Annual Agricultural Use by Detailed Use Type as Percentage of Total Agricultural Use*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | 1% | 2% | 1% | 1% | 2% | 1% | 2% | 2% | 3% | 3% | 2% |
| christmas trees | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| cranberries | 87% | 81% | 88% | 84% | 87% | 93% | 93% | 93% | 92% | 92% | 89% |
| field crops | - | - | - | - | - | - | - | - | - | - | - |
| general agriculture | 8% | 12% | 9% | 11% | 8% | 1% | 2% | 2% | 2% | 2% | 6% |
| greenhouse | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| sod | 1% | 1% | 0% | 1% | 1% | 1% | 0% | 1% | 0% | 1% | 1% |
| tree fruit | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% | 1% |
| vegetables, leaf crops | 1% | 2% | 1% | 2% | 1% | 2% | 2% | 2% | 3% | 1% | 2% |

*Table 24. Annual Consumed Water Volume by Detailed Agricultural Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | 242 | 478 | 270 | 298 | 411 | 475 | 472 | 627 | 791 | 865 | 493 |
| christmas trees | 9 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 11 | 10 |
| cranberries | 1,119 | 1,248 | 1,853 | 1,823 | 1,852 | 3,508 | 2,863 | 2,092 | 1,969 | 2,435 | 2,076 |
| field crops | - | - | - | - | - | - | - | - | - | - | - |
| general agriculture | 1,914 | 3,201 | 2,331 | 3,010 | 1,987 | 518 | 636 | 586 | 525 | 680 | 1,539 |
| greenhouse | 54 | 99 | 100 | 61 | 92 | 70 | 35 | 52 | 64 | 110 | 74 |
| sod | 244 | 290 | 27 | 255 | 215 | 341 | 139 | 211 | 127 | 202 | 205 |
| tree fruit | 178 | 310 | 218 | 329 | 266 | 296 | 159 | 187 | 168 | 261 | 237 |
| vegetables, leaf crops | 281 | 499 | 307 | 471 | 358 | 880 | 600 | 511 | 901 | 357 | 517 |
| sum | 4,042 | 6,135 | 5,115 | 6,257 | 5,191 | 6,098 | 4,913 | 4,274 | 4,555 | 4,922 | 5,150 |

*Table 25. Annual Consumed Water Percentage by Detailed Agricultural Use Type*

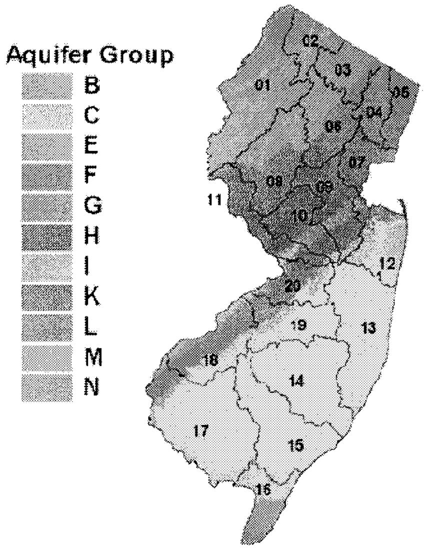
| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| christmas trees | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| cranberries | 5% | 5% | 7% | 7% | 7% | 9% | 10% | 7% | 6% | 7% | 7% |
| field crops | - | - | - | - | - | - | - | - | - | - | - |
| general agriculture | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| greenhouse | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| sod | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| tree fruit | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| vegetables, leaf crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| overall average | 16% | 21% | 17% | 21% | 18% | 15% | 15% | 12% | 13% | 13% | 16% |

## Ground-Water Withdrawals by Aquifer Group in WMA # 14

*Table 26. Annual Ground-Water Withdrawals by Aquifer Group (millions of gallons)*

| Aquifer Group | | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| code | description | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| A | glacial sediments of northern NJ | - | - | - | - | - | - | - | - | - | - | - |
| B | surficial deposits in southern NJ | - | - | - | - | - | - | - | - | - | - | - |
| C | Kirkwood & Cohansey | 5,687 | 6,753 | 6,893 | 7,583 | 7,223 | 8,551 | 8,831 | 9,495 | 10,347 | 4,941 | 7,530 |
| D | Rio Grande and Atlantic City 800-foot sand | 349 | 616 | 564 | 542 | 476 | 464 | 370 | 368 | 469 | 337 | 456 |
| E | Piney Point and Vincentown | 15 | 22 | 21 | 34 | 31 | 24 | 15 | 22 | 23 | 169 | 38 |
| F | Wenonah, Mount Laurel and Englishtown | 599 | 663 | 377 | 679 | 764 | 1,190 | 439 | 1,624 | 2,041 | 1,427 | 980 |
| G | upper Magothy, Raritan & Potomac | - | - | - | - | - | - | - | - | - | - | - |
| H | middle Magothy, Raritan & Potomac | - | - | - | - | - | - | - | - | - | - | - |
| I | lower Magothy, Raritan & Potomac | - | - | - | - | - | - | - | - | - | - | - |
| J | undifferentiated Magothy, Raritan & Potomac | - | - | - | - | - | - | - | - | - | - | - |
| K | Brunswick Supergroup | - | - | - | - | - | - | - | - | - | - | - |
| L | Lockatong & Stockton | - | - | - | - | - | - | - | - | - | - | - |
| M | limestone, dolomite and marble of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| N | noncarbonate consolidated rocks of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| P | unknown/not assigned | 142 | 143 | 138 | 143 | 144 | 171 | 238 | 249 | 285 | 865 | 252 |
| Q | domestic wells | 2,113 | 2,123 | 2,145 | 2,168 | 2,188 | 2,210 | 2,230 | 2,250 | 2,271 | 2,291 | 2,199 |
| | sum: | 8,906 | 10,321 | 9,139 | 11,148 | 10,826 | 12,610 | 12,122 | 14,008 | 15,436 | 10,031 | 11,455 |

Figure 18. Outcrop areas of aquifer groups with watershed management areas.



# NEW JERSEY WATER WITHDRAWALS, USES, TRANSFERS & DISCHARGES - Watershed Management Area Summary

V 2.5

**WMA:** *Lower Delaware*

\# 18

*Click on the box to the left and use the pull down menu to select a WMA.*

Subject to Revision    See the 'User's Guide' worksheet for more information.

Subject to revision.

*Table 12. Freshwater Withdrawals, Imports & Exports in WMA 18 (millions of gallons)*

| Withdrawals (Q) | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| surface water | 27,113 | 27,107 | 26,825 | 21,984 | 13,687 | 15,499 | 16,882 | 21,453 | 22,576 | 23,174 | 21,630 |
| ground water | 36,667 | 38,017 | 37,074 | 36,766 | 36,291 | 37,142 | 31,552 | 30,861 | 30,972 | 29,981 | 34,532 |
| total Q | 63,781 | 65,124 | 63,899 | 58,750 | 49,977 | 52,641 | 48,434 | 52,314 | 53,548 | 53,155 | 56,162 |
| | | | | | | | | | | | |
| imports | 1,813 | 2,116 | 2,030 | 2,521 | 2,796 | 3,040 | 2,729 | 2,804 | 3,073 | 2,766 | 2,569 |
| exports | 1,794 | 1,737 | 1,672 | 1,804 | 1,810 | 1,831 | 3,022 | 4,757 | 5,173 | 4,952 | 2,855 |
| net | 18 | 379 | 358 | 717 | 986 | 1,209 | (293) | (1,953) | (2,100) | (2,186) | (286) |

*Table 13. Freshwater imports to WMA 18 in 1999*

| Source WMA | MG received | % of all water withdrawn in source WMA in 1999 | % of all potable water used in WMA 18 in 1999 |
|---|---|---|---|
| 15 | 1,108 | 4.4% | 3.6% |
| 17 | 1,161 | 2.6% | 3.8% |
| 19 | 469 | 3.0% | 1.5% |
| 20 | 28 | 0.0% | 0.1% |
| sum: | 2,766 | | 9.0% |

*Table 14. Freshwater Exports from WMA 18 in 1999*

| Destination WMA | MG sent | % of all water withdrawn in WMA 18 in 1999 | % of all potable water used in destination WMA in 1999 |
|---|---|---|---|
| 15 | 12 | 0.0% | 0.1% |
| 17 | 64 | 0.1% | 0.5% |
| 19 | 4,105 | 7.7% | 37.6% |
| 20 | 771 | 1.5% | 11.2% |
| sum: | 4,952 | 9.3% | |

*Table 15. Use of Fresh Water in WMA 18 (millions of gallons) (includes imports, excludes exports)*

| Use Group | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agricultural | 854 | 1,543 | 1,065 | 1,236 | 1,049 | 1,795 | 757 | 2,128 | 2,203 | 3,060 | 1,569 |
| commercial | 3 | 6 | 23 | 22 | 21 | 23 | 11 | 12 | 15 | 10 | 15 |
| industrial | 30,403 | 29,187 | 29,193 | 23,723 | 15,689 | 16,603 | 15,624 | 16,253 | 16,432 | 16,649 | 20,976 |
| irrigation | 161 | 182 | 184 | 290 | 267 | 275 | 211 | 347 | 373 | 382 | 267 |
| mining | 418 | 535 | 506 | 473 | 546 | 610 | 514 | 377 | 330 | 308 | 462 |
| potable supply | 31,978 | 34,065 | 33,294 | 33,731 | 33,409 | 34,562 | 31,067 | 31,315 | 32,108 | 30,603 | 32,612 |
| power generation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total volume | 63,816 | 65,519 | 64,264 | 59,475 | 50,981 | 53,868 | 48,174 | 50,432 | 51,461 | 51,012 | 55,900 |
| consumed volume | 7,490 | 8,509 | 7,864 | 7,761 | 6,609 | 7,546 | 5,872 | 7,601 | 8,009 | 8,364 | 7,562 |
| consumed percent | 12% | 13% | 12% | 13% | 13% | 14% | 12% | 15% | 16% | 16% | 14% |

*Table 16. Sewage Transfers & Reclaimed-Water Discharges in WMA 18 (millions of gallons)*

| Sewage/Reclaimed Water | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| imported to WMA | 3,106 | 1,661 | 4,535 | 2,522 | 6,930 | 6,266 | 7,157 | 7,012 | 6,763 | 6,743 | 5,269 |
| exported from WMA | 1,254 | 981 | 1,014 | 1,027 | 1,103 | 1,084 | 1,187 | 1,150 | 1,183 | 1,179 | 1,116 |
| generated in WMA | 17,021 | 8,347 | 17,170 | 11,396 | 25,762 | 23,124 | 26,671 | 25,747 | 25,163 | 25,079 | 20,548 |
| discharged in WMA | 18,872 | 9,026 | 20,691 | 12,891 | 31,590 | 28,306 | 32,642 | 31,608 | 30,743 | 30,643 | 24,701 |

*Table 17. Destination of Reclaimed-Water Discharges in WMA 18 (millions of gallons)*

| Destination | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| fresh water | 17,503 | 8,886 | 20,691 | 12,891 | 31,590 | 28,306 | 32,642 | 31,608 | 30,743 | 30,643 | 24,550 |
| brackish water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| salt water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Table 18. Nonconsumptive Water Returns to WMA 18 (millions of gallons)*

| Water Use | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| potable purveyors | 27,900 | 29,499 | 28,939 | 29,168 | 29,001 | 29,985 | 27,040 | 26,959 | 27,434 | 26,357 | 28,228 |
| domestic wells | 592 | 596 | 605 | 614 | 626 | 635 | 644 | 658 | 671 | 686 | 633 |
| ind + comm + mining | 27,732 | 26,743 | 26,732 | 21,780 | 14,614 | 15,495 | 14,521 | 14,966 | 15,089 | 15,261 | 19,293 |
| ag. + irrig | 101 | 172 | 125 | 153 | 132 | 207 | 97 | 247 | 258 | 344 | 184 |
| power generation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| sum: | 56,326 | 57,010 | 56,402 | 51,715 | 44,372 | 46,323 | 42,302 | 42,831 | 43,452 | 42,648 | 48,338 |

notes:
- Volumes include an estimate of domestic-well withdrawals and their consumptive use.
- Consumed refers to water evaporated in the watershed, it does not include exports.
- This does not account for water released from onstream reservoirs for downstream intakes.
- No accounting for intakes or use of salt-water.
- The allocated volume is based on users with allocation permits.
- Sewage and reclaimed-water transfers and discharges based on sewer service areas and NJPDES discharge volumes.
- Withdrawals for offstream reservoirs in WMAs 03, 08, and 12 are problematic and complicate Figure 1.
- See the 'User's Guide' worksheet for more information.
- Subject to revision

Figure 12. Freshwater Withdrawals, Use, Imports & Exports

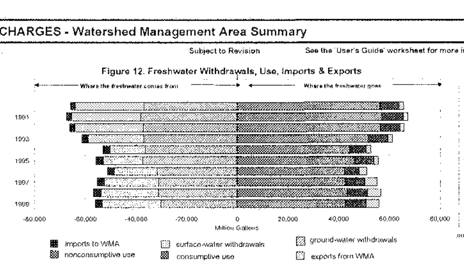


Figure 14. Use of Fresh Water in WMA

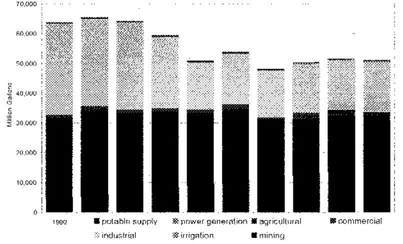


Figure 16. Sewage Generation, Transfers and Reclaimed-Water Discharges

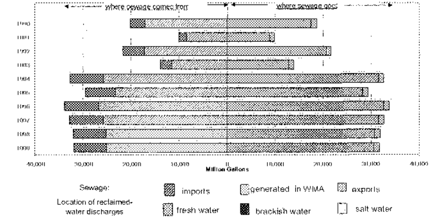
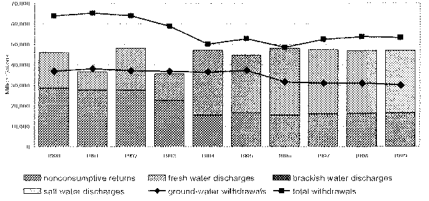


Figure 18. Net Resource Impact to WMA



See the 'Metadata' worksheet for more information.

Figure 13. 1999 Freshwater Import & Export Details

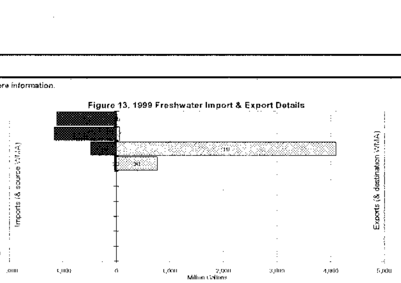


Figure 15. Monthly Consumptive & Nonconsumptive Water Use in WMA

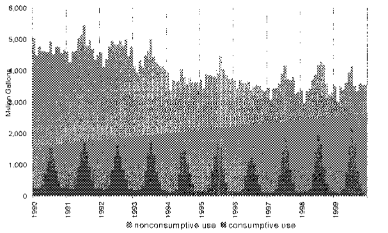
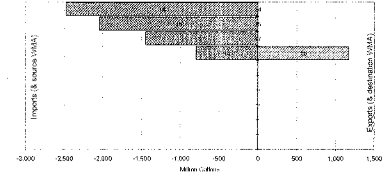


Figure 17. 1999 Sewage Import & Export Details



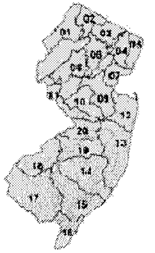


Figure 11. Watershed Management Areas & Counties in New Jersey

WMA boundaries and numbers in black.
County boundaries in white.
Pinelands outer border in green.
Highlands outer border in blue.

*Table 19. Water Allocations in WMA 18 by Water Source*

| Water Source | Million Gallons/Year |
|---|---|
| surface water | 34,895 |
| ground water | 55,784 |
| total | 90,679 |

*Table 20. Water Allocations in WMA 18 by Water Use Group*

| Use Group | Million Gallons/Year |
|---|---|
| agricultural | 19,683 |
| commercial | 105 |
| industrial | 27,137 |
| irrigation | 1,371 |
| mining | 614 |
| potable supply | 41,767 |
| power generation | 0 |
| sum | 90,679 |

*Table 21. Descriptive Statistics for WMA 18*

| | | |
|---|---|---|
| ***--- Area:*** | 391.3 | sq mi. |
| ***--- Population:*** | | |
| year | population | change |
| 1940 | 330,258 | -- |
| 1950 | 393,790 | 19.2% |
| 1960 | 529,814 | 34.5% |
| 1970 | 634,545 | 19.8% |
| 1980 | 655,012 | 3.2% |
| 1990 | 689,216 | 5.2% |
| 2000 | 713,958 | 3.6% |
| ***--- Withdrawals per square mile (average):*** | | |
| surface | 55.3 | mg/sq mi |
| ground | 88.2 | mg/sq mi |
| ***--- Land Use:*** | | |
| type | Year | |
| | 1986 | 1995 |
| ag. | 22.9% | 19.1% |
| barren | 1.8% | 1.9% |
| forest | 15.0% | 14.4% |
| water | 5.4% | 5.4% |
| urban | 41.3% | 46.0% |
| wetlands | 13.6% | 13.2% |
| ***--- % of WMA in:*** | | |
| | Pinelands: | 0.0% |
| | Highlands: | 0.0% |

April 16, 2007

*New Jersey Water Supply Plan*

*NJ Department of Environmental Protection - Land Use Management - New Jersey Geological Survey*

**WMA #18**

C:\Documents and Settings\csaltson\Desktop\Unused Desktop Shortcuts\thesis\Sample Data\[wmatransfers25.xls]WMA Details

# WMA: Lower Delaware
# 18

*Change the WMA name on the worksheet "WMA Details"*

V 2.5

## Agricultural Water Use in WMA # 18

*Table 22. Annual Agricultural Water Use by Detailed Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | - | - | - | - | - | - | - |
| christmas trees | - | 1 | - | 1 | - | - | - | - | - | - | 1 |
| cranberries | - | - | - | - | - | - | - | - | - | - | - |
| field crops | 12 | 303 | 25 | 21 | 3 | 31 | 18 | 351 | 360 | 326 | 145 |
| general agriculture | 87 | 74 | 58 | 70 | 175 | 72 | 118 | 334 | 325 | 302 | 162 |
| greenhouse | 15 | 10 | 13 | 16 | 18 | 50 | 25 | 35 | 43 | 54 | 28 |
| sod | 6 | 28 | 28 | - | - | 130 | 47 | 42 | 42 | 46 | 46 |
| tree fruit | 83 | 193 | 166 | 249 | 135 | 418 | 118 | 245 | 438 | 360 | 243 |
| vegetables, leaf crops | 650 | 934 | 775 | 879 | 718 | 1,094 | 431 | 1,120 | 993 | 1,952 | 955 |
| sum | 854 | 1,543 | 1,065 | 1,236 | 1,049 | 1,795 | 757 | 2,128 | 2,203 | 3,060 | 1,569 |

*Table 23. Annual Agricultural Use by Detailed Use Type as Percentage of Total Agricultural Use*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | - | - | - | - | - | - | - |
| christmas trees | - | 0% | - | 0% | - | - | - | - | - | - | 0% |
| cranberries | - | - | - | - | - | - | - | - | - | - | - |
| field crops | 1% | 20% | 2% | 2% | 0% | 2% | 2% | 16% | 16% | 11% | 7% |
| general agriculture | 10% | 5% | 5% | 6% | 17% | 4% | 16% | 16% | 15% | 10% | 10% |
| greenhouse | 2% | 1% | 1% | 1% | 2% | 3% | 3% | 2% | 2% | 2% | 2% |
| sod | 1% | 2% | 3% | - | - | 7% | 6% | 2% | 2% | 1% | 3% |
| tree fruit | 10% | 12% | 16% | 20% | 13% | 23% | 16% | 12% | 20% | 12% | 15% |
| vegetables, leaf crops | 76% | 61% | 73% | 71% | 68% | 61% | 57% | 53% | 45% | 64% | 63% |

*Table 24. Annual Consumed Water Volume by Detailed Agricultural Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | - | - | - | - | - | - | - |
| christmas trees | - | 1 | - | 1 | - | - | - | - | - | - | 1 |
| cranberries | - | - | - | - | - | - | - | - | - | - | - |
| field crops | 11 | 273 | 22 | 19 | 2 | 28 | 16 | 316 | 324 | 293 | 130 |
| general agriculture | 78 | 67 | 53 | 63 | 158 | 65 | 107 | 300 | 293 | 272 | 145 |
| greenhouse | 14 | 9 | 12 | 15 | 16 | 45 | 22 | 31 | 39 | 49 | 25 |
| sod | 5 | 25 | 25 | - | - | 117 | 42 | 38 | 38 | 41 | 41 |
| tree fruit | 75 | 174 | 150 | 224 | 122 | 377 | 107 | 221 | 394 | 342 | 218 |
| vegetables, leaf crops | 585 | 841 | 697 | 791 | 646 | 984 | 388 | 1,008 | 894 | 1,757 | 859 |
| sum | 768 | 1,388 | 958 | 1,112 | 944 | 1,616 | 681 | 1,915 | 1,982 | 2,754 | 1,412 |

*Table 25. Annual Consumed Water Percentage by Detailed Agricultural Use Type*

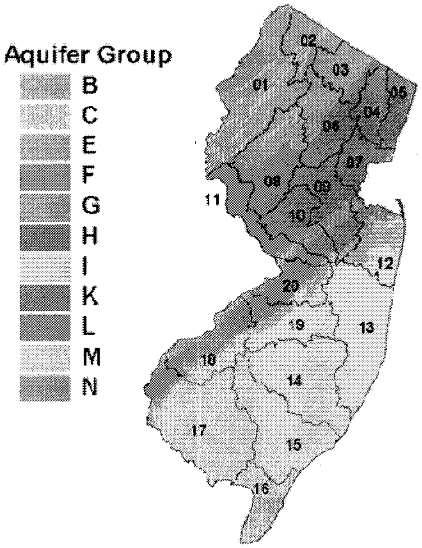
| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | - | - | - | - | - | - | - |
| christmas trees | - | 90% | - | 90% | - | - | - | - | - | - | 90% |
| cranberries | - | - | - | - | - | - | - | - | - | - | - |
| field crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| general agriculture | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| greenhouse | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| sod | 90% | 90% | 90% | - | - | 90% | 90% | 90% | 90% | 90% | 90% |
| tree fruit | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| vegetables, leaf crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| overall average | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |

## Ground-Water Withdrawals by Aquifer Group in WMA # 18

*Table 26. Annual Ground-Water Withdrawals by Aquifer Group (millions of gallons)*

| Aquifer Group | | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| code | description | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| A | glacial sediments of northern NJ | - | - | - | - | - | - | - | - | - | - | - |
| B | surficial deposits in southern NJ | 47 | 498 | 417 | 250 | 288 | 181 | 205 | 350 | 231 | 116 | 258 |
| C | Kirkwood & Cohansey | 294 | 272 | 206 | 310 | 372 | 497 | 480 | 643 | 594 | 585 | 425 |
| D | Rio Grande and Atlantic City 800-foot sand | - | - | - | - | - | - | - | - | - | - | - |
| E | Piney Point and Vincentown | - | - | - | - | - | - | - | - | - | - | - |
| F | Wenonah, Mount Laurel and Englishtown | 536 | 604 | 546 | 625 | 641 | 700 | 944 | 1,697 | 1,555 | 1,559 | 941 |
| G | upper Magothy, Raritan & Potomac | 4,972 | 7,964 | 7,641 | 7,648 | 7,925 | 7,667 | 6,305 | 6,042 | 6,908 | 5,617 | 6,869 |
| H | middle Magothy, Raritan & Potomac | 2,075 | 4,678 | 2,890 | 3,268 | 3,266 | 3,162 | 2,451 | 2,731 | 2,161 | 2,451 | 2,913 |
| I | lower Magothy, Raritan & Potomac | 13,210 | 19,949 | 21,828 | 21,077 | 21,545 | 22,553 | 18,053 | 16,644 | 16,774 | 16,737 | 18,837 |
| J | undifferentiated Magothy, Raritan & Potomac | 14,807 | 3,317 | 2,847 | 2,851 | 1,527 | 1,510 | 2,179 | 1,723 | 1,593 | 1,550 | 3,390 |
| K | Brunswick Supergroup | - | - | - | - | - | - | - | - | - | - | - |
| L | Lockatong & Stockton | - | - | - | - | - | - | - | - | - | - | - |
| M | limestone, dolomite and marble of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| N | noncarbonate consolidated rocks of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| P | unknown/not assigned | 52 | 56 | 9 | 36 | 12 | 148 | 200 | 280 | 388 | 584 | 177 |
| Q | domestic wells | 675 | 680 | 690 | 701 | 714 | 725 | 735 | 751 | 766 | 782 | 722 |
| | sum: | 36,667 | 38,017 | 37,074 | 36,766 | 36,291 | 37,142 | 31,552 | 30,861 | 30,972 | 29,981 | 34,532 |

Figure 18. Outcrop areas of aquifer groups with watershed management areas.



# NEW JERSEY WATER WITHDRAWALS, USES, TRANSFERS & DISCHARGES - Watershed Management Area Summary

V 2.5

**WMA:** *Rancocas*

\# 19

*Click on the box to the left and use the pull down menu to select a WMA.*

Subject to Revision

See the 'User's Guide' worksheet for more information.

Subject to revision.

*Table 12. Freshwater Withdrawals, Imports & Exports in WMA 19 (millions of gallons)*

| Withdrawals (Q) | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| surface water | 7,161 | 7,074 | 2,814 | 6,536 | 5,649 | 9,062 | 4,130 | 7,483 | 8,997 | 5,460 | 6,437 |
| ground water | 10,369 | 10,280 | 9,442 | 9,864 | 9,647 | 11,846 | 10,059 | 9,820 | 11,001 | 10,263 | 10,259 |
| total Q | 17,530 | 17,354 | 12,256 | 16,400 | 15,296 | 20,908 | 14,189 | 17,303 | 19,997 | 15,722 | 16,696 |
| imports | 2,087 | 2,425 | 2,591 | 2,819 | 2,667 | 2,699 | 3,672 | 5,198 | 5,113 | 5,078 | 3,436 |
| exports | 1,836 | 1,916 | 1,456 | 1,285 | 1,427 | 1,411 | 1,172 | 1,198 | 1,099 | 1,060 | 1,386 |
| net | 250 | 508 | 1,135 | 1,534 | 1,240 | 1,287 | 2,501 | 4,000 | 4,014 | 4,018 | 2,049 |

*Table 13. Freshwater imports to WMA 19 in 1999*

| Source WMA | MG received | % of all water withdrawn in source WMA in 1999 | % of all potable water used in WMA 19 in 1999 |
|---|---|---|---|
| 13 | 30 | 0.1% | 0.3% |
| 14 | 54 | 0.1% | 0.5% |
| 15 | 144 | 0.6% | 1.3% |
| 18 | 4,105 | 7.7% | 37.6% |
| 20 | 745 | 0.3% | 6.8% |
| sum: | 5,078 | | 46.5% |

*Table 14. Freshwater Exports from WMA 19 in 1999*

| Destination WMA | MG sent | % of all water withdrawn in WMA 19 in 1999 | % of all potable water used in destination WMA in 1999 |
|---|---|---|---|
| 13 | 10 | 0.1% | 0.0% |
| 14 | 11 | 0.1% | 0.3% |
| 18 | 469 | 3.0% | 1.5% |
| 20 | 569 | 3.6% | 8.2% |
| sum: | 1,059 | 6.7% | |

*Table 15. Use of Fresh Water in WMA 19 (millions of gallons) (includes imports, excludes exports)*

| Use Group | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agricultural | 7,598 | 7,652 | 3,535 | 7,578 | 5,930 | 11,285 | 5,085 | 7,870 | 10,441 | 6,455 | 7,343 |
| commercial | 0 | 0 | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 1 | 1 |
| industrial | 292 | 270 | 281 | 284 | 333 | 357 | 418 | 393 | 318 | 245 | 319 |
| irrigation | 101 | 113 | 84 | 100 | 91 | 132 | 61 | 161 | 170 | 214 | 123 |
| mining | 1,661 | 1,286 | 1,365 | 1,653 | 1,456 | 1,521 | 1,719 | 1,697 | 1,965 | 1,892 | 1,621 |
| potable supply | 8,201 | 8,603 | 8,208 | 8,477 | 8,707 | 8,883 | 9,408 | 11,172 | 11,216 | 10,922 | 9,380 |
| power generation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| total volume | 17,853 | 17,924 | 13,474 | 18,092 | 16,518 | 22,177 | 16,696 | 21,294 | 24,110 | 19,728 | 18,787 |
| consumed volume | 1,879 | 1,982 | 1,705 | 2,054 | 1,859 | 2,890 | 1,950 | 2,593 | 2,687 | 2,629 | 2,223 |
| consumed percent | 11% | 11% | 13% | 11% | 11% | 13% | 12% | 12% | 11% | 13% | 12% |
| | | | | | 18 | 13 | | 9 | | 13 | |

*Table 16. Sewage Transfers & Reclaimed-Water Discharges in WMA 19 (millions of gallons)*

| Sewage/Reclaimed Water | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| imported to WMA | 1,572 | 1,319 | 1,337 | 1,394 | 1,478 | 1,435 | 1,586 | 1,500 | 1,552 | 1,552 | 1,472 |
| exported from WMA | 290 | 27 | 455 | 223 | 827 | 741 | 847 | 801 | 700 | 789 | 579 |
| generated in WMA | 4,750 | 5,223 | 5,655 | 5,830 | 6,625 | 6,145 | 6,934 | 6,429 | 6,587 | 6,484 | 6,066 |
| discharged in WMA | 6,032 | 6,515 | 6,537 | 7,001 | 7,276 | 6,839 | 7,672 | 7,128 | 7,350 | 7,247 | 6,960 |

*Table 17. Destination of Reclaimed-Water Discharges in WMA 19 (millions of gallons)*

| Destination | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| fresh water | 6,032 | 6,515 | 6,537 | 7,001 | 7,276 | 6,839 | 7,672 | 7,128 | 7,350 | 7,247 | 6,960 |
| brackish water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| salt water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Table 18. Nonconsumptive Water Returns to WMA 19 (millions of gallons)*

| Water Use | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| potable purveyors | 5,655 | 6,278 | 5,949 | 6,136 | 6,361 | 6,472 | 6,982 | 8,483 | 8,463 | 8,211 | 6,929 |
| domestic wells | 1,308 | 1,311 | 1,320 | 1,328 | 1,339 | 1,349 | 1,359 | 1,368 | 1,381 | 1,392 | 1,346 |
| ind + comm + mining | 1,724 | 1,374 | 1,455 | 1,711 | 1,582 | 1,660 | 1,892 | 1,848 | 2,015 | 1,886 | 1,715 |
| ag + irrig | 6,986 | 6,979 | 3,045 | 6,863 | 5,376 | 9,806 | 4,513 | 7,002 | 9,564 | 5,610 | 6,574 |
| power generation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| sum: | 15,973 | 15,942 | 11,768 | 16,038 | 14,659 | 19,287 | 14,746 | 18,701 | 21,423 | 17,099 | 16,564 |

notes:
- Volumes include an estimate of domestic-well withdrawals and their consumptive use.
- Consumed refers to water evaporated in the watershed, it does not include exports.
- This does not account for water released from onstream reservoirs for downstream intakes.
- No accounting for intakes or use of salt-water.
- The allocated volume is based on users with allocation permits.
- Sewage and reclaimed-water transfers and discharges based on sewer service areas and NJPDES discharge volumes.
- Withdrawals for offstream reservoirs in WMAs 03, 08, and 12 are problematic and complicate Figure 1.
- See the 'User's Guide' worksheet for more information.
- Subject to revision.

Figure 12. Freshwater Withdrawals, Use, Imports & Exports

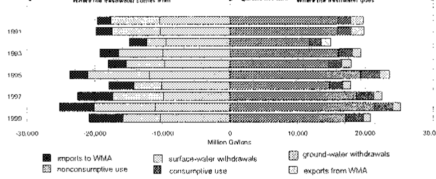


Figure 13. 1999 Freshwater Import & Export Details

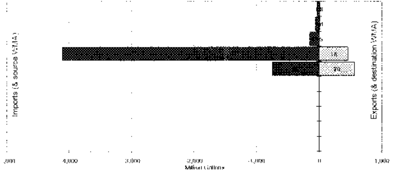


Figure 14. Use of Fresh Water in WMA

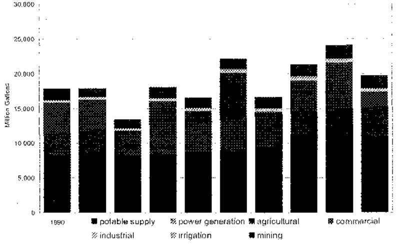


Figure 15. Monthly Consumptive & Nonconsumptive Water Use in WMA

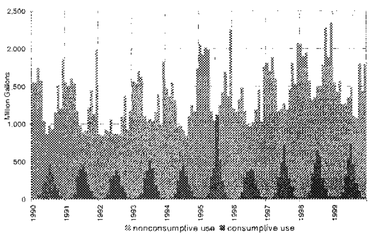


Figure 16. Sewage Generation, Transfers and Reclaimed-Water Discharges

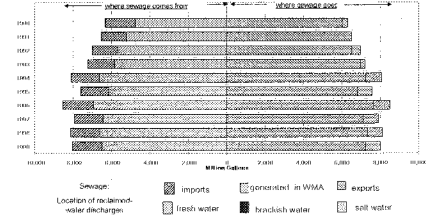
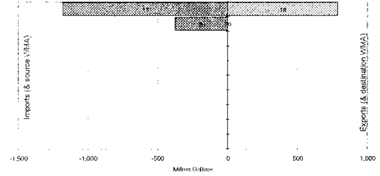


Figure 17. 1999 Sewage Import & Export Details



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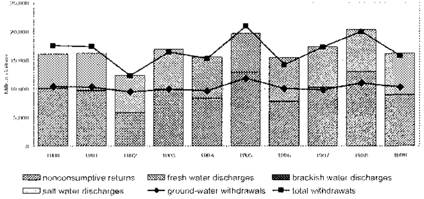

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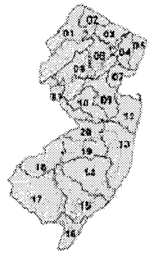


Figure 11. Watershed Management Areas & Counties in New Jersey

WMA boundaries and numbers in black.
County boundaries in white.
Pinelands outer border in green.
Highlands outer border in blue.

*Table 19. Water Allocations in WMA 19 by Water Source*

| Water Source | Million Gallons/Year |
|---|---|
| surface water | 14,941 |
| ground water | 14,877 |
| total | 29,818 |

*Table 20. Water Allocations in WMA 19 by Water Use Group*

| Use Group | Million Gallons/Year |
|---|---|
| agricultural | 19,858 |
| commercial | 37 |
| industrial | 518 |
| irrigation | 452 |
| mining | 2,760 |
| potable supply | 6,193 |
| power generation | 0 |
| sum | 29,818 |

*Table 21. Descriptive Statistics for WMA 19*

| | | |
|---|---|---|
| ***--- Area:*** | 350.8 | sq mi. |
| ***--- Population:*** | | |
| year | population | change |
| 1940 | 35,347 | -- |
| 1950 | 46,904 | 32.7% |
| 1960 | 86,972 | 85.4% |
| 1970 | 140,771 | 61.9% |
| 1980 | 205,115 | 45.7% |
| 1990 | 251,253 | 22.5% |
| 2000 | 277,732 | 10.5% |
| ***--- Withdrawals per square mile (average):*** | | |
| surface | 18.3 | mg/sq mi |
| ground | 29.2 | mg/sq mi |
| ***--- Land Use:*** | | |
| type | Year 1986 | 1995 |
| ag. | 13.7% | 11.6% |
| barren | 0.9% | 0.9% |
| forest | 36.5% | 35.7% |
| water | 2.1% | 2.2% |
| urban | 17.5% | 20.6% |
| wetlands | 29.3% | 28.9% |
| ***--- % of WMA in:*** | | |
| | Pinelands: | 67.9% |
| | Highlands: | 0.0% |

April 16, 2007

*New Jersey Water Supply Plan*

*NJ Department of Environmental Protection - Land Use Management - New Jersey Geological Survey*

WMA #19

# WMA: Rancocas
# # 19

*Change the WMA name on the worksheet "WMA Details"*

V 2.5

## Agricultural Water Use in WMA # 19

*Table 22. Annual Agricultural Water Use by Detailed Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | 1 | 1 | - | 1 | 3 | 13 | 4 |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 7,128 | 7,115 | 3,149 | 7,030 | 5,481 | 9,967 | 4,650 | 7,110 | 9,879 | 5,752 | 6,726 |
| field crops | 44 | 40 | 9 | 51 | 25 | 715 | 5 | 57 | 33 | 56 | 103 |
| general agriculture | 78 | 103 | 70 | 126 | 73 | 62 | 107 | 113 | 123 | 143 | 100 |
| greenhouse | 281 | 342 | 260 | 283 | 281 | 328 | 305 | 289 | 306 | 264 | 294 |
| sod | 36 | 20 | 19 | 40 | 35 | 169 | 8 | 174 | 50 | 163 | 71 |
| tree fruit | 0 | 4 | 0 | - | - | - | - | - | - | 4 | 2 |
| vegetables, leaf crops | 31 | 30 | 28 | 47 | 34 | 43 | 10 | 126 | 46 | 60 | 45 |
| sum | 7,598 | 7,652 | 3,535 | 7,578 | 5,930 | 11,285 | 5,085 | 7,870 | 10,441 | 6,456 | 7,343 |

*Table 23. Annual Agricultural Use by Detailed Use Type as Percentage of Total Agricultural Use*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | 0% | 0% | - | 0% | 0% | 0% | 0% |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 94% | 93% | 89% | 93% | 92% | 88% | 91% | 90% | 95% | 89% | 91% |
| field crops | 1% | 1% | 0% | 1% | 0% | 6% | 0% | 1% | 0% | 1% | 1% |
| general agriculture | 1% | 1% | 2% | 2% | 1% | 1% | 2% | 1% | 1% | 2% | 1% |
| greenhouse | 4% | 4% | 7% | 4% | 5% | 3% | 6% | 4% | 3% | 4% | 4% |
| sod | 0% | 0% | 1% | 1% | 1% | 1% | 0% | 2% | 0% | 3% | 1% |
| tree fruit | 0% | 0% | 0% | - | - | - | - | - | - | 0% | 0% |
| vegetables, leaf crops | 0% | 0% | 1% | 1% | 1% | 0% | 0% | 2% | 0% | 1% | 1% |

*Table 24. Annual Consumed Water Volume by Detailed Agricultural Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | 1 | 1 | - | 1 | 3 | 12 | 3 |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 199 | 201 | 151 | 232 | 158 | 306 | 186 | 200 | 388 | 234 | 226 |
| field crops | 40 | 36 | 8 | 46 | 23 | 643 | 5 | 51 | 29 | 50 | 93 |
| general agriculture | 70 | 93 | 63 | 114 | 66 | 56 | 96 | 102 | 111 | 129 | 90 |
| greenhouse | 253 | 308 | 234 | 255 | 253 | 295 | 274 | 260 | 276 | 238 | 265 |
| sod | 32 | 18 | 17 | 36 | 32 | 152 | 7 | 157 | 45 | 146 | 64 |
| tree fruit | 0 | 3 | 0 | - | - | - | - | - | - | 3 | 2 |
| vegetables, leaf crops | 28 | 27 | 25 | 43 | 31 | 38 | 9 | 113 | 42 | 54 | 41 |
| sum | 622 | 685 | 499 | 725 | 563 | 1,492 | 577 | 884 | 894 | 866 | 781 |

*Table 25. Annual Consumed Water Percentage by Detailed Agricultural Use Type*

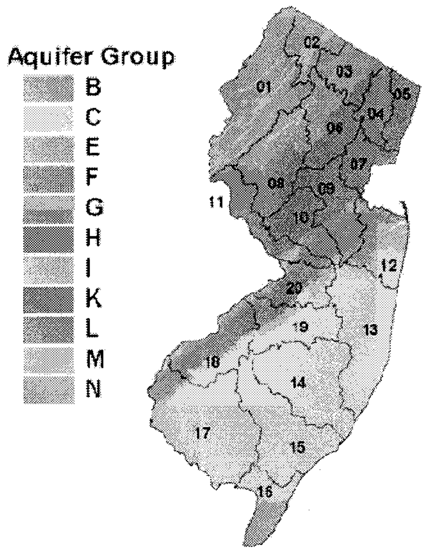
| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | - | 90% | 90% | - | 90% | 90% | 90% | 90% |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 3% | 3% | 5% | 3% | 3% | 3% | 4% | 3% | 4% | 4% | 3% |
| field crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| general agriculture | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| greenhouse | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| sod | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| tree fruit | 90% | 90% | 90% | - | - | - | - | - | - | 90% | 90% |
| vegetables, leaf crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| overall average | 8% | 9% | 14% | 10% | 9% | 13% | 11% | 11% | 9% | 13% | 11% |

## Ground-Water Withdrawals by Aquifer Group in WMA # 19

*Table 26. Annual Ground-Water Withdrawals by Aquifer Group (millions of gallons)*

| Aquifer Group | | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| code | description | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| A | glacial sediments of northern NJ | - | - | - | - | - | - | - | - | - | - | - |
| B | surficial deposits in southern NJ | - | - | - | - | - | - | - | - | - | 0 | 0 |
| C | Kirkwood & Cohansey | 2,007 | 1,688 | 1,621 | 2,070 | 1,762 | 2,771 | 2,220 | 2,475 | 2,749 | 2,740 | 2,210 |
| D | Rio Grande and Atlantic City 800-foot sand | - | - | - | - | - | - | - | - | - | - | - |
| E | Piney Point and Vincentown | 545 | 548 | 546 | 548 | 435 | 868 | 526 | 23 | 723 | 588 | 535 |
| F | Wenonah, Mount Laurel and Englishtown | 1,202 | 1,222 | 1,246 | 1,256 | 1,113 | 1,552 | 920 | 1,329 | 1,306 | 1,274 | 1,242 |
| G | upper Magothy, Raritan & Potomac | 1,356 | 1,879 | 1,741 | 1,919 | 2,140 | 2,162 | 1,775 | 1,572 | 1,524 | 1,610 | 1,768 |
| H | middle Magothy, Raritan & Potomac | 1,257 | 1,826 | 1,649 | 1,785 | 1,949 | 2,224 | 1,972 | 2,032 | 2,214 | 1,720 | 1,863 |
| I | lower Magothy, Raritan & Potomac | 421 | 506 | 460 | 423 | 485 | 491 | 525 | 470 | 575 | 629 | 498 |
| J | undifferentiated Magothy, Raritan & Potomac | 2,071 | 1,092 | 620 | 335 | 216 | 182 | 304 | 177 | 59 | 50 | 511 |
| K | Brunswick Supergroup | - | - | - | - | - | - | - | - | - | - | - |
| L | Lockatong & Stockton | - | - | - | - | - | - | - | - | - | - | - |
| M | limestone, dolomite and marble of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| N | noncarbonate consolidated rocks of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| P | unknown/not assigned | 18 | 23 | 53 | 189 | 19 | 58 | 286 | 185 | 388 | 64 | 128 |
| Q | domestic wells | 1,492 | 1,496 | 1,506 | 1,515 | 1,527 | 1,539 | 1,550 | 1,561 | 1,575 | 1,588 | 1,535 |
| | sum: | 10,369 | 10,280 | 9,442 | 10,040 | 9,647 | 11,846 | 10,078 | 9,823 | 11,112 | 10,263 | 10,290 |
| | | | | | 176 | | | 19 | 3 | 112 | | 31 |

Figure 18. Outcrop areas of aquifer groups with watershed management areas.



# NEW JERSEY WATER WITHDRAWALS, USES, TRANSFERS & DISCHARGES - Watershed Management Area Summary

V 2.5

**WMA:** *Assiscunk, Crosswicks, Doctors*

\# 20

*Click on the box to the left and use the pull down menu to select a WMA.*

Subject to Revision

See the 'User's Guide' worksheet for more information.

**Subject to revision.**

*Table 12. Freshwater Withdrawals, Imports & Exports in WMA 20 (millions of gallons)*

| Withdrawals (Q) | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| surface water | 208,427 | 174,871 | 183,955 | 197,512 | 216,393 | 206,403 | 197,668 | 257,884 | 239,324 | 233,469 | 211,590 |
| ground water | 5,750 | 6,328 | 6,675 | 7,092 | 6,727 | 6,918 | 6,455 | 6,684 | 6,194 | 6,413 | 6,524 |
| total Q | 214,177 | 181,199 | 190,631 | 204,604 | 223,120 | 213,321 | 204,123 | 264,568 | 245,518 | 239,882 | 218,114 |
| imports | 2,103 | 2,324 | 1,976 | 1,900 | 2,090 | 2,066 | 2,223 | 2,483 | 2,465 | 2,422 | 2,205 |
| exports | 486 | 929 | 1,441 | 1,484 | 1,186 | 1,276 | 1,185 | 1,239 | 717 | 873 | 1,082 |
| net | 1,617 | 1,394 | 535 | 416 | 904 | 790 | 1,039 | 1,244 | 1,747 | 1,549 | 1,124 |

*Table 13. Freshwater imports to WMA 20 in 1999*

| Source WMA | MG received | % of all water withdrawn in source WMA in 1999 | % of all potable water used in WMA 20 in 1999 |
|---|---|---|---|
| 11 | 1,082 | 2.2% | 15.6% |
| 13 | 0 | 0.0% | 0.0% |
| 18 | 771 | 1.5% | 11.2% |
| 19 | 569 | 3.6% | 8.2% |
| sum: | 2,422 | | 35.0% |

*Table 14. Freshwater Exports from WMA 20 in 1999*

| Destination WMA | MG sent | % of all water withdrawn in WMA 20 in 1999 | % of all potable water used in destination WMA in 1999 |
|---|---|---|---|
| 13 | 99 | 0.0% | 0.4% |
| 18 | 28 | 0.0% | 0.1% |
| 19 | 745 | 0.3% | 6.8% |
| sum. | 873 | 0.4% | |

*Table 15. Use of Fresh Water in WMA 20 (millions of gallons) (includes imports, excludes exports)*

| Use Group | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agricultural | 836 | 754 | 792 | 1,124 | 1,005 | 1,402 | 743 | 1,039 | 1,408 | 1,613 | 1,072 |
| commercial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| industrial | 14,043 | 10,974 | 4,434 | 15,207 | 39,359 | 37,672 | 35,994 | 35,480 | 18,323 | 1,474 | 21,296 |
| irrigation | 44 | 64 | 50 | 54 | 62 | 134 | 41 | 93 | 98 | 102 | 74 |
| mining | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| potable supply | 6,279 | 6,505 | 6,035 | 6,237 | 6,422 | 6,489 | 6,603 | 6,936 | 6,962 | 6,916 | 6,538 |
| power generation | 194,600 | 164,306 | 179,864 | 182,407 | 177,185 | 168,422 | 161,790 | 222,273 | 220,574 | 231,335 | 190,276 |
| total volume | 215,803 | 182,602 | 191,174 | 205,029 | 224,033 | 214,119 | 205,170 | 265,821 | 247,366 | 241,440 | 219,256 |
| consumed volume | 7,844 | 6,741 | 6,463 | 7,998 | 10,155 | 10,228 | 9,058 | 10,940 | 9,542 | 8,284 | 8,725 |
| consumed percent | 4% | 4% | 3% | 4% | 5% | 5% | 4% | 4% | 4% | 3% | 4% |

*Table 16. Sewage Transfers & Reclaimed-Water Discharges in WMA 20 (millions of gallons)*

| Sewage/Reclaimed Water | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| imported to WMA | 1,710 | 2,321 | 2,213 | 2,551 | 2,561 | 2,188 | 2,431 | 2,321 | 2,395 | 2,383 | 2,307 |
| exported from WMA | 412 | 440 | 428 | 481 | 490 | 460 | 523 | 464 | 493 | 485 | 468 |
| generated in WMA | 8,900 | 8,862 | 9,644 | 10,794 | 10,872 | 8,805 | 9,996 | 9,096 | 9,295 | 9,479 | 9,574 |
| discharged in WMA | 10,198 | 10,743 | 11,428 | 12,864 | 12,943 | 10,533 | 11,904 | 10,953 | 11,197 | 11,376 | 11,414 |

*Table 17. Destination of Reclaimed-Water Discharges in WMA 20 (millions of gallons)*

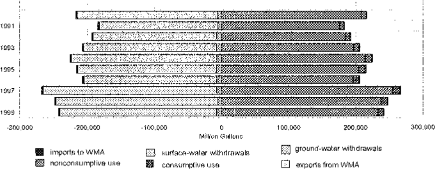
| Destination | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| fresh water | 10,198 | 10,743 | 11,428 | 12,864 | 12,943 | 10,533 | 11,904 | 10,953 | 11,197 | 11,376 | 11,414 |
| brackish water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| salt water | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Table 18. Nonconsumptive Water Returns to WMA 20 (millions of gallons)*

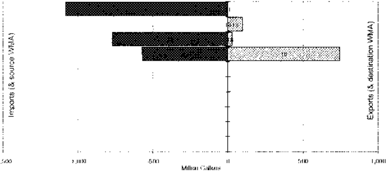
| Water Use | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| potable purveyors | 4,970 | 5,144 | 4,721 | 4,864 | 5,040 | 5,059 | 5,178 | 5,429 | 5,392 | 5,354 | 5,115 |
| domestic wells | 642 | 648 | 663 | 677 | 689 | 701 | 713 | 729 | 745 | 766 | 697 |
| ind + comm + mining | 12,639 | 9,876 | 3,990 | 13,686 | 35,423 | 33,905 | 32,395 | 31,933 | 16,496 | 1,345 | 19,169 |
| ag + irrig | 168 | 159 | 150 | 139 | 148 | 183 | 243 | 297 | 352 | 371 | 221 |
| power generation | 189,540 | 160,034 | 175,188 | 177,664 | 172,578 | 164,043 | 157,583 | 216,494 | 214,839 | 225,320 | 185,328 |
| sum: | 207,959 | 175,862 | 184,711 | 197,031 | 213,878 | 203,892 | 196,113 | 254,882 | 237,824 | 233,156 | 210,531 |

notes:
- Volumes include an estimate of domestic-well withdrawals and their consumptive use
- Consumed refers to water evaporated in the watershed, it does not include exports.
- This does not account for water released from onstream reservoirs for downstream intakes.
- No accounting for intakes or use of salt-water.
- The allocated volume is based on users with allocation permits.
- Sewage and reclaimed-water transfers and discharges based on sewer service areas and NJPDES discharge volumes.
- Withdrawals for offstream reservoirs in WMAs 03, 08, and 12 are problematic and complicate Figure 1.
- See the 'User's Guide' worksheet for more information.
- Subject to revision.

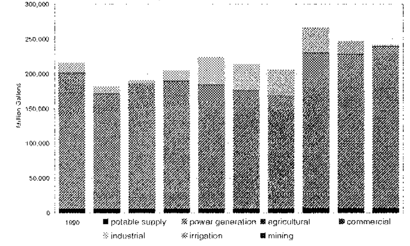
### Figure 12. Freshwater Withdrawals, Use, Imports & Exports



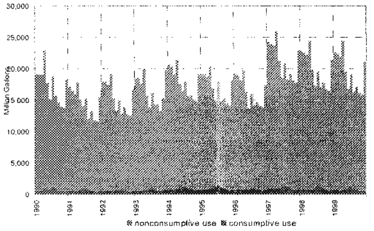
### Figure 13. 1999 Freshwater Import & Export Details



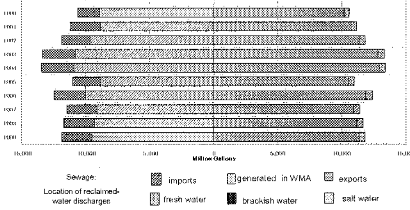
### Figure 14. Use of Fresh Water in WMA



### Figure 15. Monthly Consumptive & Nonconsumptive Water Use in WMA



### Figure 16. Sewage Generation, Transfers and Reclaimed-Water Discharges



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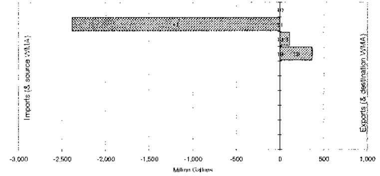
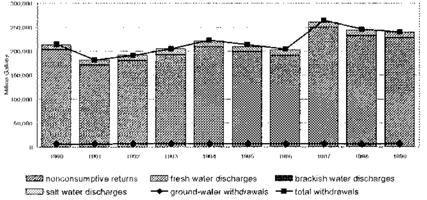
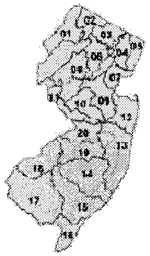


### Figure 18. Net Resource Impact to WMA





### Figure 11. Watershed Management Areas & Counties in New Jersey

WMA boundaries and numbers in black.
County boundaries in white.
Pinelands outer border in green.
Highlands outer border in blue.

See the 'Metadata' worksheet for more information.

*Table 19. Water Allocations in WMA 20 by Water Source*

| Water Source | Million Gallons/Year |
|---|---|
| surface water | 177,954 |
| ground water | 9,711 |
| total | 187,664 |

*Table 20. Water Allocations in WMA 20 by Water Use Group*

| Use Group | Million Gallons/Year |
|---|---|
| agricultural | 8,050 |
| commercial | 0 |
| industrial | 72,758 |
| irrigation | 212 |
| mining | 0 |
| potable supply | 6,644 |
| power generation | 100,000 |
| sum | 187,664 |

*Table 21. Descriptive Statistics for WMA 20*

| | | |
|---|---|---|
| **--- Area:** | 253.0 | sq mi. |
| **--- Population:** | | |
| year | population | change |
| 1940 | 61,278 | -- |
| 1950 | 91,907 | 50.0% |
| 1960 | 141,769 | 54.3% |
| 1970 | 187,856 | 32.5% |
| 1980 | 178,081 | -5.2% |
| 1990 | 185,642 | 4.2% |
| 2000 | 194,726 | 4.9% |
| **--- Withdrawals per square mile (average):** | | |
| surface | 836.4 | mg/sq mi |
| ground | 25.8 | mg/sq mi |
| **--- Land Use:** | | |
| type | Year | |
| | 1986 | 1995 |
| ag. | 35.8% | 32.0% |
| barren | 0.7% | 1.0% |
| forest | 17.3% | 17.3% |
| water | 2.2% | 2.2% |
| urban | 18.5% | 22.2% |
| wetlands | 25.6% | 25.3% |
| **--- % of WMA in:** | | |
| | Pinelands: | 9.1% |
| | Highlands: | 0.0% |

April 16, 2007

*New Jersey Water Supply Plan*

*NJ Department of Environmental Protection - Land Use Management - New Jersey Geological Survey*

WMA #20

C:\Documents and Settings\cmattson\Desktop\Unused Desktop Shortcuts\thesis\Sample Data\[wmatransfers25.xls]WMA Details

# WMA: Assiscunk, Crosswicks, Doctors
# 20

*Change the WMA name on the worksheet "WMA Details"*

V 2.5

## Agricultural Water Use in WMA # 20

*Table 22. Annual Agricultural Water Use by Detailed Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | 0 | 2 | - | 4 | - | - | - | 2 |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 92 | 89 | 78 | 26 | 49 | 36 | 202 | 224 | 240 | 242 | 128 |
| field crops | 61 | 128 | 130 | 141 | 126 | 132 | 0 | 155 | 189 | 141 | 121 |
| general agriculture | 138 | 20 | 32 | 45 | 33 | 46 | 18 | 176 | 27 | 37 | 58 |
| greenhouse | 118 | 23 | 230 | 380 | 373 | 473 | 192 | 114 | 80 | 272 | 226 |
| sod | 71 | 52 | 75 | 71 | 75 | 69 | 29 | 23 | 33 | 81 | 58 |
| tree fruit | 2 | 3 | 2 | 6 | 8 | 19 | 1 | 14 | 8 | 11 | 7 |
| vegetables, leaf crops | 354 | 429 | 245 | 456 | 339 | 629 | 291 | 334 | 831 | 829 | 474 |
| sum | 836 | 754 | 792 | 1,124 | 1,005 | 1,402 | 743 | 1,039 | 1,408 | 1,613 | 1,072 |

*Table 23. Annual Agricultural Use by Detailed Use Type as Percentage of Total Agricultural Use*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | 0% | 0% | - | 1% | - | - | - | 0% |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 11% | 12% | 10% | 2% | 5% | 3% | 27% | 22% | 17% | 15% | 12% |
| field crops | 7% | 17% | 16% | 13% | 13% | 9% | 1% | 15% | 13% | 9% | 11% |
| general agriculture | 16% | 4% | 4% | 4% | 3% | 3% | 2% | 17% | 2% | 2% | 6% |
| greenhouse | 14% | 3% | 29% | 34% | 37% | 34% | 26% | 11% | 6% | 17% | 21% |
| sod | 9% | 7% | 9% | 6% | 7% | 5% | 4% | 2% | 2% | 5% | 6% |
| tree fruit | 0% | 0% | 0% | 1% | 1% | 1% | 0% | 1% | 1% | 1% | 1% |
| vegetables, leaf crops | 42% | 57% | 31% | 41% | 34% | 45% | 39% | 32% | 59% | 51% | 43% |

*Table 24. Annual Consumed Water Volume by Detailed Agricultural Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | 0 | 2 | - | 4 | - | - | - | 2 |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 3 | 3 | 4 | 2 | 3 | 3 | 17 | 18 | 15 | 19 | 9 |
| field crops | 55 | 115 | 117 | 127 | 114 | 118 | 5 | 140 | 170 | 127 | 109 |
| general agriculture | 124 | 26 | 29 | 40 | 30 | 41 | 16 | 159 | 24 | 33 | 52 |
| greenhouse | 106 | 21 | 207 | 342 | 336 | 425 | 173 | 103 | 72 | 245 | 203 |
| sod | 64 | 47 | 68 | 64 | 67 | 62 | 26 | 20 | 30 | 73 | 52 |
| tree fruit | 1 | 3 | 2 | 5 | 8 | 17 | 1 | 12 | 7 | 10 | 7 |
| vegetables, leaf crops | 319 | 386 | 220 | 411 | 305 | 566 | 262 | 300 | 748 | 746 | 426 |
| sum | 673 | 601 | 647 | 991 | 863 | 1,232 | 503 | 751 | 1,066 | 1,252 | 858 |

*Table 25. Annual Consumed Water Percentage by Detailed Agricultural Use Type*

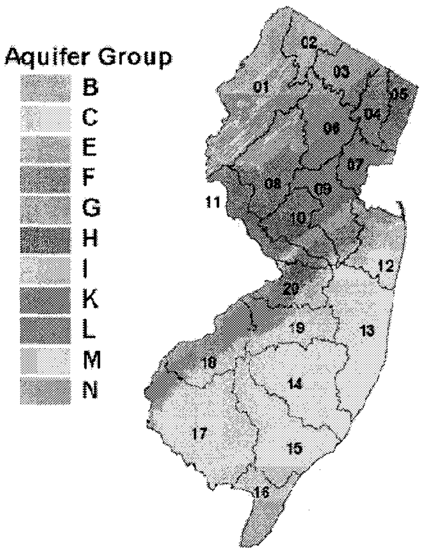
| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | - | - | - |
| aquaculture | - | - | - | - | - | - | - | - | - | - | - |
| blueberries | - | - | - | 90% | 90% | - | 90% | - | - | - | 90% |
| christmas trees | - | - | - | - | - | - | - | - | - | - | - |
| cranberries | 4% | 4% | 5% | 6% | 6% | 8% | 8% | 8% | 6% | 8% | 6% |
| field crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| general agriculture | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| greenhouse | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| sod | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| tree fruit | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| vegetables, leaf crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| overall average | 80% | 80% | 82% | 88% | 86% | 88% | 68% | 72% | 76% | 78% | 80% |

## Ground-Water Withdrawals by Aquifer Group in WMA # 20

*Table 26. Annual Ground-Water Withdrawals by Aquifer Group (millions of gallons)*

| Aquifer Group | | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| code | description | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| A | glacial sediments of northern NJ | - | - | - | - | - | - | - | - | - | - | - |
| B | surficial deposits in southern NJ | - | - | - | - | - | - | 1 | 1 | 0 | - | 1 |
| C | Kirkwood & Cohansey | 82 | 249 | 130 | 225 | 215 | 285 | 36 | 111 | 258 | 122 | 171 |
| D | Rio Grande and Atlantic City 800-foot sand | - | - | - | - | - | - | - | - | - | - | - |
| E | Piney Point and Vincentown | - | - | - | - | - | - | - | 1 | 7 | 6 | 4 |
| F | Wenonah, Mount Laurel and Englishtown | 82 | 78 | 81 | 73 | 134 | 254 | 115 | 114 | 141 | 134 | 121 |
| G | upper Magothy, Raritan & Potomac | 328 | 285 | 324 | 347 | 332 | 312 | 339 | 394 | 261 | 206 | 313 |
| H | middle Magothy, Raritan & Potomac | 2,525 | 3,256 | 3,682 | 3,801 | 3,863 | 3,769 | 3,682 | 3,678 | 3,075 | 3,213 | 3,454 |
| I | lower Magothy, Raritan & Potomac | 204 | 251 | 327 | 337 | 318 | 261 | 299 | 316 | 327 | 337 | 298 |
| J | undifferentiated Magothy, Raritan & Potomac | 1,790 | 1,464 | 1,365 | 1,528 | 1,076 | 1,228 | 1,170 | 1,236 | 1,219 | 1,295 | 1,337 |
| K | Brunswick Supergroup | - | - | - | - | - | - | - | - | - | - | - |
| L | Lockatong & Stockton | - | - | - | - | - | - | - | - | - | - | - |
| M | limestone, dolomite and marble of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| N | noncarbonate consolidated rocks of the Valley & Ridge and Highlands provinces | - | - | - | - | - | - | - | - | - | - | - |
| P | unknown/not assigned | 14 | 14 | 18 | 17 | 13 | 19 | 9 | 12 | 157 | 236 | 51 |
| Q | domestic wells | 733 | 739 | 756 | 773 | 786 | 800 | 813 | 832 | 850 | 874 | 796 |
| | sum: | 5,759 | 6,337 | 6,684 | 7,101 | 6,736 | 6,927 | 6,464 | 6,693 | 6,295 | 6,422 | 6,542 |
| | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 101 | 9 | 18 |

Figure 18. Outcrop areas of aquifer groups with watershed management areas.



# NEW JERSEY WATER WITHDRAWALS, USES, TRANSFERS & DISCHARGES - Statewide Summary

Subject to Revision    See the 'User's Guide' worksheet for more information.

| 1990 pop | 2000 pop | Δ |
|---|---|---|
| 7.730.188 | 8.411,350 | 8.1% |

*Table 1. Statewide Freshwater Withdrawals (millions of gallons)*

| Withdrawals (Q) | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| surface water | 819.502 | 748.595 | 730.199 | 748.286 | 729.740 | 727,865 | 652,630 | 737,460 | 681.708 | 698,034 | 727.402 |
| ground water | 229.609 | 237.726 | 230.057 | 244,047 | 246.152 | 250,126 | 238,225 | 249,025 | 253,902 | 246,903 | 242.577 |
| total Q | 1.049.112 | 986.321 | 960.257 | 992,333 | 975,892 | 977,990 | 890,855 | 986,485 | 935,611 | 944,938 | 969.979 |

*Table 2. Statewide Use of Fresh Water (millions of gallons)*

| Use Group | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agricultural | 44.698 | 52.183 | 46.942 | 54.202 | 49.385 | 68.514 | 48.447 | 58,727 | 62,957 | 62.072 | 54.713 |
| commercial | 459 | 534 | 496 | 620 | 556 | 594 | 612 | 467 | 549 | 294 | 518 |
| industrial | 87.414 | 79.615 | 73.231 | 84.138 | 100.892 | 88.555 | 86,450 | 81,899 | 63,699 | 46,245 | 79,214 |
| irrigation | 2.077 | 2.992 | 2.512 | 3.839 | 3.303 | 4.091 | 2.635 | 4.044 | 4,415 | 4,168 | 3,407 |
| mining | 26.351 | 29.209 | 38.982 | 31.958 | 37.254 | 36.962 | 32,455 | 40,419 | 34,268 | 32,376 | 34,023 |
| potable supply | 414,253 | 418.984 | 401.211 | 416.986 | 429.151 | 420.505 | 415.482 | 425.396 | 429.025 | 431,068 | 420,206 |
| power generation | 464,976 | 373.828 | 364.828 | 362.913 | 331,604 | 315.574 | 297.445 | 358,333 | 315,329 | 333,193 | 351,802 |
| total volume | 1.040,229 | 957,345 | 927,201 | 954,656 | 952,145 | 934.796 | 883.526 | 969.285 | 910.241 | 909,415 | 943.884 |
| consumed volume | 75.596 | 83.134 | 77,159 | 86,382 | 85,258 | 88.118 | 77.228 | 87.739 | 88.454 | 87.684 | 83,675 |
| consumed percent | 7.3% | 8.7% | 8.3% | 9.0% | 9.0% | 9.4% | 8.7% | 9.1% | 9.7% | 9.6% | 8.9% |
| check | 0.8% | 2.9% | 3.4% | 3.8% | 2.4% | 4 4% | 0.8% | 1.7% | 2.7% | 3.8% | |

*Table 3. Destination of Reclaimed Water Discharges (millions of gallons)*

| Destination | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| fresh water | 79.777 | 78.489 | 94.796 | 91.223 | 112,313 | 101 773 | 119,384 | 109,329 | 110,968 | 106.575 | 100.463 |
| brackish water | 136.141 | 147.086 | 140.706 | 150.360 | 152,003 | 138,244 | 158,228 | 144,115 | 147.403 | 141.954 | 145.624 |
| salt water | 121.110 | 128.634 | 127.342 | 139.219 | 144,780 | 132,689 | 153,444 | 142,864 | 148.160 | 137.026 | 137,527 |
| sum | 337.027 | 354.209 | 362.844 | 380.802 | 409,096 | 372,705 | 431,055 | 396,308 | 406,531 | 385,554 | 383,613 |

*Table 4. Statewide Nonconsumptive Water Returns (millions of gallons)*

| Water Use | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| potable purveyors | 344.692 | 347.293 | 332.067 | 344.040 | 355,636 | 347,650 | 343.585 | 350,087 | 352,286 | 353,688 | 347,102 |
| domestic wells | 25.483 | 25.608 | 25.901 | 26,217 | 26.545 | 26,858 | 27,123 | 27,412 | 27,732 | 28,084 | 26,696 |
| ind + comm + mining | 102.213 | 97.754 | 100.585 | 104.331 | 124.016 | 112,675 | 106,915 | 109,648 | 87,951 | 70,400 | 101,649 |
| ag + irrig | 32.422 | 34.044 | 31.450 | 35.578 | 33.799 | 48.377 | 35,564 | 41,897 | 44.307 | 42.462 | 37.990 |
| power generation | 459.825 | 369 515 | 360,043 | 358.110 | 326.891 | 311 117 | 293.111 | 352,502 | 309,511 | 327,098 | 346.772 |
| sum | 964.636 | 874.213 | 850,047 | 868,275 | 866.887 | 846.678 | 806,298 | 881,546 | 821,787 | 821,731 | 860.210 |
| error | 0.0% | 0.0% | 0 0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | |

*Table 5. Statewide Water Allocations by Water Source*

| Water Source | Million Gallons/Year |
|---|---|
| surface water | 3.239.147 |
| ground water | 680.010 |
| total | 3.919.158 |

*Table 6. Statewide Water Allocation by Water Use Group*

| Use Group | Million Gallons/Year |
|---|---|
| agricultural | 253,846 |
| commercial | 3.431 |
| industrial | 782,756 |
| irrigation | 13.256 |
| mining | 152,039 |
| potable supply | 683,796 |
| power generation | 2,030,033 |
| total | 3,919,158 |

notes:
- ♦ Volumes include an estimate of domestic well withdrawals and their consumptive use.
- ♦ Consumed refers to water evaporated in the watershed. it does not include exports.
- ♦ This does not account for water released from onstream reservoirs for downstream intakes.
- ♦ No accounting for salt-water intakes.
- ♦ The allocated volume is based on users with allocation permits.
- ♦ Sewage and reclaimed-water transfers and discharges based on sewer service areas and NJPDES discharge volumes.
- ♦ Withdrawals for offstream reservoirs in WMAs 03. 08. and 12 are problematic and complicate Figure 1.
- ♦ See the 'User's Guide' worksheet for more information.
- ♦ Subject to revision.

Figure 1. Statewide Freshwater Withdrawals and Use

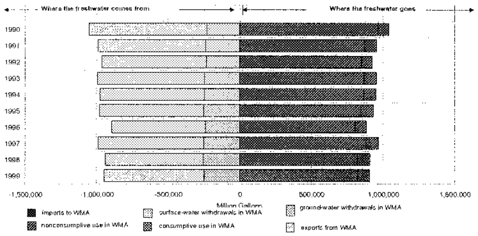


Figure 2. Statewide Use of Fresh Water

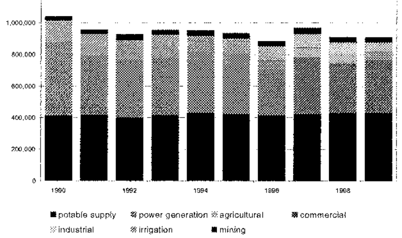
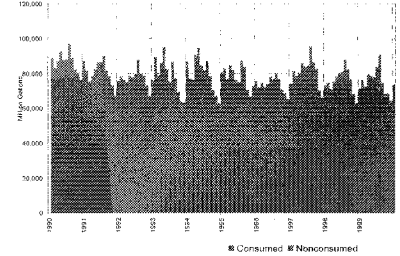


Figure 3. Statewide Monthly Consumptive & Nonconsumptive Water Use



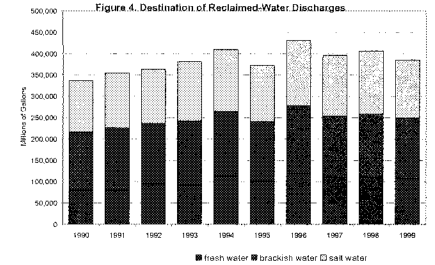


Figure 4. Destination of Reclaimed-Water Discharges

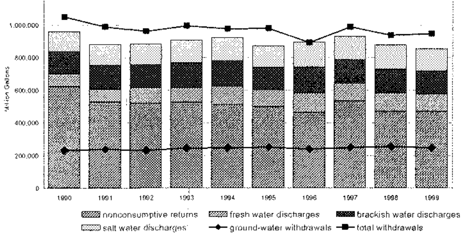


Figure 5. Net Resource Impact to New Jersey

# Statewide Agricultural Water Use

*Table 7. Statewide Annual Agricultural Water Use by Detailed Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| aquaculture | 2,266 | 2,755 | 2,971 | 2,932 | 3,054 | 3,030 | 2,939 | 3,097 | 3,258 | 3,088 | 2,939 |
| blueberries | 612 | 1,426 | 602 | 977 | 1,160 | 1,314 | 1,060 | 1,202 | 1,974 | 1,932 | 1,226 |
| christmas trees | 60 | 63 | 62 | 65 | 63 | 100 | 100 | 96 | 100 | 125 | 83 |
| cranberries | 30,158 | 30,709 | 28,988 | 32,601 | 31,056 | 47,065 | 34,472 | 39,227 | 41,305 | 39,890 | 35,547 |
| field crops | 463 | 1,348 | 1,031 | 859 | 1,222 | 1,748 | 284 | 1,318 | 1,266 | 1,285 | 1,082 |
| general agriculture | 4,215 | 6,033 | 3,870 | 4,896 | 3,408 | 1,691 | 1,438 | 2,078 | 1,732 | 2,161 | 3,152 |
| greenhouse | 1,263 | 1,454 | 1,507 | 2,119 | 2,117 | 2,418 | 1,825 | 1,992 | 2,701 | 2,445 | 1,984 |
| sod | 931 | 988 | 626 | 893 | 960 | 1,870 | 1,107 | 1,482 | 1,373 | 1,482 | 1,171 |
| tree fruit | 456 | 1,026 | 643 | 947 | 788 | 1,272 | 581 | 1,022 | 1,070 | 1,341 | 915 |
| vegetables, leaf crops | 4,275 | 6,380 | 5,642 | 7,911 | 5,557 | 8,008 | 4,643 | 7,213 | 8,178 | 8,322 | 6,613 |
| sum | 44,698 | 52,183 | 45,942 | 54,202 | 49,385 | 68,514 | 48,447 | 58,727 | 62,957 | 62,072 | 54,713 |

*Table 8. Statewide Annual Agricultural Use by Detailed Use Type as Percentage of Total Agricultural Use*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| aquaculture | 5% | 5% | 6% | 5% | 6% | 4% | 6% | 5% | 5% | 5% | 5% |
| blueberries | 1% | 3% | 1% | 2% | 2% | 2% | 2% | 2% | 3% | 3% | 2% |
| christmas trees | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| cranberries | 67% | 59% | 63% | 60% | 63% | 69% | 71% | 67% | 66% | 64% | 65% |
| field crops | 1% | 3% | 2% | 2% | 2% | 3% | 1% | 2% | 2% | 2% | 2% |
| general agriculture | 9% | 12% | 8% | 9% | 7% | 2% | 3% | 4% | 3% | 3% | 6% |
| greenhouse | 3% | 3% | 3% | 4% | 4% | 4% | 4% | 3% | 4% | 4% | 4% |
| sod | 2% | 2% | 1% | 2% | 2% | 3% | 2% | 3% | 2% | 2% | 2% |
| tree fruit | 1% | 2% | 1% | 2% | 2% | 2% | 1% | 2% | 2% | 2% | 2% |
| vegetables, leaf crops | 10% | 12% | 12% | 15% | 11% | 12% | 10% | 12% | 13% | 13% | 12% |

*Table 9. Statewide Annual Consumed Water Volume by Detailed Agricultural Use Type (millions of gallons)*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| aquaculture | 113 | 138 | 149 | 147 | 153 | 151 | 147 | 155 | 163 | 154 | 147 |
| blueberries | 551 | 1,284 | 542 | 880 | 1,044 | 1,182 | 954 | 1,082 | 1,777 | 1,738 | 1,103 |
| christmas trees | 54 | 57 | 56 | 59 | 57 | 90 | 90 | 86 | 90 | 112 | 75 |
| cranberries | 1,323 | 1,453 | 2,010 | 2,060 | 2,015 | 3,818 | 3,067 | 2,317 | 2,373 | 2,687 | 2,312 |
| field crops | 417 | 1,213 | 928 | 773 | 1,100 | 1,573 | 255 | 1,186 | 1,140 | 1,157 | 974 |
| general agriculture | 3,793 | 5,430 | 3,483 | 4,407 | 3,067 | 1,522 | 1,294 | 1,870 | 1,559 | 1,945 | 2,837 |
| greenhouse | 1,137 | 1,309 | 1,356 | 1,907 | 1,906 | 2,176 | 1,642 | 1,793 | 2,431 | 2,201 | 1,786 |
| sod | 838 | 889 | 563 | 804 | 864 | 1,683 | 996 | 1,334 | 1,235 | 1,334 | 1,054 |
| tree fruit | 411 | 923 | 579 | 852 | 709 | 1,145 | 523 | 920 | 963 | 1,207 | 823 |
| vegetables, leaf crops | 3,847 | 5,742 | 5,078 | 7,120 | 5,001 | 7,207 | 4,179 | 6,492 | 7,360 | 7,490 | 5,952 |
| sum | 12,484 | 18,438 | 14,743 | 19,008 | 15,916 | 20,547 | 13,147 | 17,235 | 19,091 | 20,027 | 17,063 |

*Table 10. Statewide Annual Consumed Water Percentage by Detailed Agricultural Use Type*

| Detailed Use Type | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| agriculture irrigation | - | - | - | - | - | - | - | - | 90% | - | 90% |
| aquaculture | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| blueberries | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| christmas trees | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| cranberries | 4% | 5% | 7% | 6% | 6% | 8% | 9% | 6% | 6% | 7% | 7% |
| field crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| general agriculture | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| greenhouse | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| sod | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| tree fruit | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| vegetables, leaf crops | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% | 90% |
| overall average | 28% | 35% | 32% | 35% | 32% | 30% | 27% | 29% | 30% | 32% | 31% |

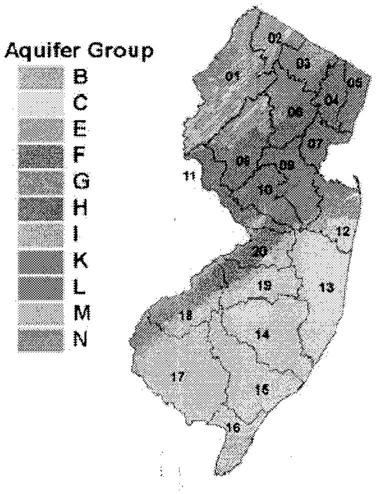
# Statewide Ground-Water Withdrawals by Aquifer Group

*Table 11. Statewide Annual Ground-Water Withdrawals by Aquifer Group (millions of gallons)*

| Aquifer Group | | Year | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| code | description | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | |
| A | glacial sediments of northern NJ | 29,092 | 33,156 | 31,566 | 34,084 | 33,091 | 32,654 | 32,762 | 34,154 | 34,558 | 35,807 | 33,093 |
| B | surficial deposits in southern NJ | 2,048 | 2,129 | 2,460 | 3,331 | 3,716 | 4,084 | 3,979 | 4,163 | 4,014 | 3,940 | 3,386 |
| C | Kirkwood & Cohansey | 44,903 | 46,078 | 43,501 | 48,213 | 49,314 | 52,297 | 49,067 | 55,186 | 56,531 | 48,158 | 49,325 |
| D | Rio Grande and Atlantic City 800-foot sand | 7,280 | 8,722 | 8,254 | 8,869 | 9,765 | 9,850 | 9,689 | 10,126 | 10,639 | 10,728 | 9,392 |
| E | Piney Point and Vincentown | 1,478 | 2,244 | 2,230 | 2,516 | 2,032 | 2,414 | 2,102 | 2,625 | 3,201 | 3,286 | 2,413 |
| F | Wenonah, Mount Laurel and Englishtown | 6,395 | 5,914 | 5,392 | 5,817 | 5,772 | 6,854 | 5,577 | 8,194 | 8,535 | 7,691 | 6,614 |
| G | upper Magothy, Raritan & Potomac | 18,478 | 24,786 | 23,713 | 25,595 | 26,077 | 25,942 | 24,059 | 23,811 | 24,065 | 22,684 | 23,921 |
| H | middle Magothy, Raritan & Potomac | 14,267 | 19,186 | 16,220 | 16,908 | 17,933 | 17,512 | 15,486 | 16,524 | 15,896 | 16,019 | 16,595 |
| I | lower Magothy, Raritan & Potomac | 14,215 | 21,122 | 23,099 | 22,171 | 22,603 | 23,549 | 19,108 | 17,614 | 17,891 | 17,946 | 19,932 |
| J | undifferentiated Magothy, Raritan & Potomac | 25,472 | 10,044 | 8,729 | 9,310 | 6,376 | 6,026 | 7,180 | 6,548 | 6,027 | 6,415 | 9,213 |
| K | Brunswick Supergroup | 19,334 | 22,673 | 23,035 | 24,905 | 25,241 | 23,249 | 23,261 | 22,816 | 22,927 | 22,603 | 23,005 |
| L | Lockatong & Stockton | 699 | 1,034 | 994 | 1,074 | 1,082 | 925 | 794 | 747 | 743 | 792 | 888 |
| M | limestone, dolomite and marble of the Valley & Ridge and Highlands provinces | 5,206 | 5,356 | 5,786 | 6,228 | 7,446 | 8,037 | 8,302 | 7,654 | 8,026 | 7,670 | 6,971 |
| N | noncarbonate consolidated rocks of the Valley & Ridge and Highlands provinces | 3,302 | 2,661 | 2,391 | 2,639 | 3,054 | 3,157 | 2,941 | 3,074 | 3,745 | 3,788 | 3,075 |
| P | unknown/not assigned | 8,371 | 3,408 | 3,139 | 2,476 | 2,365 | 2,936 | 2,975 | 4,518 | 5,466 | 7,899 | 4,355 |
| Q | domestic wells | 29,069 | 29,214 | 29,548 | 29,909 | 30,283 | 30,640 | 30,943 | 31,272 | 31,638 | 32,040 | 30,456 |
| | sum: | 229,609 | 237,726 | 230,057 | 244,047 | 246,152 | 250,126 | 238,225 | 249,025 | 253,902 | 247,465 | 242,633 |
| | | | | | | | | | | | 561 | |

Figure 6. Outcrop areas of aquifer groups with watershed management areas.

Notes:
- * Aquifer group A not shown as it overlies portions of northern NJ
- * Additional areas of aquifer group B in southern NJ not shown. These additional depostis tend to be in coastal areas and not significant water producers.
- * Aquifer group D occurs only in subcrop and cannot be shown on this map.
- * Aquifer group J not shown as it is undifferentiated Magothy, Raritan & Potomac (aquifer groups G, H and I).
- * Aquifer groups P and Q cannot be shown as these are used to account for wells for which the tapped aquifer is unknown.



# Summary of Water Transfers, 1999

**V 2.5**

Figure 7. 1999 WMA Sources of Fresh Water

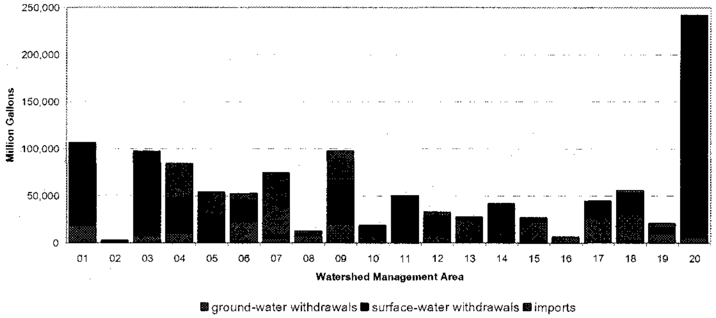


Figure 8. 1999 WMA Total Fresh-Water Demands

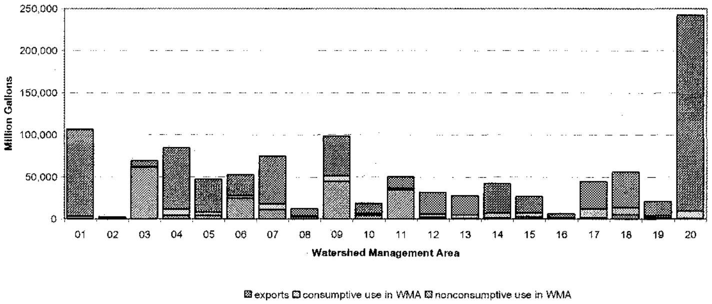


Figure 9. 1999 WMA Depletive (Exports) & Consumptive (Evaporated)

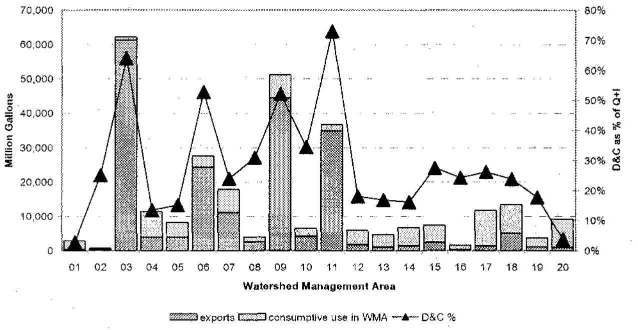


Figure 10. 1999 Reclaimed-Water Discharge Volumes & Receiving Water

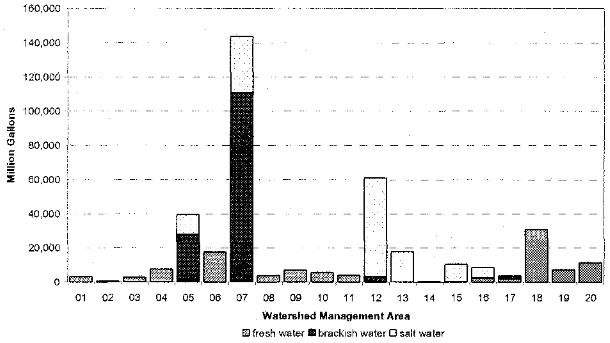
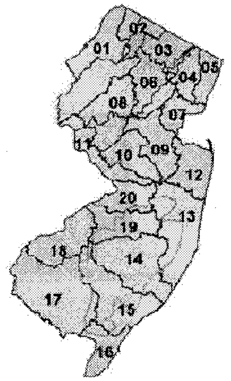


Figure 11. Watershed Management Areas & Counties in New Jersey



WMA boundaries and numbers in black.
County boundaries in white.
Pinelands outer border in green.
Highlands outer border in blue.

# APPENDIX D

## Impaired Water Bodies in Burlington County

## Table 1
## Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 14

| Station Name/Waterbody | Site ID | Parameters |
|---|---|---|
| Great Bay | Great Bay-1 thru 6 | Fecal Colform |
| Little Bay | Little Bay-1, 2 | Fecal Colform |
| Mullica River Estuary | R26, R27, R28, R29, 2005, 2002A, 2009A, 2011A | Fecal Colform |
| Belhaven Lake-14 | Belhaven Lake | Fecal Coliform |
| Chips Folly-14 | Chips Folly | Fecal Coliform |
| Egg Harbor City Lake-14 | Egg Harbor City Lake (Eastside) and (Westside), LINLAKED | Fecal Coliform |
| Hammonton Creek at Westcoatville | 01409416, 14-HAM-2, 14-HAM-1 | Fecal Coliform |
| Hobb Lake-14 | Great Times Camp | Fecal Coliform |
| Lake Inawendiwin-14 | Boy Scouts | Fecal Coliform |
| Lake Mo-Li-Th-Ma-14 | Camp Haluwasa, NPUHALUW | Fecal Coliform |
| Mill Pond-14 | Nacote Creek Beach | Fecal Coliform |
| Moss Mill Lake-14 | Evergreen Woods | Fecal Coliform |
| Paradise Lake-14 | Paradise Lake, NALPARAD | Fecal Coliform |
| Pilgrim Lake-14 | Pilgrim Lake Campground | Fecal Coliform |
| Red Wing Lakes-14 | Red Wing | Fecal Coliform |
| Timberline Lakes-14 | Timberline Lake Campground | Fecal Coliform |
| Absegami Lake-14 | Absegami Lake | Fecal Coliform, Phosphorus |
| Hammonton Lake-14 | Hammonton Lake, Hammonton Bathing Beach (Center), (Left), and (Right); LHAMLAKE | Fecal Coliform, Phosphorus |
| Batsto Lake-14 | Batsto Lake, BBATLAKE | Phosphorus |
| Harrisville Pond-14 | Harrisville Pond, OOSHARLK | Phosphorus |
| Indian Mills Pond-14 | Indian Mills Pond, BMULAKED | Phosphorus |
| Oswego Lake-14 | Oswego Lake, OOSWLAKE | Phosphorus |
| Stockton State(Fred) Lake-14 | Stockton State(Fred) Lake, LMOSTOCK | Phosphorus |
| Atsion Lake-14 | Atsion Lake, MMUATSIO | Phosphorus, Fecal Coliform |
| Indian Mills Brook at Indian Mills | 01409449 | Phosphorus, Fecal Coliform |
| Mullica River at Green Bank | Mullica River at Green Bank | Phosphorus, Fecal Coliform |
| Bass River E Br near New Gretna | 01410150, 14-EBR-1 | Phosphorus, Fecal Coliform, Nitrate |
| Batsto River at Batsto | 01409500, 14-BAT-1 | Phosphorus, Fecal Coliform, Nitrate |

## Table 1
## Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 14

| Station Name/Waterbody | Site ID | Parameters |
|---|---|---|
| Blue Anchor Brook at Elm | 0140940950 | Phosphorus, Fecal Coliform, Nitrate |
| Great Swamp Branch Below Rt 206 near Hammonton | 0140941070 | Phosphorus, Fecal Coliform, Nitrate |
| Mullica River at Outlet Of Atsion Lake at Atsion | 01409387, 14-MUL-2 | Phosphorus, Fecal Coliform, Nitrate |
| Mullica River near Batsto | 0140940050 | Phosphorus, Fecal Coliform, Nitrate |
| Oswego River at Harrisville | 01410000, 14-OSW-1 | Phosphorus, Fecal Coliform, Nitrate |
| Papoose Branch near Sim Place | 01409960 | Phosphorus, Fecal Coliform, Nitrate |
| Pump Branch near Waterford Works | 01409408 | Phosphorus, Fecal Coliform, Nitrate |
| Skit Branch near Hampton Gate | 01409435 | Phosphorus, Fecal Coliform, Nitrate |
| WadIng River W Br at Maxwell | 01409815 | Phosphorus, Fecal Coliform, Nitrate |
| Albertson Branch near Elm | 0140940970 | Phosphorus, Nitrate |
| Batsto River at Hampton Furnace | 01409432 | Phosphorus, Nitrate |
| Batsto River at Quaker Bridge | 01409470 | Phosphorus, Nitrate |
| Clark Branch near Atsion | 0140940480 | Phosphorus, Nitrate |
| Hammonton Creek at Westcoatville | 01409416, 14-HAM-2, 14-HAM-1 | Phosphorus, Nitrate |
| Hays Mill Creek at Atco | 01409401 | Phosphorus, Nitrate |
| Hays Mill Creek near Chesilhurst | 01409402 | Phosphorus, Nitrate |
| LandIng Creek near Egg Harbor | 01409600 | Phosphorus, Nitrate |
| Mullica River at Indian Mills | 01409383 | Phosphorus, Nitrate |
| Mullica River near Atco | 01409375 | Phosphorus, Nitrate |
| Nescochague Creek at Pleasant Mills | 01409411 | Phosphorus, Nitrate |
| Skit Branch at Hampton Furnace | 01409439 | Phosphorus, Nitrate |
| Sleeper Branch near Atsion | 0140940370 | Phosphorus, Nitrate |
| Springers Brook near Hampton Furnace | 01409455 | Phosphorus, Nitrate |
| Tulpehocken Creek near JenkIns | 01409780 | Phosphorus, Nitrate |
| WadIng River W Br at Chatsworth | 01409690 | Phosphorus, Nitrate |
| WadIng River W Br near JenkIns | 01409750 | Phosphorus, Nitrate |

Source: New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d): A Report on the Water Quality In New Jersey Pursuant to The New Jersey Water Quality Planning Act, and Sections 305(b) and 303(d) of the Federal Clean Water Act

**Table 2**
**Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 18**

| Station Name/Waterbody | Site ID | Impairment |
|---|---|---|
| Bell Lake-18 | Greenwood Park Bells Lake | Fecal Coliform |
| Bellmawr Lake-18 | Bellmawr Lake | Fecal Coliform |
| Big Timber Creek N Br at Glendora | 01467359 | Fecal Coliform |
| Big Timber Creek S Br at Blackwood Terrace | 01467329, 18-BIG-1 | Fecal Coliform |
| Big Timber Creek S Br at Glenloch | 01467327 | Fecal Coliform |
| Cooper River at Lindenwold | 01467120 | Fecal Coliform |
| Cooper River N Br at Kresson | 01467155, 18-CO-2 | Fecal Coliform |
| Delaware River Zone 4 | Delaware River Zone 4 | Fecal Coliform |
| Gilman Lake-18 | Lake Gilman | Fecal Coliform |
| Hurff Lake | Hurff Lake | Fecal Coliform |
| Kandle Lake-18 | Lake Kandle | Fecal Coliform |
| Lake Silvestro | Lake Silvestro | Fecal Coliform |
| Oldmans Creek at Jessups Mill | 01477440 | Fecal Coliform |
| Oldmans Creek at Porches Mill | 01477510 | Fecal Coliform |
| Oldmans Creek Lake-18 | Oldmans Creek Lake | Fecal Coliform |
| Pennsauken Creek N Br near Morrestown | 01467069, 18-PE-1, 18-PE-2 | Fecal Coliform |
| Pennsauken Creek S Br at Cherry Hill | 01467081, 18-PE-3 | Fecal Coliform |
| Pine Hill Scout Camp Lake-18 | Camp Pine Hill | Fecal Coliform |
| Raccoon Creek near Swedesboro | 01477120, 18-RAC-1 | Fecal Coliform |
| Still Run near Mickelton | 01476600 | Fecal Coliform |
| Washington Lake-18 | Washington Township Lake | Fecal Coliform |
| Wenonah Lake-18 | Wenonah Lake Playground | Fecal Coliform |
| Big Timber Creek N Br at Glendora | 01467359 | Nitrate |
| Big Timber Creek S Br at Almonesson Rd in Blenheim | EWQ0659 | Nitrate |
| Big Timber Creek S Br at Blackwood Terrace | 01467329, 18-BIG-1 | Nitrate |
| Cooper River at Haddonfield | 01467150, 01467140, 18-CO-4 | Nitrate |
| Cooper River at Kaighn Ave in Camden | 01467191 | Nitrate |
| Cooper River N Br at Kresson | 01467155, 18-CO-2 | Nitrate |
| Edwards Run at Jefferson | 01475090 | Nitrate |
| Mantua Creek at Rt 45 in W. Deptford | 01475045 | Nitrate |
| Newton Creek at Rt 168 in W Collingswood | EWQ0653 | Nitrate |
| Oldmans Creek at Pointers - Auburn Rd in Auburn | EWQ0689 | Nitrate |
| Oldmans Creek at Porches Mill | 01477510 | Nitrate |
| Pennsauken Creek at Rt 130 in Pennsauken | 01467082 | Nitrate |
| Pennsauken Creek N Br near Morrestown | 01467069, 18-PE-1, 18-PE-2 | Nitrate |
| Pennsauken Creek S Br at Cherry Hill | 01467081, 18-PE-3 | Nitrate |
| Raccoon Creek near Swedesboro | 01477120, 18-RAC-1 | Nitrate |
| Still Run near Mickelton | 01476600 | Nitrate |

## Table 2
## Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 18

| Station Name/Waterbody | Site ID | Impairment |
|---|---|---|
| Woodbury Creek at Rt 45, Woodbury Creek Park, in Woodbury | 01474730 | Nitrate |
| Alcyon Lake-18 | Alcyon Lake | Phosphorus |
| Bell Lake-18 | Bell Lake | Phosphorus |
| Bethel Lake-18 | Bethel Lake | Phosphorus |
| Big Timber Creek N Br at Glendora | 01467359 | Phosphorus |
| Big Timber Creek S Br at Almonesson Rd in Blenheim | EWQ0659 | Phosphorus |
| Big Timber Creek S Br at Blackwood Terrace | 01467329, 18-BIG-1 | Phosphorus |
| Blackwood Lake-18 | Blackwood Lake | Phosphorus |
| Cooper River at Kaighn Ave in Camden | 1467191 | Phosphorus |
| Cooper River at Lindenwold | 01467120 | Phosphorus |
| Cooper River Lake-18 | Cooper River Lake | Phosphorus |
| Cooper River N Br at Kresson | 01467155, 18-CO-2 | Phosphorus |
| Evans Lake-18 | Evans Lake | Phosphorus |
| Greenwich Lake-18 | Greenwich Lake | Phosphorus |
| Grenloch Lake-18 | Grenloch Lake | Phosphorus |
| Haddon Lake-18 | Haddon Lake | Phosphorus |
| Harrisonville Lake-18 | Harrisonville Lake | Phosphorus |
| Kirkwood Lake-18 | Kirkwood Lake | Phosphorus |
| Mantua Creek at Rt 45 in W. Deptford | 01475045 | Phosphorus |
| Narriticon Lake-18 | Narriticon Lake | Phosphorus |
| Newton Creek at Rt 168 in W Collingswood | EWQ0653 | Phosphorus |
| Oldmans Creek at Pointers - Auburn Rd in Auburn | EWQ0689 | Phosphorus |
| Oldmans Creek at Porches Mill | 01477510 | Phosphorus |
| Pennsauken Creek at Rt 130 in Pennsauken | 01467082 | Phosphorus |
| Pennsauken Creek N Br near Morrestown | 01467069, 18-PE-1, 18-PE-2 | Phosphorus |
| Pennsauken Creek S Br at Cherry Hill | 01467081, 18-PE-3 | Phosphorus |
| Raccoon Creek near Swedesboro | 01477120, 18-RAC-1 | Phosphorus |
| Still Run near Mickelton | 01476600 | Phosphorus |
| Strawbridge Lake-18 | Strawbridge Lake | Phosphorus |
| Woodbury Creek at Rt 45, Woodbury Creek Park in Woodbury | 01474730 | Phosphorus |
| Woodbury Lake-18 | Woodbury Lake | Phosphorus |
| Cooper River at Haddonfield | 01467150, 01467140, 18-CO-4 | Phosphorus, Fecal Coliform |
| Edwards Run at Jefferson | 01475090 | Phosphorus, Fecal Coliform |
| Big Timber Creek S Br at Turnersville | 01467325 | Phosphorus, Fecal Coliform, Nitrate |
| Big Timber Creek S Br at Glenloch | 01467327 | Phosphorus, Nitrate |
| Oldmans Creek at Jessups Mill | 01477440 | Phosphorus, Nitrate |
| Pargy Creek at Swedesboro Ave in E G | EWQ0677 | Phosphorus, Nitrate |
| Swedes Run at Rt 130 in Delran | EWQ0176 | Phosphorus, Nitrate |

Source: New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d): A Report on the Water Quality In New Jersey Pursuant to The New Jersey Water Quality Planning Act, and Sections 305(b) and 303(d) of the Federal Clean Water Act

## Table 3
## Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 19

| Station Name/Waterbody | Site ID | Parameters |
|---|---|---|
| Birchwood Lake-19 | Birchwood Lakes Beach | Fecal Coliform |
| Blue Lake-19 | Blue Lake Beach | Fecal Coliform |
| Braddocks Millpond-19 | Braddocks Mill Lake | Fecal Coliform |
| Cardinal Ridge-19 | Cardinal Ridge Condos | Fecal Coliform |
| Centennial Lake-19 | Centennial Lake | Fecal Coliform |
| Country Lake-19 | Country Lakes | Fecal Coliform |
| Delanco Camp Lake-19 | Delanco Camp Meeting | Fecal Coliform |
| Flamingo Lake-19 | Clubhouse Marlton Lake Civic Assn., East Lake Marlton Lake Civic Assn. | Fecal Coliform |
| Harmony Lake-19 | Harmony Lake | Fecal Coliform |
| Holly Lake-19 | Holly Lake Association | Fecal Coliform |
| JCC Camp Lake-19 | JCC Camps at Medford | Fecal Coliform |
| Kettle Run-19 | Girl Scouts Kettle Run, WKEGIRLS | Fecal Coliform |
| Lake Coxtoxen-19 | Camp Darkwaters | Fecal Coliform |
| Lake Inawendiwin-19 | Camp Inawendiwin, SFRCAMPI | Fecal Coliform |
| Lake James-19 | Kings Grant | Fecal Coliform |
| Lake Mishe-Mokwa-19 | Medford Lakes Colony Club Beach 3 and Beach 4 | Fecal Coliform |
| Lake Stockwell-19 | Camp Ockanickon Boys, Family, and Pomona | Fecal Coliform |
| Lakeside | Lakeside | Fecal Coliform |
| Lion Tamers Club | Lion Tamers Club | Fecal Coliform |
| Lower Aetna Lake-19 | Medford Lakes Colony Club Beach 1 and Beach 2 | Fecal Coliform |
| Mimosa Lakes-19 | Mimosa Lake Beach | Fecal Coliform |
| Mohegan Lake-19 | Mohegan Lake YMCA Camp Moore, YMCA Camp Moore Family Lake, WHATRYMC | Fecal Coliform |
| Mt. Misery Lake-19 | Methodist Camps, GMOUCAMP | Fecal Coliform |
| Oakwood Lake-19 | Oakwood Lakes | Fecal Coliform |
| Pine Lake-19 | East Lake Pine Colony Club, South Lake Pine Colony Club, Main Lake Pine Colony Club, WHAPINEL | Fecal Coliform |
| Saipe Lake-19 | Medford Pines | Fecal Coliform |
| Shawnee Country Lake-19 | Shawnee Country OSA | Fecal Coliform |
| Sherwood Forest Pond-19 | Sherwood Forest | Fecal Coliform |
| Squaw Lake-19 | Camp Ockanickon Girls, WHATRSQU | Fecal Coliform |
| Sturbridge Lake-19 | Chatham Lake, Foxview Beach | Fecal Coliform |

## Table 3
## Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 19

| Station Name/Waterbody | Site ID | Parameters |
|---|---|---|
| Tamarack Lake-19 | Tamarkack Lake, WHATROAK | Fecal Coliform |
| Taunton Lake-19 | Taunton Lake, WHATAUNL | Fecal Coliform |
| Timber Lake-19 | Timber Lake | Fecal Coliform |
| Union Mill Lake-19 | Union Mill Lake Colony Club | Fecal Coliform |
| Upper Aetna Lake-19 | Medford Lakes Colony Club Beach 5 | Fecal Coliform |
| Wood Lake-19 | Woodlake | Fecal Coliform |
| Pakim Lake-19 | Pakim Lake, GCOPAKIM | Phosphorus |
| Smithville Lake-19 | Smithville Lake | Phosphorus |
| Mirror Lake-19 | Mirror Lake | Phosphorus, Fecal Coliform |
| Presidential Lake-19 | Presidential Lake, GBIPRESU | Phosphorus, Fecal Coliform |
| Rancocas Creek N Br at Browns Mills | 01465970 | Phosphorus, Fecal Coliform |
| Greenwood Branch at New Lisbon Rd | 01466900 | Phosphorus, Fecal Coliform, Nitrate |
| Little Creek at Chairville | 01465893 | Phosphorus, Fecal Coliform, Nitrate |
| McDonalds Branch in Lebanon State Forest | 01466500 | Phosphorus, Fecal Coliform, Nitrate |
| Mount Misery Brook at Upton | 01466100 | Phosphorus, Fecal Coliform, Nitrate |
| Rancocas Creek N Br at Iron Works Park at M | 01467005, 01467006, 01467003, 19-RA-4N | Phosphorus, Fecal Coliform, Nitrate |
| Rancocas Creek N Br at Pemberton | 01467000, 19-RA-3N | Phosphorus, Fecal Coliform, Nitrate |
| Rancocas Creek S Br at Hainesport | Rancocas, EWQ0176S, 19-RA-1S | Phosphorus, Fecal Coliform, Nitrate |
| Rancocas Creek S Br at VIncentown | 01465850, 19-RA-3S | Phosphorus, Fecal Coliform, Nitrate |
| Sharps Run at Rt 541 at Medford | 01465884 | Phosphorus, Fecal Coliform, Nitrate |
| Barton Run at Tuckerton Rd on Hoot Owl Est | EWQ0166 | Phosphorus, Nitrate |
| Indian Run at Birmingham Rd in Pemberton | EWQ0151A | Phosphorus, Nitrate |
| Jade Run at Rt 206 in Vincentown | 01465847 | Phosphorus, Nitrate |
| Mill Creek at Levitt Pkwy in Willingboro | EWQ0175 | Phosphorus, Nitrate |
| Ong Run at West Lake Shore Dr in Pembertor | EWQ0149A | Phosphorus, Nitrate |
| Parkers Creek at Creek Rd in Moorestown | EWQ0174 | Phosphorus, Nitrate |
| Pole Bridge Branch near Browns Mills | 01466200 | Phosphorus, Nitrate |
| Rancocas Creek N Br at Hanover Furnace | 01465950, 19-RA-1N | Phosphorus, Nitrate |
| Rancocas Creek S Br at Ridge Rd in Southam | EWQ0156 | Phosphorus, Nitrate |
| Rancocas Creek SW Br at Rt 70 in Medford | EWQ0169, 19-RA-2S | Phosphorus, Nitrate |

Source: New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d): A Report on the Water Quality In New Jersey Pursuant to The New Jersey Water Quality Planning Act, and Sections 305(b) and 303(d) of the Federal Clean Water Act

## Table 4
## Fecal Coliform and Nutrient Impaired Water Bodies Located in WMA 20

| Station Name/Waterbody | Site ID | Parameters |
|---|---|---|
| Allentown Lake-20 | Allentown Lake | Phosphorus |
| Delaware River Zone 2, Delaware River 02040202-053 | Delaware River Zone 2, Delaware River 02040202-053 | Fecal Coliform |
| Delaware River Zone 3, Delaware River 02040202-043 | Delaware River Zone 3, Delaware River 02040202-043 | Fecal Coliform |
| Liberty Lake-20 | Liberty Lake | Fecal Coliform |
| Crosswicks Creek near New Egypt | 01464420 | Phosphorus |
| Crystal Lake-20 | Crystal Lake | Phosphorus |
| Imlaystown Lake-20 | Imlaystown Lake | Phosphorus |
| Lower Sylvan Lake-20 | Lower Sylvan Lake | Phosphorus |
| Oakford Lake-20 | Oakford Lake | Phosphorus |
| Prospertown Lake-20 | Prospertown Lake | Phosphorus |
| Spring Lake-20 | Spring Lake | Phosphorus |
| Upper Sylvan Lake-20 | Sylvan Lake | Phosphorus, Fecal Coliform |
| Annaricken Brook near Jobstown | 01464578 | Phosphorus, Fecal Coliform, Nitrate |
| Bacons Creek near Mansfield Square | 01464529 | Phosphorus, Fecal Coliform, Nitrate |
| Barkers Brook N Br near Jobstown | 01464583 | Phosphorus, Fecal Coliform, Nitrate |
| Blacks Creek at Chesterfield - Georgetown Rd | 01464527 | Phosphorus, Fecal Coliform, Nitrate |
| Crosswicks Creek at Extonville | 01464500, 20-CRO-1 | Phosphorus, Fecal Coliform, Nitrate |
| Crosswicks Creek at Groveville Rd at Groveville | 01464504, 20-CRO-2 | Phosphorus, Fecal Coliform, Nitrate |
| Crosswicks Creek at Walnford Rd in Upper Freehold | 2 | Phosphorus, Fecal Coliform, Nitrate |
| Crosswicks Creek near New Egypt | 01464420 | Phosphorus, Fecal Coliform, Nitrate |
| Doctors Creek at Allentown | 01464515 | Phosphorus, Fecal Coliform, Nitrate |
| Doctors Creek at Route 539 in Upper Freehold | 3 | Phosphorus, Fecal Coliform, Nitrate |
| Lahaway Creek At Rt 537 At Mercerville | 01464440 | Phosphorus, Fecal Coliform, Nitrate |
| North Run at Cookstown | 01464380 | Phosphorus, Fecal Coliform, Nitrate |

Source: New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report (305(b) and 303(d): A Report on the Water Quality In New Jersey Pursuant to The New Jersey Water Quality Planning Act, and Sections 305(b) and 303(d) of the Federal Clean Water Act

# APPENDIX E

## Elmwood Effluent Quality Monitoring Data (2004-2005)

Joe Rizzitello JB

## EVESHAM MUNICIPAL UTILITIES AUTHORITY

# RECLAIMED WATER FOR BENEFICIAL REUSE ON THE INDIAN SPRINGS GOLF COURSE AND ON THE LANDSCAPED AREAS OF THE ELMWOOD WASTEWATER TREATMENT FACILITY

## OPERATIONS PROTOCOL

OUR FILE NO. M-140-261
APRIL 24, 2000

RECEIVED
Burlington County

MAR 2 4 2004

DEPARTMENT OF
RESOURCE CONSERVATION

C:\WINDOWS\TEMP\EMUARWBROPERPROTOCOL.DOC

The purpose of this document is to provide the operators of the Elmwood Wastewater Treatment Facility guidance to ensure that only reuse water meeting the applicable standards is released to the Indian Springs Golf Course or the treatment facility's landscaped areas. The applicable standards are contained in Table III-A-1 of the facility's NJPDES permit, a copy of which is included as Appendix A of this document.

For the most part, these standards continue the discharge limitations which the plant has been meeting for discharge into the Rancocas Creek. To ensure proper disinfection, however, the total suspended solids concentration prior to chlorination must be less than 5 mg/L and a chlorine concentration of 1.0 mg/L or more must be maintained for at least fifteen minutes prior to beneficial reuse. These parameters must be continuously monitored and signals from the analyses must disable the reclaimed water pump if the limitations are exceeded. A fecal coliform concentration of 2.2/100 mL (weekly median) must not be exceeded. This limit is increased to 14.0/100 mL for any one sample per month.

To provide the continuous analysis required for TSS, a turbidimeter has been installed in the effluent trough of the treatment facility's sand filters. The turbidimeter does not directly measure suspended solids. A calibration for suspended solids and turbidity was performed, however, and turbidity values can now be used to ensure low solids concentrations. The results of the calibration runs, as shown in Appendix B, determined that the maximum turbidity allowable prior to distribution for beneficial reuse is ______ NTU. This value must be programmed into the central monitoring and control system so that the reclaimed water pump is disabled whenever the value is exceeded.

Likewise, the chlorine residual analyzer must be programmed so that if the residual concentration immediately prior to dechlorination is less than 1.0 mg/L, the reclaimed water pump is deactivated. The intent of requiring a TSS concentration of less than 5 mg/L and chlorine residual at least equal to 1.0 mg/L is to ensure full disinfection prior to beneficial reuse. These two parameters must be continuously monitored with automatic shutoff of the reclaimed water pump for concentrations out of the desired range enabled at all times.

The Elmwood operating staff must also be aware that it is their duty to be alert for other exceedences of the limitations listed in Table III-A-1 and their effect on the beneficial reuse program. Any time it is suspected that a violation of one or more of these limitations may occur, the reclaimed water pump must be manually switched off and not switched back to automatic before it is certain that all limitations are being met. In the event that routine laboratory analyses show a limitation exceedence, the pump must be switched off and not switched back to automatic until two subsequent tests show the effluent is once again in compliance.

It is anticipated that the reclaimed water pump will be activated at times when the Elmwood plant is not attended. Since irrigation of the golf course is normally conducted between midnight and dawn, the pump will be called upon to refill the irrigation supply pond prior to the arrival of operating personnel. The continuous turbidity and chlorine residual monitors will ensure that proper conditions exist for adequate disinfection prior to beneficial reuse. The operating personnel, as part of their normal surveillance routine, should observe the conditions of the influent and all process tanks upon arrival at the plant and immediately prior to departure at the end of the day. If there is any evidence of illegal discharges in the influent or substandard operating conditions in the process tanks, the reclaimed water pump must be switched off and not switched back to automatic until it is confirmed that the reclaimed water is in full compliance with Table III-A-1.

This procedure should also be followed any time a process unit is taken out of service and a degradation of effluent quality is possible as a result.

Operating personnel must be aware that the reclaimed water system is a cooperative effort between the EMUA and Evesham Township. It is their responsibility, therefore, to notify the golf course superintendent any time that reclaimed water pump is switched off. Likewise, notification should also be provided once beneficial reuse can be resumed. It is expected that less coordination will be required for the irrigation of the Elmwood landscaped areas with reclaimed water. It should be noted, however, that the reclaimed water will also not be available for the Elmwood plant whenever it is not available for the golf course.

*WDS/das*

**Surface Water WCR - Semi Annual Reporting Requirements:**

Submit a Semi-Annual WCR: within twenty-five days after the end of every 6 month monitoring period beginning from the effective date of the permit (EDP).

**Table III - A - 3: Surface Water WCR - Semi Annual Limits and Monitoring Requirements**

February - July
August - January

| Parameter | Compliance Quantity | Units | Sample Type | Monitoring Period | Phase | Quantification Limit |
|---|---|---|---|---|---|---|
| Zinc,<br>Total Recoverable | REPORT | UG/L | 24 Hour Composite | January thru December | Final | 30<br>Rec Quant Level |
| Copper,<br>Total Recoverable | REPORT | UG/L | 24 Hour Composite | January thru December | Final | 10<br>Rec Quant Level |

## RWBR BENEFICIAL REUSE SW

### Location Description

Specific requirements for monitoring beneficial reuse can be found in Part IV. Approved public access sites can be found in Appendix B.

### Discharge Categories

Sanitary Wastewater

**Surface Water WCR - Monthly Reporting Requirements:**

Submit a Monthly WCR: within twenty-five days after the end of every month beginning from the effective date of the permit (EDP).

**Table III - B - 1: Surface Water WCR - Monthly Limits and Monitoring Requirements**

| Parameter | Compliance Quantity | Units | Sample Type | Monitoring Period | Phase | Quantification Limit |
|---|---|---|---|---|---|---|
| Flow, In Conduit or Thru Treatment Plant | REPORT | MGD | Metered | January thru December | Final | |
| Solids, Total Suspended | REPORT | MG/L | Grab | January thru December | Final | |
| Coliform, Fecal General | REPORT | #/100ML | Grab | January thru December | Final | |
| Chlorine Produced Oxidants | REPORT | UG/L | Continuous | January thru December | Final | |
| Turbidity | REPORT | NTU | Continuous | January thru December | Final | |

a. The permittee may request a minor modification for a reduction in monitoring frequency for a non-limited parameter when four consecutive test results of "not detected" have occurred using the specified QL.

2. **Causes for modification**

   a. Pursuant to N.J.A.C. 7:14A-6.2(a)(10)(iii), the Department may modify or revoke and reissue any permit to incorporate limitations or requirements to control the discharge of toxic pollutants, including whole effluent, chronic and acute toxicity requirements, chemical specific limitations or toxicity reduction requirements, as applicable.

   b. The Department may incorporate requirements to file monitoring data required by this permit electronically through a minor modification in accordance with N.J.A.C. 7:14A-16.5(a)1.

   c. The permittee may request a minor modification to eliminate the monitoring requirements associated with a discharge authorized by this permit when the discharge ceases due to changes at the facility.

## H. Custom Requirement

1. **Reclaimed Water for Beneficial reuse (RWBR) Public Access**

   a. RWBR Submittal Requirements: the following are required of the permittee.

      i. The permittee must maintain an Operations Protocol as detailed in the Department's "Technical Manual for Reclaimed Water for Beneficial Reuse" (Reuse Guidance Manual).

      ii. The permittee must maintain an Engineering Report as detailed in the Department's Reuse Guidance Manual, to spray irrigate effluent at the sites listed in Appendix B, Public Access Sites.

      iii. The permittee shall submit a copy of the Reuse Supplier and User Agreement with each request to the Department for authorization to distribute water for reuse.

      iv. Submit a Beneficial Reuse Annual Report: by February 1 of each year beginning from the effective date of the permit (EDP). The permittee shall compile the total volume of reuse water distributed to each authorized reuse site for the previous calendar year. Specific requirements for the annual report are identified in the Reuse Guidance Manual.

      v. Any changes and/or revisions to the Operations Protocol shall be submitted to the Department for approval prior to implementation.

      vi. All submittals shall be mailed or delivered to: New Jersey Department of Environmental Protection, Division of Water Quality, Bureau of Point Source Permitting Region 2, PO Box 029, Trenton, New Jersey 08625.

2. **RWBR Operational Requirements**

   a. The following operational requirements are applicable when distributing effluent to the sites listed in Appendix B, Public Access Sites.

      i. The permittee shall not place the reuse system into operation until the Department approves the Operations Protocol.

      ii. The application of beneficial reuse water shall not produce surface runoff or ponding.

      iii. All setback distances shall be consistent with the requirements of the Reuse Guidance Manual.

      iv. The public shall be notified of the distribution of RWBR at each site. This shall be accomplished by publication of a notice in a local newspaper and the posting of advisory signs designating the nature of the project area where beneficial reuse is practiced, consistent with the requirements of the Reuse Guidance Manual.

v. No cross connections to potable water systems shall be allowed.

vi. All beneficial reuse water valves and outlets shall be appropriately tagged or labeled to warn the public and employees that the water is not intended for drinking.

vii. All piping, pipelines, valves and outlets shall be color coded, or otherwise marked, to differentiate reclaimed water from domestic or other water, as detailed in the Reuse Guidance Manual.

viii. A daily log noting the volume of water supplied and where it is being distributed shall be maintained on-site by the permittee and made available to the Department upon request.

ix. No other beneficial reuse sites are authorized, other those listed in Appendix B, Public Access Sites, without additional Departmental approval.

x. Any truck used to transport and/or distribute water for reuse shall be appropriately marked and shall not be used to transport water or other fluid that does not meet, at a minimum, all limitations and requirements as specified in this permit for water diverted for ruse unless the tank has been emptied and adequately cleaned prior to the addition of RWBR.

3. **RWBR Effluent Monitoring and Reporting Requirements**

a. In addition to the effluent limitations contained in Part III for DSN 001A, the following limitations and monitoring requirements are applicable for RWBR.

i. All water not meeting the high level treatment requirements for reuse included herein or the operational requirements in the approved Operations Protocol shall be diverted for discharge to surface waters as otherwise specified in this permit.

ii. The hydraulic loading rate when spray irrigating RWBR shall not exceed a maximum annual average of 2 inches per week.

b. Any water diverted for reuse from DSN 001A shall comply with the requirements for DSN 001A in Part III of this permit. Additionally, the reuse outfall (RWBR) shall be monitored and shall comply with the high level treatment requirements and limitations listed below and the operational requirements in the approved Operations Protocol. If any of these limitations or requirements are not met, the effluent shall be diverted for discharge to surface waters through outfall 001A.

i. Total Suspended Solids: Instantaneous maximum of 5.0 mg/L.

ii. Fecal Coliform: 7-day median maximum of 2.2/100 mL and an instantaneous maximum of 14/100 mL.

iii. Chlorine Produced Oxidants (CPO): Instantaneous minimum of 1.0 mg/L after fifteen minutes contact time at peak hourly flow.

c. Monitoring of the water to be distributed for beneficial reuse shall be conducted in the following manner.

i. Flow monitoring shall be continuous.

ii. The monitoring frequency for Total Suspended Solids (TSS) shall be three per month and shall be monitored before the chlorine contact tank.

iii. The monitoring frequency for turbidity shall be continuous and shall be monitored before the chlorine contact tank.

iv. The monitoring frequency for fecal coliform shall three per month and shall be monitored in the chlorine contact chamber at the effluent weir before dechlorination.

v. The monitoring frequency for CPO shall be continuous and shall be monitored in the chlorine contact chamber at the effluent weir before dechlorination.

d. All monitoring results of the RWBR shall be reported each month on the Water Characterization Report (Monthly WCR).

i. The value reported for flow shall be the total volume of all the water distributed for beneficial reuse during the month. Flow sampling for DSN 001A shall be performed prior to diverting effluent for beneficial reuse. Flow monitoring for RWBR shall be of the water actually diverted for reuse.

ii. The values reported for TSS, turbidity, ~~nitrogen~~ and fecal coliform shall be the highest sampling result obtained during the reporting month.

iii. The value reported for CPO shall be the minimum sampling result obtained during the reporting month.

4. **Removal or Modification of Final WQBEL for Phosphorus**

a. The Department will consider a modification request proposing to modify or remove the final water quality based total phosphorus effluent limitation from the permit if the following study(ies) is (are) submitted in accordance with items b. through d. below. Studies that will be considered by the Department include a limiting nutrient analysis and/or use impairment evaluation that have been prepared in accordance with the Department guidance document entitled: "Technical Manual for Phosphorus Evaluation for NJPDES DSW Permits." This document may be downloaded from the Department's website at www.state.nj.us/dep/dwq/techman.htm.

b. On or before the effective date of the permit (EDP) + two (2) months, the permittee must notify the Department in writing, whether the intention is to proceed towards attainment of the new WQBEL phosphorus limitation or to pursue the option to undertake and submit the study(ies) and report(s) specified in item "a." above. Should the permittee choose not to pursue the option to undertake and submit the study(ies) and report(s) specified in item "a." above, the final WQBEL for phosphorus will become effective at EDP + 59 months.

   i. Submit a letter of intent: within 60 days from the effective date of the permit (EDP).

c. Studies listed in item a. above are required to have a work plan approved by the Department prior to commencing and are to be submitted to the Department.

d. If the permittee has chosen to pursue the option to undertake and submit the study(ies) and report(s) specified in item "a." above, the permittee must submit the workplan: within 90 days of the effective date of the permit (EDP). The Department intends to respond to the workplan submittals within two months of their receipt from the permittee.

e. If the permittee has chosen to pursue the option to undertake and submit the study(ies) and report(s) specified in item "a." above, the information shall be submitted to the Department no later than EDP + 24 months.

f. The Department will begin an administrative review of the submitted information from item a. above within thirty days of receipt from the permittee. In the event that the request for modification/removal of the WQBEL, after the review of the material submitted in response to items a., c. and d. above is justified, it is the intent of the Department to draft the appropriate permit action within 90 days of its final determination.

g. In the event that the permittee has notified the Department of its intent not to pursue the option to undertake the studies listed in a. above, or the request for modification/removal of the WQBEL is denied after review of the materials submitted in response to items a., c. and d. above, the permittee shall submit to the Department, beginning after receipt of the denial, or if not pursuing the optional studies at EDP + 12 months, semi annual progress reports detailing the progress made towards meeting the phosphorus limitation that becomes effective on EDP + 59 months.

**EVESHAM**
**MUNICIPAL UTILITIES AUTHORITY**
*"Working with you to Protect the Environment"*

February 10, 2004

**CERTIFIED MAIL**

State of New Jersey
Department of Environmental Protection
Division of Water Quality
Bureau of Point Source Permitting Region 2
P.O. Box 029
Trenton, NJ 08625-0029
Attn: Mr. Joseph Mannick

Re: Revised 2003 Annual Reuse Report

Dear Mr. Mannick:

In 2003, the Elmwood Wastewater Treatment Facility, NJ0024031, had a total influent flow of 691.020 MG and a total effluent flow of 783.712 MG. Of the 783.712 MG of treated effluent, 11.3292 MG or 1.45 % of the total effluent flow was diverted to Indian Spring Golf Course, reuse site # R01. The maximum monthly average flow over the past twelve months was 145,265 gallons per day, which occurred in July. There were zero gallons pumped to reuse site # R02, Elmwood Wastewater Treatment Facility, because the infrastructure to distribute the reclaimed water was not in place.

The Evesham Municipal Utilities Authority also utilized final treated effluent for sewer jetting and street sweeping throughout the township. In 2003, 108,260 gallons or 0.014 % of the total effluent flow was used for those purposes.

I can be reached at (856) 983 – 0331 x25 should you require further information.

*Office Location*
984 Tuckerton Road, Room 211 • P.O. Box 467 • Evesham, New Jersey 08053
Phone: 856-983-1878 • Fax: 856-983-9145

*Plant Location*
Elmwood Road WWTF • Evesham, New Jersey 08053

Sincerely,

Joseph V. Rizzuto
Laboratory Manager
Evesham Municipal Utilities Authority

cc: Louis D. Russo, EMUA Executive Director
Rocco J. Maiellano, EMUA Operations Manager
Rich Martin, EMUA Operations Supervisor

PI 46311

New Jersey Department of Environmental Protection
Division of Water Quality

## Surface Water Discharge Monitoring Report Submittal Form

| NJPDES PERMIT | MONITORING PERIOD | MONITORED LOCATION: |
|---|---|---|
| NJ0024031 | Month 5 Day 1 Year 2003 To Month 5 Day 31 Year 2003 | 001A - Sanitary Wastewater |

**PERMITTEE:**
EVESHAM MUNICIPAL UTILITIES
AUTHORITY
PO BOX 467
984 TUCKERTON RD
MARLTON, NJ 08053

**LOCATION OF ACTIVITY:**
ELMWOOD WTP
N ELMWOOD RD
MARLTON, NJ 08053-0000

**REPORT RECIPIENT:**
EVESHAM MUA
PO BOX 467
MARLTON, NJ 08053

**REGION / COUNTY: Southern / Burlington County**

**CHECK IF APPLICABLE:** ☐ **No Discharge this Monitoring Period** ☒ **Monitoring Report Comments Attached**

**WHO MUST SIGN** The highest ranking official having day-to-day managerial and operational responsibilities for the discharging facility shall sign the certification or, in his absence a person designated by that person. For a local agency, the highest ranking operator of the treatment works shall sign the certification. Where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that reponsibility or person designated by that person shall also sign the second certification at the bottom of this page. If the local agency has contracted with another entity to operate the treatment works, the highest-ranking official of the contracted entity shall sign the certification.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and/or imprisonment, pursuant to N.J.A.C. 7:14A-6.9(B). The New Jersey Water Pollution Control Act provides for penalties up to $50,000 per violation.

Rocco J. Maiellano, Operations Manager
**NAME AND TITLE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

S.4498
**GRADE AND REGISTRY NUMBER (IF APPLICABLE)**

**SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

6-16-03
**DATE**

856.983.0331
**AREA CODE/PHONE NUMBER**

**For a local agency where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that responsibility or person designated by that person shall sign the following certification:*

I certify under penalty of law and in accordance with N.J.S.A. 58:10A-6F(5) that I have received and reviewed the attached discharge monitoring reports.

Louis D. Russo, Executive Director
**NAME AND TITLE**

**SIGNATURE**

6/17/03
**DATE**

856.983.1081
**AREA CODE/PHONE NUMBER**

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| **NJ0024031** | **001A Sanitary Wastewater** | **5/1/2003 TO 5/31/2003** | **ELMWOOD WTP** |

| PARAMETER | ☒ | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Flow, In Conduit or Thru Treatment Plant**<br>50050 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2.147 | 2.894 | MGD | ****** | ****** | ****** | ****** | 0 | CONTIN | CONTIN |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01DAMX | | ****** | ****** | ****** | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1650 | 2057 | KG/DAY | ****** | 210 | 200 | MG/L | 0 | 1/week | comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 18 | 21 | KG/DAY | ****** | 2 | 3 | MG/L | 0 | 1/week | comp24 |
| | PERMIT REQUIREMENT | 113<br>01MOAV | 169<br>01WKAV | | ****** | 10<br>01MOAV | 15<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 98 | ****** | ****** | PERCENT | 0 | 1/week | calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85<br>01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| pH<br>00400 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.90 | ****** | 7.60 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | ****** | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| pH<br>00400 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.90 | ****** | 7.40 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 6.0<br>01RPMN | ****** | 9.0<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*Pre-Print Creation Date: 4/1/2003*

| PERMIT NUMBER: | MONITORED LOCATION: | MONITORING PERIOD: | FACILITY NAME: |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 5/1/2003 TO 5/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total<br>(as CaCO3)<br>00410 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 106 | 114 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOAV | REPORT<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 2.6 | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | 5.0<br>01RPINMX | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 2316 | 4508 | KG/DAY | ****** | 293 | 572 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 10 | 13 | KG/DAY | ****** | 1 | 2 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | 113<br>01MOAV | 169<br>01WKAV | | ****** | 10<br>01MOAV | 15<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 99 | ****** | ****** | PERCENT | 0 | 1/week | Calctd |
| | PERMIT REQUIREMENT | ****** | ****** | | 85<br>01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| Oil and Grease<br>00556 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <5 | <5 | MG/L | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 10<br>01MOAV | 15<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*PERMIT NUMBER:* **NJ0024031**

*MONITORED LOCATION:* **001A Sanitary Wastewater**

*MONITORING PERIOD:* **5/1/2003 TO 5/31/2003**

*FACILITY NAME:* **ELMWOOD WTP**

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia<br>Total (as N)<br>00610 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 6 | 23 | KG/DAY | ****** | 0.7 | 2.9 | MG/L | 0 | 1/week | comp24 |
| | PERMIT REQUIREMENT | 18<br>01MOAV | 45<br>01DAMX | | ****** | 1.6<br>01MOAV | 4.0<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Kjeldahl<br>Total (as N)<br>00625 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 15 | 33 | KG/DAY | ****** | 2 | 4 | MG/L | 0 | 1/week | comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Enterococci: Group D<br>Mf Trans, M-e, Eia<br>31639 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <10 | <10 | #/100ML | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOGE | REPORT<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Dissolved (TDS)<br>70295 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2416 | 2642 | KG/DAY | ****** | 306 | 340 | MG/L | 0 | 1/week | comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Nitrate<br>Total (as NO3)<br>71850 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 15 | 33 | KG/DAY | ****** | 1.8 | 4.0 | MG/L | 0 | 8/month* | comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 2.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Coliform, Fecal<br>General<br>74055 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 2 | 13 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 2.2<br>01WKME | 14<br>01RPINMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |

Nitrogen, Nitrate, 71850, Effluent gross value analyzed 8 times in May 2003 for optimal plant performance.

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*PERMIT NUMBER:* NJ0024031

*MONITORED LOCATION:* 001A Sanitary Wastewater

*MONITORING PERIOD:* 5/1/2003 TO 5/31/2003

*FACILITY NAME:* ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coliform, Fecal<br>General<br>74055 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 3 | 12 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 200<br>01MOGE | 400<br>01MOMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |
| LC50 Stat 96hr Acu<br>Pimephales<br>TAB6C 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | CODE N | ****** | ****** | %EFFL | 0 | 1/Quarter | Comp |
| | PERMIT REQUIREMENT | ****** | ****** | | 94<br>01RPMN | ****** | ****** | | | 1/Quarter | COMPOS |
| | MDL | | | | | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | 1.01 | ****** | ****** | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 1.0<br>01RPINMN | ****** | ****** | | | 2/Day | GRAB |
| | MDL | | | | 0.1 | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | <0.8 | <1.10 | KG/DAY | ****** | <0.1 | <0.1 | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | 0.07<br>01MOAV | 0.23<br>01DAMX | | ****** | 0.006<br>01MOAV | 0.02<br>01DAMX | | | 2/Day | GRAB |
| | MDL | 1.14 | 1.14 | | | 0.1 | 0.1 | | | | |
| Temperature,<br>oC<br>00010 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 15.8 | 17.4 | 19.5 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| Temperature,<br>oC<br>00010 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 16.7 | 18.1 | 19.6 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

CODE N = LC50, TAB6C, Effluent gross value

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*PERMIT NUMBER:* NJ0024031

*MONITORED LOCATION:* 001A Sanitary Wastewater

*MONITORING PERIOD:* 5/1/2003 TO 5/31/2003

*FACILITY NAME:* ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity<br>00070 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 2.75 | NTU | 0 | contin | Contin. |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | REPORT<br>01RPINMX | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| Oxygen, Dissolved<br>(DO)<br>00300 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 8.3 | 8.3 | ****** | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 5.0<br>01DAMN | 6.5<br>01WKAVMN | ****** | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Phosphorus, Total<br>(as P)<br>00665 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 1.0 | 1.0 | KG/DAY | ****** | 0.13 | 0.2 | MG/L | 0 | 1/week | Comp 24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 1.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Lab Certification #<br>99999 99<br>Lab | SAMPLE MEASUREMENT | PA166 | 03055 | | | | | | | | |
| | PERMIT REQUIREMENT | REPORT<br>Lab # | REPORT<br>Lab # | | REPORT<br>Lab # | REPORT<br>Lab # | REPORT<br>Lab # | | | Not Applic | NOT AP |
| | MDL | | | | | | | | | | |

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PI 46311

New Jersey Department of Environmental Protection
Division of Water Quality

## Surface Water Discharge Monitoring Report Submittal Form

| NJPDES PERMIT | MONITORING PERIOD | | | | | | | MONITORED LOCATION: |
|---|---|---|---|---|---|---|---|---|
| | Month | Day | Year | | Month | Day | Year | |
| NJ0024031 | 6 | 1 | 2003 | To | 6 | 30 | 2003 | 001A - Sanitary Wastewater |

**PERMITTEE:**
EVESHAM MUNICIPAL UTILITIES
AUTHORITY
PO BOX 467
984 TUCKERTON RD
MARLTON, NJ 08053

**LOCATION OF ACTIVITY:**
ELMWOOD WTP
N ELMWOOD RD
MARLTON, NJ 08053-0000

**REPORT RECIPIENT:**
EVESHAM MUA
PO BOX 467
MARLTON, NJ 08053

**REGION / COUNTY: Southern / Burlington County**

CHECK IF APPLICABLE: ☐ **No Discharge this Monitoring Period** ☒ **Monitoring Report Comments Attached**

WHO MUST SIGN The highest ranking official having day-to-day managerial and operational responsibilities for the discharging facility shall sign the certification or, in his absence a person designated by that person. For a local agency, the highest ranking operator of the treatment works shall sign the certification. Where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that reponsibility or person designated by that person shall also sign the second certification at the bottom of this page. If the local agency has contracted with another entity to operate the treatment works, the highest-ranking official of the contracted entity shall sign the certification.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and/or imprisonment, pursuant to N.J.A.C. 7:14A-6.9(B). The New Jersey Water Pollution Control Act provides for penalties up to $50,000 per violation.

Rocco J. Maiellano, Operations Manager
NAME AND TITLE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR

S-4498
GRADE AND REGISTRY NUMBER (IF APPLICABLE)

Rocco J
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR

7-17-03
DATE

856.983.0331
AREA CODE/PHONE NUMBER

**For a local agency where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that responsibility or person designated by that person shall sign the following certification:*

I certify under penalty of law and in accordance with N.J.S.A. 58:10A-6F(5) that I have ~~received~~ and reviewed the attached discharge monitoring reports.

Louis D. Russo, Executive Director
NAME AND TITLE

SIGNATURE

7/18/03
DATE

856.983.1081
AREA CODE/PHONE NUMBER

# Surface Water Discharge Monitoring Report

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| **NJ0024031** | **001A Sanitary Wastewater** | **6/1/2003 TO 6/30/2003** | **ELMWOOD WTP** |

| PARAMETER | ☒ | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow, In Conduit or Thru Treatment Plant<br>50050 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2.360 | 2.786 | MGD | ****** | ****** | ****** | ****** | 0 | CONTIN | CONTIN |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01DAMX | | ****** | ****** | ****** | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1520 | 1810 | KG/DAY | ****** | 172 | 220 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 15 | 17 | KG/DAY | ****** | 2 | 2 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | 113<br>01MOAV | 169<br>01WKAV | | ****** | 10<br>01MOAV | 15<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 99 | ****** | ****** | PERCENT | 0 | 1/week | Calctd |
| | PERMIT REQUIREMENT | ****** | ****** | | 85<br>01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| pH<br>00400 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.9 | ****** | 7.5 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | ****** | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| pH<br>00400 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.9 | ****** | 7.4 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 6.0<br>01RPMN | ****** | 9.0<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*Pre-Print Creation Date: 4/1/2003*

## Surface Water Discharge Monitoring Report

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| **NJ0024031** | **001A Sanitary Wastewater** | **6/1/2003 TO 6/30/2003** | **ELMWOOD WTP** |

| PARAMETER | ☒ | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total<br>(as CaCO3)<br>00410 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | | ****** | 94 | 100 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | ****** | ****** | ****** | ****** | REPORT<br>01MOAV | REPORT<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | | ****** | ****** | 1.8 | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | ****** | ****** | ****** | 5.0<br>01RPINMX | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1332 | 2633 | KG/DAY | ****** | 154 | 320 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 9 | 10 | KG/DAY | ****** | <1 | <1 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 113<br>01MOAV | 169<br>01WKAV | | ****** | 10<br>01MOAV | 15<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | | 99 | ****** | ****** | PERCENT | 0 | 1/week | Calctd |
| | PERMIT REQUIREMENT | ****** | ****** | ****** | 85<br>01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| Oil and Grease<br><br>00556 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | | ****** | <5 | <5 | MG/L | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | ****** | ****** | 10<br>01MOAV | 15<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |

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*PERMIT NUMBER:* **NJ0024031**

*MONITORED LOCATION:* **001A Sanitary Wastewater**

*MONITORING PERIOD:* **6/1/2003 TO 6/30/2003**

*FACILITY NAME:* **ELMWOOD WTP**

| PARAMETER | ☒ | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia<br>Total (as N)<br>00610 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 4 | 8 | KG/DAY | ****** | 0.5 | 0.8 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 18<br>01MOAV | 45<br>01DAMX | | ****** | 1.6<br>01MOAV | 4.0<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Kjeldahl<br>Total (as N)<br>00625 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 17 | 23 | KG/DAY | ****** | 2 | 3 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Enterococci: Group D<br>Mf Trans, M-e, Eia<br>31639 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <10 | <10 | #/100ML | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOGE | REPORT<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Dissolved (TDS)<br>70295 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2613 | 2803 | KG/DAY | ****** | 294 | 313 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Nitrate<br>Total (as NO3)<br>71850 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 15 | 22 | KG/DAY | ****** | 1.8 | 2.4 | MG/L | 0 | 10/month | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 2.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Coliform, Fecal<br>General<br>74055 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 1 | 1 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 2.2<br>01WKME | 14<br>01RPINMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |

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| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 6/1/2003 TO 6/30/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coliform, Fecal<br>General<br>74055 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 2 | 9 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 200<br>01MOGE | 400<br>01MOMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |
| LC50 Stat 96hr Acu<br>Pimephales<br>TAB6C 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | CODE N | ****** | ****** | %EFFL | 0 | 1/Quarter | comp |
| | PERMIT REQUIREMENT | ****** | ****** | | 94<br>01RPMN | ****** | ****** | | | 1/Quarter | COMPOS |
| | MDL | | | | | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | 1.01 | ****** | ****** | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 1.0<br>01RPINMN | ****** | ****** | | | 2/Day | GRAB |
| | MDL | | | | 0.1 | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | <0.9 | <1.05 | KG/DAY | ****** | <0.1 | <0.1 | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | 0.07<br>01MOAV | 0.23<br>01DAMX | | ****** | 0.006<br>01MOAV | 0.02<br>01DAMX | | | 2/Day | GRAB |
| | MDL | 1.14 | 1.14 | | | 0.1 | 0.1 | | | | |
| Temperature,<br>oC<br>00010 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 16.6 | 19.0 | 21.7 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| Temperature,<br>oC<br>00010 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 17.7 | 20.1 | 23.0 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

CODE N = LC50, TAB6C, Effluent Gross value

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*PERMIT NUMBER:* **NJ0024031**

*MONITORED LOCATION:* **001A Sanitary Wastewater**

*MONITORING PERIOD:* **6/1/2003 TO 6/30/2003**

*FACILITY NAME:* **ELMWOOD WTP**

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Turbidity**<br>00070 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 2.7 | NTU | 0 | CONTIN | CONTIN. |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | REPORT<br>01RPINMX | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| Oxygen, Dissolved<br>(DO)<br>00300 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.8 | 8.5 | ****** | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 5.0<br>01DAMN | 6.5<br>01WKAVMN | ****** | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Phosphorus, Total<br>(as P)<br>00665 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 0.6 | 0.9 | KG/DAY | ****** | 0.07 | 0.09 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 1.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Lab Certification #<br>99999 99<br>Lab | SAMPLE MEASUREMENT | PA166 | 03055 | | | | | | | | |
| | PERMIT REQUIREMENT | REPORT<br>Lab # | REPORT<br>Lab # | | REPORT<br>Lab # | REPORT<br>Lab # | REPORT<br>Lab # | | | Not Applic | NOT AP |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

New Jersey Department of Environmental Protection
Division of Water Quality

PI 46311

## Surface Water Discharge Monitoring Report Submittal Form

| NJPDES PERMIT | MONITORING PERIOD | | | | | | | MONITORED LOCATION: |
|---|---|---|---|---|---|---|---|---|
| | Month | Day | Year | | Month | Day | Year | |
| NJ0024031 | 7 | 1 | 2003 | To | 7 | 31 | 2003 | 001A - Sanitary Wastewater |

**PERMITTEE:**
EVESHAM TWP MUA
984 TUCKERTON TD
PO BOX 467
MARLTON, NJ 08053

**LOCATION OF ACTIVITY:**
ELMWOOD WTP
N ELMWOOD RD
MARLTON, NJ 08053-0000

**REPORT RECIPIENT:**
EVESHAM MUA
PO BOX 467
MARLTON, NJ 08053

REGION / COUNTY: **Southern / Burlington County**

CHECK IF APPLICABLE: ☐ **No Discharge this Monitoring Period** ☒ **Monitoring Report Comments Attached**

WHO MUST SIGN The highest ranking official having day-to-day managerial and operational responsibilities for the discharging facility shall sign the certification or, in his absence a person designated by that person. For a local agency, the highest ranking operator of the treatment works shall sign the certification. Where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that reponsibility or person designated by that person shall also sign the second certification at the bottom of this page. If the local agency has contracted with another entity to operate the treatment works, the highest-ranking official of the contracted entity shall sign the certification.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and/or imprisonment, pursuant to N.J.A.C. 7:14A-6.9(B). The New Jersey Water Pollution Control Act provides for penalties up to $50,000 per violation.

Rocco J. Marcellano, Operations Manager
**NAME AND TITLE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

S-4498
**GRADE AND REGISTRY NUMBER (IF APPLICABLE)**

**SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

8-20-03
**DATE**

856-983-0331
**AREA CODE/PHONE NUMBER**

**For a local agency where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that responsibility or person designated by that person shall sign the following certification:*

I certify under penalty of law and in accordance with N.J.S.A. 58:10A-6F(5) that I have received and reviewed the attached discharge monitoring reports.

Louis D. Russo, Executive Director
**NAME AND TITLE**

**SIGNATURE**

8/21/03
**DATE**

856-983-1081
**AREA CODE/PHONE NUMBER**

# Surface Water Discharge Monitoring Report

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 7/1/2003 TO 7/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow, In Conduit or Thru Treatment Plant | SAMPLE MEASUREMENT | 1.987 | 2.355 | MGD | ****** | ****** | ****** | ****** | 0 | CONTIN | CONTIN |
| 50050 1 Effluent Gross Value | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01DAMX | | ****** | ****** | ****** | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC) | SAMPLE MEASUREMENT | 1940 | 2340 | KG/DAY | ****** | 252 | 300 | MG/L | 0 | 1/week | comp |
| 00310 G Raw Sew/influent | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC) | SAMPLE MEASUREMENT | 28 | 38 | KG/DAY | ****** | 4 | 5 | MG/L | 0 | 1/week | comp |
| 00310 1 Effluent Gross Value | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC) | SAMPLE MEASUREMENT | ****** | ****** | ****** | 98 | ****** | ****** | PERCENT | 0 | 1/week | calctd |
| 00310 K Percent Removal | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| pH | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.00 | ****** | 7.40 | SU | 0 | 2/Day | Grab |
| 00400 G Raw Sew/Influent | PERMIT REQUIREMENT | ****** | ****** | | REPORT 01RPMN | ****** | REPORT 01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| pH | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.00 | ****** | 7.50 | SU | 0 | 2/Day | Grab |
| 00400 1 Effluent Gross Value | PERMIT REQUIREMENT | ****** | ****** | | 6.0 01RPMN | ****** | 9.0 01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

# Surface Water Discharge Monitoring Report

PI 463

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 7/1/2003 TO 7/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total<br>(as CaCO3)<br>00410 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 97 | 103 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT 01MOAV | REPORT 01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | <1 | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | 5.0 01RPINMX | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 G<br>Raw Sew/Influent | SAMPLE MEASUREMENT | 2371 | 3280 | KG/DAY | ****** | 304 | 432 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 8 | 9 | KG/DAY | ****** | 1 | 1 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 99 | ****** | ****** | PERCENT | 0 | 1/week | calctd |
| | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| Oil and Grease<br><br>00556 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <5 | <5 | MG/L | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 10 01MOAV | 15 01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*Pre-Print Creation Date: 7/2/2003*

# Surface Water Discharge Monitoring Report

PI 4631

| PERMIT NUMBER: | MONITORED LOCATION: | MONITORING PERIOD: | FACILITY NAME: |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 7/1/2003 TO 7/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia<br>Total (as N)<br>00610 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 7 | 26 | KG/DAY | ****** | 0.9 | 3.5 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 18<br>01MOAV | 45<br>01DAMX | | ****** | 1.6<br>01MOAV | 4.0<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Kjeldahl<br>Total (as N)<br>00625 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 14 | 30 | KG/DAY | ****** | 2 | 4 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Enterococci: Group D<br>Mf Trans, M-e, Eia<br>31639 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <10 | <10 | #/100ML | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOGE | REPORT<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Dissolved (TDS)<br>70295 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2382 | 2715 | KG/DAY | ****** | 309 | 348 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Nitrate<br>Total (as NO3)<br>71850 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 15 | 25 | KG/DAY | ****** | 2.0 | 3.15 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 2.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Coliform, Fecal<br>General<br>74055 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 2 | 14 | #/100ML | 0 | 18/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 2.2<br>01WKME | 14<br>01RPINMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |

Fecal coliform, 74055, Beneficial reuse sampled 18 times for optimal plant performance

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*Pre-Print Creation Date: 7/2/2003*

# Surface Water Discharge Monitoring Report

PI 4631

*PERMIT NUMBER:* NJ0024031

*MONITORED LOCATION:* 001A Sanitary Wastewater

*MONITORING PERIOD:* 7/1/2003 TO 7/31/2003

*FACILITY NAME:* ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coliform, Fecal<br>General<br>74055 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 5 | 12 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 200<br>01MOGE | 400<br>01MOMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |
| LC50 Stat 96hr Acu<br>Pimephales<br>TAB6C 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | >100 | ****** | ****** | %EFFL | 0 | 1/Quarter | comp |
| | PERMIT REQUIREMENT | ****** | ****** | | 94<br>01RPMN | ****** | ****** | | | 1/Quarter | COMPOS |
| | MDL | | | | | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | 1.01 | ****** | ****** | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 1.0<br>01RPINMN | ****** | ****** | | | 2/Day | GRAB |
| | MDL | | | | 0.1 | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | <0.8 | <0.9 | KG/DAY | ****** | <0.1 | <0.1 | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | 0.07<br>01MOAV | 0.23<br>01DAMX | | ****** | 0.006<br>01MOAV | 0.02<br>01DAMX | | | 2/Day | GRAB |
| | MDL | 1.14 | 1.14 | | | 0.1 | 0.1 | | | | |
| Temperature,<br>oC<br>00010 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 19.7 | 21.7 | 23.6 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| Temperature,<br>oC<br>00010 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 20.2 | 23.0 | 24.9 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

# Surface Water Discharge Monitoring Report

PI 4631

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 7/1/2003 TO 7/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 2.4 | NTU | 0 | CONTIN | CONTIN |
| 00070 @<br>Beneficial Reuse | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | REPORT 01RPINMX | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| Oxygen, Dissolved<br>(DO) | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.5 | 7.7 | ****** | MG/L | 0 | 1/week | Grab |
| 00300 1<br>Effluent Gross Value | PERMIT REQUIREMENT | ****** | ****** | | 5.0 01DAMN | 6.5 01WKAVMN | ****** | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Phosphorus, Total<br>(as P) | SAMPLE MEASUREMENT | 0.8 | 1.2 | KG/DAY | ****** | 0.10 | 0.13 | MG/L | 0 | 1/week | Comp |
| 00665 1<br>Effluent Gross Value | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | 1.0 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Lab Certification # | SAMPLE MEASUREMENT | PA166 | 03055 | | | | | | | | |
| 99999 99<br>Lab | PERMIT REQUIREMENT | REPORT Lab # | REPORT Lab # | | REPORT Lab # | REPORT Lab # | REPORT Lab # | | | Not Applic | NOT AP |
| | MDL | | | | | | | | | | |

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*Pre-Print Creation Date: 7/2/2003*

PI 46311

New Jersey Department of Environmental Protection
Division of Water Quality

# Surface Water Discharge Monitoring Report Submittal Form

| NJPDES PERMIT | MONITORING PERIOD | | | | | | | MONITORED LOCATION: |
|---|---|---|---|---|---|---|---|---|
| | Month | Day | Year | | Month | Day | Year | |
| NJ0024031 | 8 | 1 | 2003 | To | 8 | 31 | 2003 | 001A - Sanitary Wastewater |

**PERMITTEE:**
EVESHAM TWP MUA
984 TUCKERTON TD
PO BOX 467
MARLTON, NJ 08053

**LOCATION OF ACTIVITY:**
ELMWOOD WTP
N ELMWOOD RD
MARLTON, NJ 08053-0000

**REPORT RECIPIENT:**
EVESHAM MUA
PO BOX 467
MARLTON, NJ 08053

**REGION / COUNTY: Southern / Burlington County**

**CHECK IF APPLICABLE:** ☐ **No Discharge this Monitoring Period** ☒ **Monitoring Report Comments Attached**

WHO MUST SIGN The highest ranking official having day-to-day managerial and operational responsibilities for the discharging facility shall sign the certification or, in his absence a person designated by that person. For a local agency, the highest ranking operator of the treatment works shall sign the certification. Where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that reponsibility or person designated by that person shall also sign the second certification at the bottom of this page. If the local agency has contracted with another entity to operate the treatment works, the highest-ranking official of the contracted entity shall sign the certification.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and/or imprisonment, pursuant to N.J.A.C. 7:14A-6.9(B). The New Jersey Water Pollution Control Act provides for penalties up to $50,000 per violation.

Rocio J. Maiellano, Operations Manager
**NAME AND TITLE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

S 4498
**GRADE AND REGISTRY NUMBER (IF APPLICABLE)**

**SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

9/23/03
**DATE**

856.983.0331
**AREA CODE/PHONE NUMBER**

***For a local agency where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that responsibility or person designated by that person shall sign the following certification:**

I certify under penalty of law and in accordance with N.J.S.A. 58:10A-6F(5) that I have received and reviewed the attached discharge monitoring reports.

Louis D. Russo, Executive Director
**NAME AND TITLE**

**SIGNATURE**

9/23/03
**DATE**

856.983.0381
**AREA CODE/PHONE NUMBER**

# Surface Water Discharge Monitoring Report

| *PERMIT NUMBER:* | *MONITORED LOCATION:* | *MONITORING PERIOD:* | *FACILITY NAME:* |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 8/1/2003 TO 8/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow, In Conduit or Thru Treatment Plant<br>50050 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 1.988 | 2.223 | MGD | ****** | ****** | ****** | ****** | 0 | CONTIN. | CONTIN. |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01DAMX | | ****** | ****** | ****** | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1476 | 1822 | KG/DAY | ****** | 197 | 250 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 31 | 35 | KG/DAY | ****** | 4 | 5 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 97 | ****** | ****** | PERCENT | 0 | 1/week | calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| pH<br>00400 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.00 | ****** | 7.40 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT 01RPMN | ****** | REPORT 01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| pH<br>00400 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.00 | ****** | 7.50 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 6.0 01RPMN | ****** | 9.0 01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*Pre-Print Creation Date: 7/2/2003*

| PERMIT NUMBER: | MONITORED LOCATION: | MONITORING PERIOD: | FACILITY NAME: |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 8/1/2003 TO 8/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total<br>(as CaCO3)<br>00410 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 98 | 106 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT 01MOAV | REPORT 01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 1.0 | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | 5.0 01RPINMX | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1615 | 2098 | KG/DAY | ****** | 217 | 288 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 7 | 8 | KG/DAY | ****** | 1.0 | 1.0 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 99 | ****** | ****** | PERCENT | 0 | 1/week | calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| Oil and Grease<br>00556 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <5 | <5 | MG/L | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 10 01MOAV | 15 01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |

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| | MONITORED LOCATION: | MONITORING PERIOD: | FACILITY NAME: |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 8/1/2003 TO 8/31/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia<br>Total (as N)<br>00610 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 3 | 7 | KG/DAY | ****** | 0.44 | 1.00 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | 18<br>01MOAV | 45<br>01DAMX | | ****** | 1.6<br>01MOAV | 4.0<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Kjeldahl<br>Total (as N)<br>00625 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 13 | 17 | KG/DAY | ****** | 2 | 2 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Enterococci: Group D<br>Mf Trans, M-e, Eia<br>31639 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <10 | <10 | #/100ML | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOGE | REPORT<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Dissolved (TDS)<br>70295 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2147 | 2494 | KG/DAY | ****** | 286 | 338 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Nitrate<br>Total (as NO3)<br>71850 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 13 | 18 | KG/DAY | ****** | 1.8 | 2.2 | MG/L | 0 | 1/week | Comp24 |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 2.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Coliform, Fecal<br>General<br>74055 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 2 | 23 | #/100ML | 3* | 13/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 2.2<br>01WKME | 14<br>01RPINMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |

*Coliform, Fecal, 74055, Beneficial reuse case#'s 03-08-06-1320-07 of #25; 03-08-20-1608-23 of #21; 03-08-27-1344-16 of

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FACILITY NAME:

001A Sanitary Wastewater | 8/1/2003 TO 8/31/2003 | ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coliform, Fecal<br>General<br>74055 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 9 | 17 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 200<br>01MOGE | 400<br>01MOMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |
| LC50 Stat 96hr Acu<br>Pimephales<br>TAB6C 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | CODE N | ****** | ****** | %EFFL | 0 | 1/Quarter | Comp. |
| | PERMIT REQUIREMENT | ****** | ****** | | 94<br>01RPMN | ****** | ****** | | | 1/Quarter | COMPOS |
| | MDL | | | | | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | 1.08 | ****** | ****** | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 1.0<br>01RPINMN | ****** | ****** | | | 2/Day | GRAB |
| | MDL | | | | 0.1 | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | <0.8 | <0.8 | KG/DAY | ****** | <0.1 | <0.1 | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | 0.07<br>01MOAV | 0.23<br>01DAMX | | ****** | 0.006<br>01MOAV | 0.02<br>01DAMX | | | 2/Day | GRAB |
| | MDL | 1.14 | 1.14 | | | 0.1 | 0.1 | | | | |
| Temperature,<br>oC<br>00010 G<br>Raw Sew/Influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 21.7 | 23.0 | 24.4 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| Temperature,<br>oC<br>00010 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 22.3 | 24.1 | 25.4 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

CODE N = LC50, TAB6C, Effluent Gross Value

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FACILITY NAME:

001A Sanitary Wastewater 8/1/2003 TO 8/31/2003 **ELMWOOD WTP**

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | SAMPLE MEASUREMENT | ****** | ****** | | ****** | ****** | 2.15 | | 0 | CONTIN. | CONTIN. |
| 00070 @<br>Beneficial Reuse | PERMIT REQUIREMENT | ****** | ****** | ****** | ****** | ****** | REPORT<br>01RPINMX | NTU | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| Oxygen, Dissolved<br>(DO) | SAMPLE MEASUREMENT | ****** | ****** | | 7.0 | 7.5 | ****** | | 0 | 1/week | Grab |
| 00300 1<br>Effluent Gross Value | PERMIT REQUIREMENT | ****** | ****** | ****** | 5.0<br>01DAMN | 6.5<br>01WKAVMN | ****** | MG/L | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Phosphorus, Total<br>(as P) | SAMPLE MEASUREMENT | 0.5 | 0.7 | | ****** | 0.06 | 0.09 | | 0 | 1/week | comp24 |
| 00665 1<br>Effluent Gross Value | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | KG/DAY | ****** | 1.0<br>01MOAV | REPORT<br>01WKAV | MG/L | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Lab Certification # | SAMPLE MEASUREMENT | PA166 | 03055 | | | | | | | | |
| 99999 99<br>Lab | PERMIT REQUIREMENT | REPORT<br>Lab # | REPORT<br>Lab # | | REPORT<br>Lab # | REPORT<br>Lab # | REPORT<br>Lab # | | | Not Applic | NOT AP |
| | MDL | | | | | | | | | | |

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*Pre-Print Creation Date: 7/2/2003*

Division of Water Quality

## Surface Water Discharge Monitoring Report Submittal Form

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **NJPDES PERMIT** | **MONITORING PERIOD** | | | | | | | **MONITORED LOCATION:** |
| **NJ0024031** | **Month** | **Day** | **Year** | To | **Month** | **Day** | **Year** | **001A - Sanitary Wastewater** |
| | **9** | **1** | **2003** | | **9** | **30** | **2003** | |

**PERMITTEE:**
EVESHAM TWP MUA
984 TUCKERTON TD
PO BOX 467
MARLTON, NJ 08053

**LOCATION OF ACTIVITY:**
ELMWOOD WTP
N ELMWOOD RD
MARLTON, NJ 08053-0000

**REPORT RECIPIENT:**
EVESHAM MUA
PO BOX 467
MARLTON, NJ 08053

**REGION / COUNTY: Southern / Burlington County**

**CHECK IF APPLICABLE:** ☐ **No Discharge this Monitoring Period** ☒ **Monitoring Report Comments Attached**

WHO MUST SIGN The highest ranking official having day-to-day managerial and operational responsibilities for the discharging facility shall sign the certification or, in his absence a person designated by that person. For a local agency, the highest ranking operator of the treatment works shall sign the certification. Where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that reponsibility or person designated by that person shall also sign the second certification at the bottom of this page. If the local agency has contracted with another entity to operate the treatment works, the highest-ranking official of the contracted entity shall sign the certification.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and/or imprisonment, pursuant to N.J.A.C. 7:14A-6.9(B). The New Jersey Water Pollution Control Act provides for penalties up to $50,000 per violation.

Rocco J. Maiellano, Operations Manager
NAME AND TITLE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR

S-4498
GRADE AND REGISTRY NUMBER (IF APPLICABLE)

Rocco J Mai
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR

10-18-03
DATE

856.983.0331
AREA CODE/PHONE NUMBER

**For a local agency where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that responsibility or person designated by that person shall sign the following certification:*

I certify under penalty of law and in accordance with N.J.S.A. 58:10A-6F(5) that I have ~~received~~ and reviewed the attached discharge monitoring reports.

Louis D. Russo, Executive Director
NAME AND TITLE

SIGNATURE

10/20/03
DATE

856.983.1081
AREA CODE/PHONE NUMBER

| | | MONITORING PERIOD: | FACILITY NAME: |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 9/1/2003 TO 9/30/2003 | ELMWOOD WTP |

| PARAMETER | ☒ | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow, In Conduit or<br>Thru Treatment Plant<br>50050 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2.062 | 2.338 | MGD | ****** | ****** | ****** | ****** | 0 | CONTIN. | CONT IN. |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01DAMX | | ****** | ****** | ****** | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1509 | 1962 | KG/DAY | ****** | 196 | 245 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 24 | 35 | KG/DAY | ****** | 3 | 4 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 113<br>01MOAV | 169<br>01WKAV | | ****** | 10<br>01MOAV | 15<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 98 | ****** | ****** | PERCENT | 0 | 1/week | Calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85<br>01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| pH<br>0400 G<br>aw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.60 | ****** | 7.50 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | ****** | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| H<br>0400 1<br>ffluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.80 | ****** | 7.50 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 6.0<br>01RPMN | ****** | 9.0<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

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*-Print Creation Date: 7/2/2003*

MONITORING PERIOD: FACILITY NAME:

NJ0024031 001A Sanitary Wastewater 9/1/2003 TO 9/30/2003 ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total<br>(as CaCO3)<br>00410 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 84 | 89 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT 01MOAV | REPORT 01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 1.10 | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | 5.0 01RPINMX | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1570 | 3172 | KG/DAY | ****** | 202 | 396 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 8 | 8 | KG/DAY | ****** | <1 | <1 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 97 | ****** | ****** | PERCENT | 0 | 1/week | calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| il and Grease<br>0556 1<br>ffluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <5 | <5 | MG/L | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 10 01MOAV | 15 01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |

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*Print Creation Date: 7/2/2003*

| | | MONITORING PERIOD: | FACILITY NAME: |
|---|---|---|---|
| NJ0024031 | 001A Sanitary Wastewater | 9/1/2003 TO 9/30/2003 | ELMWOOD WTP |

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia<br>Total (as N)<br>00610 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 3 | 4 | KG/DAY | ****** | 0.3 | 0.5 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 18<br>01MOAV | 45<br>01DAMX | | ****** | 1.8<br>01MOAV | 4.0<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Kjeldahl<br>Total (as N)<br>00625 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 11 | 19 | KG/DAY | ****** | 1 | 2 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Enterococci: Group D<br>Mf Trans, M-e, Eia<br>31639 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <10 | <10 | #/100ML | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOGE | REPORT<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Dissolved (TDS)<br>70295 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2289 | 2547 | KG/DAY | ****** | 297 | 318 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Nitrate<br>Total (as NO3)<br>71850 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 17 | 22 | KG/DAY | ****** | 2.1* | 2.8 | MG/L | 1 | 7/mnth | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 2.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Coliform, Fecal<br>General<br>74055 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 1 | 5 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 2.2<br>01WKME | 14<br>01RPINMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |

Nitrogen, Nitrate Total (as NO3), 71850, Effluent gross value case# 03-09-30-1035-37 Op. #04

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e-Print Creation Date: 7/2/2003

NJ0024031 | 001A Sanitary Wastewater | 9/1/2003 TO 9/30/2003 | FACILITY NAME: ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coliform, Fecal<br>General<br>74055 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 4 | 7 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 200<br>01MOGE | 400<br>01MOMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |
| LC50 Stat 96hr Acu<br>Pimephales<br>TAB6C 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | CODE N | ****** | ****** | %EFFL | 0 | 1/Quarter | Comp |
| | PERMIT REQUIREMENT | ****** | ****** | | 94<br>01RPMN | ****** | ****** | | | 1/Quarter | COMPOS |
| | MDL | | | | | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | 1.0 | ****** | ****** | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 1.0<br>01RPINMN | ****** | ****** | | | 2/Day | GRAB |
| | MDL | | | | 0.1 | | | | | | |
| hlorine Produced<br>xidants<br>CPOX 1<br>ffluent Gross Value | SAMPLE MEASUREMENT | <0.8 | <0.9 | KG/DAY | ****** | <0.1 | <0.1 | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | 0.07<br>01MOAV | 0.23<br>01DAMX | | ****** | 0.006<br>01MOAV | 0.02<br>01DAMX | | | 2/Day | GRAB |
| | MDL | 1.14 | 1.14 | | | 0.1 | 0.1 | | | | |
| emperature,<br>C<br>0010 G<br>aw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 19.4 | 22.0 | 23.8 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| mperature,<br><br>010 1<br>fluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 18.6 | 22.7 | 24.2 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

C50, TAB6C, Effluent gross value > code N

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FACILITY NAME:

NJ0024031 001A Sanitary Wastewater 9/1/2003 TO 9/30/2003 ELMWOOD WTP

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | 2.5 | NTU | 0 | CONT. | CONT. |
| 00070 @<br>Beneficial Reuse | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | REPORT<br>01RPINMX | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| Oxygen, Dissolved<br>(DO) | SAMPLE MEASUREMENT | ****** | ****** | ****** | 7.5 | 7.6 | ****** | MG/L | 0 | 1/week | Grab |
| 00300 1<br>Effluent Gross Value | PERMIT REQUIREMENT | ****** | ****** | | 5.0<br>01DAMN | 6.5<br>01WKAVMN | ****** | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Phosphorus, Total<br>(as P) | SAMPLE MEASUREMENT | 0.4 | 0.5 | KG/DAY | ****** | 0.05 | 0.06 | MG/L | 0 | 1/week | comp. |
| 00665 1<br>Effluent Gross Value | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 1.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Lab Certification # | SAMPLE MEASUREMENT | PA166 | 03055 | | | | | | | | |
| 99999 99<br>Lab | PERMIT REQUIREMENT | REPORT<br>Lab # | REPORT<br>Lab # | | REPORT<br>Lab # | REPORT<br>Lab # | REPORT<br>Lab # | | | Not Applic | NOT AP |
| | MDL | | | | | | | | | | |

omments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact oseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

Division of Water Quality

## Surface Water Discharge Monitoring Report Submittal Form

| NJPDES PERMIT | MONITORING PERIOD | MONITORED LOCATION: |
|---|---|---|
| NJ0024031 | Month 10, Day 1, Year 2003 To Month 10, Day 31, Year 2003 | 001A - Sanitary Wastewater |

**PERMITTEE:**
EVESHAM TWP MUA
984 TUCKERTON TD
PO BOX 467
MARLTON, NJ 08053

**LOCATION OF ACTIVITY:**
ELMWOOD WTP
260 N ELMWOOD RD
MARLTON, NJ 08053-0000

**REPORT RECIPIENT:**
EVESHAM MUA
PO BOX 467
MARLTON, NJ 08053

**REGION / COUNTY: Southern / Burlington County**

**CHECK IF APPLICABLE:** ☐ **No Discharge this Monitoring Period** ☒ **Monitoring Report Comments Attached**

WHO MUST SIGN The highest ranking official having day-to-day managerial and operational responsibilities for the discharging facility shall sign the certification or, in his absence a person designated by that person. For a local agency, the highest ranking operator of the treatment works shall sign the certification. Where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that reponsibility or person designated by that person shall also sign the second certification at the bottom of this page. If the local agency has contracted with another entity to operate the treatment works, the highest-ranking official of the contracted entity shall sign the certification.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and/or imprisonment, pursuant to N.J.A.C. 7:14A-6.9(B). The New Jersey Water Pollution Control Act provides for penalties up to $50,000 per violation.

Rocco J Maiellano, Operations Manager
**NAME AND TITLE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

S-4498
**GRADE AND REGISTRY NUMBER (IF APPLICABLE)**

Rocco J Maiellano
**SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER, AUTHORIZED AGENT, OR *LICENSED OPERATOR**

11/17/03
**DATE**

856-983-0331
**AREA CODE/PHONE NUMBER**

**For a local agency where the highest ranking operator does not have the ability to authorize capital expenditures and hire personnel, a person having that responsibility or person designated by that person shall sign the following certification:*

I certify under penalty of law and in accordance with N.J.S.A. 58:10A-6F(5) that I have received and reviewed the attached discharge monitoring reports.

Louis D. Russo, Executive Director
**NAME AND TITLE**

**SIGNATURE**

11/21/03
**DATE**

856-983-1081
**AREA CODE/PHONE NUMBER**

| PARAMETER | ☒ | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow, In Conduit or<br>Thru Treatment Plant<br>50050 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2.078 | 2.547 | MGD | ****** | ****** | ****** | ****** | 0 | CONTIN. | CONTIN. |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01DAMX | | ****** | ****** | ****** | | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1363 | 1964 | KG/DAY | ****** | 178 | 258 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 17 | 21 | KG/DAY | ****** | 2 | 3 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| BOD, 5-Day (20 oC)<br>00310 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 98 | ****** | ****** | PERCENT | 0 | 1/week | Calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| pH<br>00400 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.80 | ****** | 7.50 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT 01RPMN | ****** | REPORT 01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| pH<br>00400 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 6.80 | ****** | 7.40 | SU | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 6.0 01RPMN | ****** | 9.0 01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

Comments: Your monitoring report forms have been converted to the Department's new N. J. Environmental Management System (NJEMS). If there are any questions in regards to this form, please contact Joseph Mannick of BPSP-Region 2 at (609) 292-4860 or via email at jmannick@dep.state.nj.us.

*Pre-Print Creation Date: 10/1/2003*

*Pre-Print Creation Date:*

NJ0024031 001A Sanitary Wastewater 10/1/2003 TO 10/31/2003 **ELMWOOD WTP**

| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity, Total<br>(as CaCO3)<br>00410 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 89 | 95 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT 01MOAV | REPORT 01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | ****** | <1 | MG/L | 0 | 1/week | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | ****** | 5.0 01RPINMX | | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | 1036 | 1974 | KG/DAY | ****** | 135 | 256 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT 01MOAV | REPORT 01WKAV | | ****** | REPORT 01MOAV | REPORT 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 8 | 8 | KG/DAY | ****** | 1 | 1 | MG/L | 0 | 1/week | comp |
| | PERMIT REQUIREMENT | 113 01MOAV | 169 01WKAV | | ****** | 10 01MOAV | 15 01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Suspended<br>00530 K<br>Percent Removal | SAMPLE MEASUREMENT | ****** | ****** | ****** | 99 | ****** | ****** | PERCENT | 0 | 1/week | calctd. |
| | PERMIT REQUIREMENT | ****** | ****** | | 85 01MOAVMN | ****** | ****** | | | 1/Week | CALCTD |
| | MDL | | | | | | | | | | |
| Oil and Grease<br>00556 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <5 | <5 | MG/L | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 10 01MOAV | 15 01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |

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| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen, Ammonia<br>Total (as N)<br>00610 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2 | 5 | KG/DAY | ****** | 0.2 | 0.6 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | 18<br>01MOAV | 45<br>01DAMX | | ****** | 1.6<br>01MOAV | 4.0<br>01DAMX | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Kjeldahl<br>Total (as N)<br>00625 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 9 | 13 | KG/DAY | ****** | 1 | 2 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Enterococci: Group D<br>Mf Trans, M-e, Eia<br>31639 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | <10 | <10 | #/100ML | 0 | 1/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | REPORT<br>01MOGE | REPORT<br>01RPINMX | | | 1/Month | GRAB |
| | MDL | | | | | | | | | | |
| Solids, Total<br>Dissolved (TDS)<br>70295 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 2279 | 2390 | KG/DAY | ****** | 297 | 314 | MG/L | 0 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | REPORT<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Nitrogen, Nitrate<br>Total (as NO3)<br>71850 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | 21 | 30 | KG/DAY | ****** | 2.70 | 3.8 | MG/L | 1 | 1/week | Comp |
| | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | | ****** | 2.0<br>01MOAV | REPORT<br>01WKAV | | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Coliform, Fecal<br>General<br>74055 @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 1 | 1 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 2.2<br>01WKME | 14<br>01RPINMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |

Nitrogen, Nitrate Total (as NO3), 71850, Effluent gross value monthly average 2.70 mg/L limit = 2.0 mg/L.
case # 03-10-31-1455-11 op. #23.

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| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coliform, Fecal<br>General<br>74055 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | ****** | 1 | 1 | #/100ML | 0 | 4/month | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | ****** | 200<br>01MOGE | 400<br>01MOMX | | | 4/Month | GRAB |
| | MDL | | | | | | | | | | |
| LC50 Stat 96hr Acu<br>Pimephales<br>TAB6C 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | CODE N | ****** | ****** | %EFFL | 0 | 1/Quarter | Comp |
| | PERMIT REQUIREMENT | ****** | ****** | | 94<br>01RPMN | ****** | ****** | | | 1/Quarter | COMPOS |
| | MDL | | | | | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX @<br>Beneficial Reuse | SAMPLE MEASUREMENT | ****** | ****** | ****** | 1.0 | ****** | ****** | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | 1.0<br>01BPINMN | ****** | ****** | | | 2/Day | GRAB |
| | MDL | | | | 0.1 | | | | | | |
| Chlorine Produced<br>Oxidants<br>*CPOX 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | <0.8 | <1.0 | KG/DAY | ****** | <0.1 | <0.1 | MG/L | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | 0.07<br>01MOAV | 0.23<br>01DAMX | | ****** | 0.006<br>01MOAV | 0.02<br>01DAMX | | | 2/Day | GRAB |
| | MDL | 1.14 | 1.14 | | | 0.1 | 0.1 | | | | |
| Temperature,<br>oC<br>00010 G<br>Raw Sew/influent | SAMPLE MEASUREMENT | ****** | ****** | ****** | 17.2 | 19.9 | 21.8 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |
| Temperature,<br>oC<br>00010 1<br>Effluent Gross Value | SAMPLE MEASUREMENT | ****** | ****** | ****** | 17.9 | 20.1 | 21.8 | DEG.C | 0 | 2/Day | Grab |
| | PERMIT REQUIREMENT | ****** | ****** | | REPORT<br>01RPMN | REPORT<br>01MOAV | REPORT<br>01RPMX | | | 2/Day | GRAB |
| | MDL | | | | | | | | | | |

CODE N = LC50, TAB6C, Effluent gross value.

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| PARAMETER | | QUANTITY OR LOADING | | UNITS | QUALITY OR CONCENTRATION | | | UNITS | NO. EX. | FREQ. OF ANALYSIS | SAMPLE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | SAMPLE MEASUREMENT | ****** | ****** | | ****** | ****** | 2.4 | | 0 | CONTIN | CONTIN. |
| 00070 @<br>Beneficial Reuse | PERMIT REQUIREMENT | ****** | ****** | ****** | ****** | ****** | REPORT<br>01RPINMX | NTU | | Continuous | CONTIN |
| | MDL | | | | | | | | | | |
| Oxygen, Dissolved<br>(DO) | SAMPLE MEASUREMENT | ****** | ****** | | 7.5 | 8.5 | ****** | | 0 | 1/week | Grab |
| 00300 1<br>Effluent Gross Value | PERMIT REQUIREMENT | ****** | ****** | ****** | 5.0<br>01DAMN | 6.5<br>01WKAVMN | ****** | MG/L | | 1/Week | GRAB |
| | MDL | | | | | | | | | | |
| Phosphorus, Total<br>(as P) | SAMPLE MEASUREMENT | 0.6 | 1 | | ****** | 0.08 | 0.1 | | 0 | 1/week | comp |
| 00665 1<br>Effluent Gross Value | PERMIT REQUIREMENT | REPORT<br>01MOAV | REPORT<br>01WKAV | KG/DAY | ****** | 1.0<br>01MOAV | REPORT<br>01WKAV | MG/L | | 1/Week | COMP24 |
| | MDL | | | | | | | | | | |
| Lab Certification # | SAMPLE MEASUREMENT | PA166 | 03055 | | | | | | | | |
| 99999 99<br>Lab | PERMIT REQUIREMENT | REPORT<br>Lab # | REPORT<br>Lab # | | REPORT<br>Lab # | REPORT<br>Lab # | REPORT<br>Lab # | | | Not Applic | NOT AP |
| | MDL | | | | | | | | | | |

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# APPENDIX F

## Analytical Summary Tables

### Table 1:
### Surface Water Analytical Summary Table
### Indian Springs Golf Course
### Evesham Township, Burlington County, New Jersey
### (all analytical data in mg/L)

| Sample Location | Date | Water Quality Parameters | | | | | |
|---|---|---|---|---|---|---|---|
| | | Chemical Oxygen Demand | | Nitrate - Nitrogen | | Total Phosphorus | |
| | | Sample | Sample Duplicate | Sample | Sample Duplicate | Sample | Sample Duplicate |
| **IS P1** | 04/22/04 | 9.6 | 10.5 | 1.1 | 1.2 | 1.4 | 0.94 |
| | 06/17/04 | 127.7 | 128.3 | 0.3 | 0.1 | 1.12 | 1.32 |
| | 08/13/04 | 109.8 | 103.2 | 0.3 | 0.4 | 1.38 | 1.32 |
| | 10/11/04 | 38.6 | 28.8 | 0.6 | 0.6 | 0.77 | 0.75 |
| | 12/18/04 | 67.7 | 63.4 | 0.2 | 0.2 | 0.9 | 0.87 |
| | 02/19/05 | 120.6 | 116.6 | 0.3 | 0.3 | 0.05 | 0.07 |
| | 04/02/05 | 14.4 | 18 | 5.2 | 5.2 | 0.59 | 0.69 |
| **IS P2** | 04/22/04 | 12.3 | 12.4 | 0.9 | 0.97 | 0.63 | 0.66 |
| | 06/17/04 | 128.7 | 124 | 0.8 | 0.5 | 1.75 | 1.69 |
| | 08/13/04 | 95.2 | 87.8 | 0.8 | 0.8 | 0.54 | 0.51 |
| | 10/11/04 | 22 | 21.4 | 0.7 | 0.6 | 1.05 | 1.15 |
| | 12/18/04 | 53.6 | 56.4 | 0.3 | 0.3 | 0.8 | 0.63 |
| | 02/19/05 | 128.8 | 120.4 | 0.3 | 0.3 | 0.05 | 0.07 |
| | 04/02/05 | 18.2 | 18 | 0.7 | 0.7 | 0.37 | 0.31 |
| **IS P3A** | 04/22/04 | 15.5 | 22.5 | 1.5 | 1.48 | 1.48 | 1 |
| | 06/17/04 | 130.4 | 128 | 0.7 | 0.4 | 1.37 | 1.42 |
| | 08/13/04 | 75.8 | 73.6 | 0.4 | 0.4 | 1.64 | 1.57 |
| | 10/11/04 | 9.4 | 9.2 | 0.2 | 0.2 | 1.15 | 1.2 |
| | 12/18/04 | 37 | 46.3 | 0.2 | 0.2 | 0.82 | 0.78 |
| | 02/19/05 | 105.6 | 93 | 0.1 | 0.1 | 0.08 | 0.06 |
| | 04/02/05 | 7.3 | 6.2 | 0.9 | 0.9 | 0.47 | 0.44 |
| **IS P3B** | 04/22/04 | 20.5 | 17.3 | 1.6 | 1.59 | 1.6 | 1.66 |
| | 06/17/04 | 122 | 125 | 0.65 | 0.7 | 1.05 | 0.98 |
| | 08/13/04 | 72.6 | 77.8 | 0.4 | 0.6 | 0.41 | 0.39 |
| | 10/11/04 | 14.9 | 14 | 0.4 | 0.3 | 0.96 | 0.95 |
| | 12/18/04 | 46.6 | 38.6 | 0.4 | 0.5 | 1.1 | 0.92 |
| | 02/19/05 | 92.6 | 88.8 | 0.2 | 0.2 | 0.05 | 0.04 |
| | 04/02/05 | 7.3 | 7.7 | 1.7 | 1.7 | 0.46 | 0.66 |

## Table 2:
## Surface Water Analytical Summary Table
## Medford Lakes Country Club
## Medford Lakes, Burlington County, New Jersey
## (all analytical data in mg/L)

| Sample Location | Date | Water Quality Parameters | | | | | |
|---|---|---|---|---|---|---|---|
| | | Chemical Oxygen Demand | | Nitrate - Nitrogen | | Total Phosphorus | |
| | | Sample | Sample Duplicate | Sample | Sample Duplicate | Sample | Sample Duplicate |
| **ML P1** | 04/22/04 | 41.1 | 43.3 | 0.3 | 0.4 | 0.77 | 0.75 |
| | 06/17/04 | 145.8 | 144.2 | 0.7 | 0.6 | 0.46 | 0.39 |
| | 08/13/04 | 77.2 | 85.2 | 1.8 | 1.6 | 0.72 | 0.7 |
| | 10/11/04 | 22.8 | 21.4 | 1.9 | 2.1 | 0.75 | 0.7 |
| | 12/18/04 | 63.6 | 58.1 | 0.9 | 0.7 | 0.6 | 0.74 |
| | 02/19/05 | 123.6 | 114.2 | 0.5 | 0.5 | 1.09 | 0.88 |
| | 04/02/05 | 44.4 | 42.7 | 2 | 2 | 0.44 | 0.37 |
| **ML P2** | 04/22/04 | 31.5 | 30.2 | 1 | 0.8 | 0.23 | 0.28 |
| | 06/17/04 | 128.7 | 128.4 | 1.7 | 1.7 | 0.3 | 0.28 |
| | 08/13/04 | 96.4 | 100.6 | 1.3 | 1.2 | 0.65 | 0.67 |
| | 10/11/04 | 85.4 | 84 | 1.5 | 1.6 | 0.49 | 0.44 |
| | 12/18/04 | 44.6 | 53.6 | 1.4 | 0.9 | 0.61 | 0.74 |
| | 02/19/05 | 76.2 | 74 | 1.1 | 1.1 | 0.03 | 0.01 |
| | 04/02/05 | 10.5 | 6.2 | 1.7 | 1.7 | 0.22 | 0.17 |
| **ML WT** | 04/22/04 | 37.2 | 36.1 | 2.9 | 2.1 | 0.19 | 0.17 |
| | 06/17/04 | 155 | 162.9 | 2.1 | 2.6 | 0.78 | 0.82 |
| | 08/13/04 | 69.6 | 71 | 2.5 | 2.7 | 0.53 | 0.89 |
| | 10/11/04 | 54.4 | 58 | 1 | 1.3 | 0.48 | 0.45 |
| | 12/18/04 | 57.3 | 51 | 1 | 0.8 | 0.46 | 0.68 |
| | 02/19/05 | 90.2 | 92 | 1.1 | 1.1 | 0.01 | 0.01 |
| | 04/02/05 | 16.1 | 15.2 | 1.9 | 1.9 | 0.13 | 0.2 |

## Table 3:
## Surface Water Analytical Summary Table
## Indian Springs Golf Course
## Evesham Township, Burlington County, New Jersey
## (all analytical data in CFU/100 mL)

| Sample Location | Date | Microbiological Parameters | | |
|---|---|---|---|---|
| | | Coliform Bacteria | Escherichia coli | Total Coliform Bacteria |
| **IS P1** | 04/22/04 | 400 | 0 | 400 |
| | 06/17/04 | 200,000 | 20,000 | 220,000 |
| | 08/13/04 | 47,000 | 2,000 | 49,000 |
| | 10/11/04 | 4,000 | 0 | 4,000 |
| | 12/18/04 | 0 | 0 | 0 |
| | 02/19/05 | 60 | 240 | 300 |
| | 04/02/05 | 20 | 0 | 20 |
| **IS P2** | 04/22/04 | 400 | 0 | 400 |
| | 06/17/04 | 200,000 | 20,000 | 220,000 |
| | 08/13/04 | 47,000 | 2,000 | 49,000 |
| | 10/11/04 | 4,000 | 0 | 4,000 |
| | 12/18/04 | 0 | 0 | 0 |
| | 02/19/05 | 60 | 240 | 300 |
| | 04/02/05 | 20 | 0 | 20 |
| **IS P3A** | 04/22/04 | 1,200 | 0 | 1,200 |
| | 06/17/04 | 850,000 | 40,000 | 890,000 |
| | 08/13/04 | 39,000 | 1,000 | 40,000 |
| | 10/11/04 | 5,000 | 0 | 5,000 |
| | 12/18/04 | 1,200 | 20 | 1,220 |
| | 02/19/05 | 20 | 0 | 20 |
| | 04/02/05 | 60 | 0 | 60 |
| **IS P3B** | 04/22/04 | 1800 | 0 | 1,800 |
| | 06/17/04 | 850000 | 40000 | 890,000 |
| | 08/13/04 | 39000 | 1000 | 40,000 |
| | 10/11/04 | 22000 | 2000 | 24,000 |
| | 12/18/04 | 1200 | 40 | 1,240 |
| | 02/19/05 | 20 | 0 | 20 |
| | 04/02/05 | 60 | 0 | 60 |

## Table 4:
## Surface Water Analytical Summary Table
## Medford Lakes Country Club
## Medford Lakes, Burlington County, New Jersey
## (all analytical data in CFU/100 mL)

| Sample Location | Date | Microbiological Parameters | | |
|---|---|---|---|---|
| | | Coliform Bacteria | Escherichia coli | Total Coliform Bacteria |
| **ML P1** | 04/22/04 | 600 | 0 | 600 |
| | 06/17/04 | 350,000 | 20,000 | 370,000 |
| | 08/13/04 | 23,000 | 2,000 | 25,000 |
| | 10/11/04 | 15,000 | 0 | 15,000 |
| | 12/18/04 | 100 | 0 | 100 |
| | 02/19/05 | 40 | 0 | 40 |
| | 04/02/05 | 20 | 0 | 20 |
| **ML P2** | 04/22/04 | 10,100 | 0 | 10,100 |
| | 06/17/04 | 400,000 | 30,000 | 430,000 |
| | 08/13/04 | 18,000 | 1,000 | 19,000 |
| | 10/11/04 | 1,000 | 0 | 1,000 |
| | 12/18/04 | 0 | 0 | 0 |
| | 02/19/05 | 20 | 0 | 20 |
| | 04/02/05 | 0 | 0 | 0 |
| **ML WT** | 04/22/04 | 4,800 | 5,000 | 9,800 |
| | 06/17/04 | 60,000 | 130,000 | 190,000 |
| | 08/13/04 | 39,000 | 41,000 | 80,000 |
| | 10/11/04 | 1,000 | 1,000 | 2,000 |
| | 12/18/04 | 300 | 320 | 620 |
| | 02/19/05 | 40 | 40 | 80 |
| | 04/02/05 | 80 | 80 | 160 |

# APPENDIX G

## Quality Assurance and Quality Control Procedures

# Impacts to Wetlands from Beneficial Re-Use of Wastewater

## Quality Assurance Project Plan for Environmental Monitoring

Prepared for: Division of Environmental Science and Assessment
U. S. Environmental Protection Agency, Region II

Prepared by:________________________________________
Air and Water QA Team

Approved by:________________________________________
Marcus E. Kantz, Air and Water QA Team Leader

Approved by:________________________________________
Monitoring and Assessment Branch Chief

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**Project Partners**

Burlington County Resource Conservation Department
Water Resources Program
Gina A. Berg, Coordinator

-------------------------------------------------------------------------
signature date

Rowan University
Civil and Environmental Engineering Department
Kauser Jahan, PE, PhD.

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signature date

Alaimo Associates
Joseph Augustyn, PP

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signature date

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## Project Description

Burlington County has been engaged in land use planning through a number of different programs. The County endeavors to protect and enhance environmental values through open space acquisition and preservation, farmland preservation, watershed management initiatives, and smart growth planning. The County is also involved in water supply management via a proposed Credit Bank through which we would allocate a limited supply from the Potomac-Raritan-Magothy (PRM) aquifer to the various users in the County. Work completed in the various planning programs noted above might be augmented, by development of a regional wastewater re-use plan. The County would like to evaluate potential impacts to wetlands so that the plan can address that concern as well as address a water supply shortage identified in the Critical Water Area #2 designation.

Supposing that wastewater may be re-used as irrigation water for agriculture, recreational fields and landscaping purposes, these uses may pose a threat to wetlands if the wetlands are proximal to the wastewater application site. The impact is unknown, but may depend on the level of treatment of the effluent, the distance and slope between the area of application and the type of wetlands. In addition, many agricultural fields that might be considered prime candidates for wastewater re-use, may also be located on modified, drained wetlands. Those lands and adjoining wetlands may be especially vulnerable to impacts.

The overall goal of the project is to assess vulnerability of natural and modified wetlands to ecological impacts from nearby application of treated wastewater effluent. The goal will be achieved by accomplishing the following objectives:

1) Characterize average or common nutrient and chemical composition of potential effluent sources
2) Identify parameters that would increase the potential for impacts, such as, but not only, slope, vegetative cover, soils type, distance to wetlands, groundwater hydraulics
3) Create a planning tool or GIS-based index that would categorize existing undeveloped lands and golf courses based on those identified parameters
4) Develop and implement a monitoring program in wetlands adjacent to or on an existing golf course that uses treated effluent for irrigation to evaluate the accuracy of the parameter assumptions.

At the conclusion of the monitoring and assessment the County foresees development of a wastewater re-use plan. That plan will identify potential sources, re-use sites and implementation options. This monitoring and assessment will increase protection for vulnerable wetlands through implementation of the beneficial re-use plan. Implementation of the plan will also achieve better wetlands protection by reducing surface water withdrawals for irrigation purposes. Those surface water withdrawals often result in lowering water tables, thereby affecting the habitat of wetland obligate species.

This project was undertaken by the Burlington County Board of Chosen Freeholders. The project is managed through the Water Resources Program in the Department of Resource Conservation. Water sampling and analyses are sub-contracted to Rowan University, Department of Civil Engineering. Dr. Kauser Jahan is the Quality Assurance Officer directing field sampling and sample analyses. Alaimo Associates, and engineering and planning firm in Mount Holly, New Jersey, will be conducting the literature search and modeling exercise. Mr. Joseph Augustyn, is the project manager for this project at Alaimo Associates.

## Plan Components

The project consists of two principal components. The first component is a comparative analysis of water quality impacts in wetlands adjacent to two comparable golf courses. This water sampling exercise will analyze samples taken from wetlands adjacent to a golf course where treated effluent has been applied for irrigation for over three years and from wetlands adjacent to a golf course where wastewater re-use is planned, but has not yet occurred.

Both golf courses are located in the Pinelands Protection Area, a federally designated reserve, and in the Outer Coastal Plain geologic province. The golf courses share similar geology and hydrology with sandy soils and a water table within 1-6 feet of the natural ground surface. The sandy soils and high water table afford environmental conditions where there is the most potential for impacts from any particular land use on nearby wetlands. Within Burlington County, regions outside the Pinelands tend to be less susceptible due to a deeper water table and heavier soils. The heavier soils allow greater cation exchange capacity, as well as higher soil water tension and lower porosity, characteristics that would typically impede movement of nutrients or contaminants into nearby wetlands. As these sites are both within the more susceptible Pinelands environment, it is believed they would represent the "worst case" scenario within Burlington County. Hence, future plans to provide irrigation water from treated wastewater effluent in other parts of the County could rely to some degree on the impact to, or lack thereof, wetlands and water quality.

The Pinelands Commission is a state governmental agency that manages land use and growth in the Pinelands Area. The Science Office within the Pinelands Commission has conducted numerous studies on the relationship of various water quality parameters to the ecology of biota within wetlands of the Pinelands. Using the relationship of water quality to ecology documented through various Pinelands studies of the Rancocas Creek and the Mullica River, this study attempts to document potential impact to wetlands through the analyses of water quality parameters, rather than a protracted study of the vegetal and animal compositions of the wetlands.

Both sites are located within the Southwest Branch Rancocas Creek watershed, a tributary of the South Branch Rancocas Creek and the Rancocas Creek within the Delaware River Basin.

### *Technical Design*

The technical design components are project schedule, location mapping, sample type, sample methods, and sample analysis. The project schedule provides for a year-long sample collection. This schedule provides for wide variations in water quality, that may be seasonally affected, to be included. Locations will be mapped using Geographic Positioning System (GPS). This method is used for the simple expediency of determining the location using a hand-held device and of being able to relocate the sample sites with great accuracy.

Surface water samples will be collected. Sample sites are adjacent to, or surrounded by, the targeted land use. As golf courses have been selected for the project, sample locations are less than 10 meters from the active use and manage turf on the parcel. This is intended to remove the potential for other offsite factors having an effect on the water quality.

**Figure 1. Indian Springs Course Wetlands. Site 1.**

Samples will be collected from surface water within wetlands areas on the site. Surface water sampling was selected for a number of reasons, although well sampling was considered. First, the golf courses subject of the study have been in existence for a long period (more than 15 years) of time. Second, due to the shallow aquifer depth and groundwater topography depicted in the USGS study, Hydrology of the Unconfined Aquifer System, Rancocas Creek Area: Rancocas, Crosswicks, Assunpink, Blacks and Crafts Creek Basins, New Jersey, 1996 (Watt, et al.,2002), as well as the sandy geology, it appears that the wetlands are supported by this shallow aquifer flow and would be impacted by the land use well within the three year time-frame that effluent has been applied to the Indian Mills course. Further, it was determined that groundwater alone would not be completely indicative of the water quality that would affect the wetlands areas. The surface water, which would have both the groundwater inflow, plus a surface water run-off contribution, would be more indicative of the water quality impacting biota and wetlands characteristics. For these reasons, a surface water sampling program was selected.

**Figure 2. Medford Lakes Site 1 Wetlands.**

Surface water quality has been a documented indicator of wetlands health in the Pinelands region. In particular, we relied on recent work completed by the Pinelands Commission (Zampella & Laidig, 2003), as well as the longer-term studies on the water quality in the Rancocas Basin completed by that office. Those studies have shown that as water quality parameters are shifted from the normal chemistry of the Pinelands, species of vegetation and animals shift toward non-Pinelands species. Relying upon that relationship, we are using water quality analysis to show whether the wetlands subject of our study are impacted by the use of treated effluent for irrigation nearby. In other words, rather than do a more detailed analysis of species present or of vegetation health or species regeneration which would be too long-term and intensive for this scope of work, we will rely simply on water quality parameters to determine whether the irrigation effluent is having a detrimental effect on the wetlands. No attempt will be made to index or characterize the degree of shift that may or may not be detected by this project, but we hope to determine only whether a shift in the wetlands surface water quality is effected by the use of treated effluent to irrigate nearby. The selected sites are located within the Pinelands. The work completed by the Pinelands therefore has applicability to this project.

### *Project Schedule*

Field sampling is scheduled to begin in April 2004. Samples will be collected bi-monthly with a total of six rounds to be completed by March 2005. A final report on sample results will be completed by May 2005.

The second piece of this project is a literature search and modeling exercise to predict the impacts throughout Burlington County to wetlands near lands where treated wastewater may be used for irrigation. It is hoped that this exercise will predict the results of the water sampling piece, thereby giving an indication of the reliability of the model. Conversely, if there is no correlation between the projected impacts and the actual water sampling results, it will indicate that further study is necessary before Burlington County might support a wide-scale program for beneficial re-use of wastewater. A bibliography is included with this document.

### *Mapping - GPS*

- ***Hardware***

The GPS unit used for data collection is a Trimble Geo-XT. The datum that will be applied to location collection is North America Datum 1983 (NAD83). The projection coordinate system is New Jersey State Plane. The GPS unit can achieve sub-meter accuracy if appropriate conditions exist. In addition, for a point feature, a minimum of 60 satellite readings is required. For line and polygon features, the satellite receiver will log at a 3-second interval.

- ***Target Precision and Accuracy***

GPS data collection will follow the New Jersey Department of Environmental Protection's standard guidelines for GPS data collection, as summarized in Table 1.

### Table 1: Standard GPS Collection Parameter Settings

| | |
|---|---|
| Position Mode | All position fixes must be determined with 4 or more satellites. Manual 3D or over determined 3D (5 satellites minimum) modes are acceptable. 2D fixes (using only 3 satellites) are **not** acceptable. 3D positions generated from 2D fixes supplemented with user entered elevations are also **not** acceptable. |
| Elevation Mask | 15 degrees above horizon. |
| PDOP Mask | 6 |
| Signal to Noise Ratio Mask (SNR) | If this parameter setting exists, set it to the manufacturer's recommendation. |
| Minimum Positions for Point Features | Use the manufacturer's recommended minimum number that will enable the collector to achieve the better than 5 meter, 95% confidence level. For some receivers this will mean logging between 100-200 fixes per point feature. For receivers capable of 1 meter accuracy, a minimum of 60 total fixes, at a 1 second log rate will be collected. Alternatively, a minimum of 12 total fixes, at a 5 second log rate, can be collected. Single fix solutions are not acceptable. |
| Logging Intervals | Intervals for point features will be 1 second or faster. Intervals for line and area features depend on the velocity at which the receiver will be traveling and the nature of the feature and the operating environment. Under normal circumstances (i.e., when the user is walking with the receiver) the interval for line and area features will be set to a 5 second interval. |
| Logging of DOP | If the receiver allows, this parameter setting will be set to allow the logging of DOP data along with position fixes. |

Under circumstances where collection is being performed using real time differential corrections, the following additional parameters will be set accordingly:

### Table 2: Additional Real-Time Differential GPS Collection Parameter Settings

| | |
|---|---|
| Logging of Post Process Data | If the receiver allows, this parameter setting will be set to enable the real-time differentially corrected data to be optionally differentially corrected in a post process step. |
| RTCM Station | If the receiver allows, set this parameter setting so that the receiver will use RTCM GPS correction signals from the closest beacon. In the New Jersey area, beacons are located at Sandy Hook, Cape Henlopen (Delaware), and Montauk Point (New York). |

## *Water Sampling*

- ***Project Assessments and Oversight***

The project team consists of Rowan University personnel (faculty and graduate and undergraduate students). Rowan University is primarily responsible for water sample collection, analyses for three parameters nitrate, phosphate and bacteria. Rowan University will conduct these analyses and follow QA/QC procedures outlined in this document.

The Program Manager (PM), Dr. Kauser Jahan, is responsible for the overall direction, coordination, technical consistency, and review of the entire project. She will be fully responsible and accountable for contractual, technical, and scheduling activities, and will serve as the focal point and main channel of communication between the Burlington County and the Rowan University team. She will ensure that necessary resources are made available (including personnel, materials, and equipment), long-range program plans are prepared and potential problems or conflicts are identified and resolved in a timely manner. The Program Manager will be responsible for technical oversight of the project, and overall project execution. The PM will, as necessary, perform audits, surveillance, document reviews, and other quality functions as required to ensure the continued effectiveness of this QAPP. The Program Manager is also responsible for proper implementation of established safety procedures.

- ***Personnel Training***

This specific project does not require specialized training (such as the 40 hour OSHA HAZWOPER) or security clearance. Undergraduate and graduate students will be trained by a faculty member (in this case Dr. Kauser Jahan) knowledgeable in specific analytical procedures relevant to the proposal. This training includes sample collection, storage and preservation protocols, equipment handling protocols, sample analyses procedures for relevant water quality parameters, data recording, analyses and validation and laboratory and field safety procedures. Students will also be trained on project documentation procedures such as sample labeling, chain of custody forms, laboratory book entries. SOPs (Standard Operating Procedures) will be available at all times for involved personnel.

Personnel will also be trained on laboratory and personnel safety.

- ***Water Sample Collection***

Samples will be grab samples, collected in 1 (one) liter sterilized plastic sample bottles. Samples will be surface water samples from within wetlands areas on the golf course sites. Analytical parameters include nitrate, total phosphorus, total coliform and chemical oxygen demand. None of these parameters need preservation. Holding times cannot exceed days for all parameters.

Sample management: One site is visited per day. One liter containers are kept in a cooler with ice and immediately transported back to the laboratory. Analyses occur within 24 hours per method requirements. For analyses not occurring immediately, but within 24 hours of collection, the one liter container is refrigerated at (40 deg. F.) until analysis. All samples will be labeled and preserved in the field. Sample labels will contain all pertinent information, including sample identifier, source, location, sample number, date/time, grab/composite, preservative, and collector. Sampling events and analyses are held under the supervision of Dr. Kauser Jahan.

No equipment is being used in the field. Table 3 indicates field supplies with brand names and catalog numbers. These supplies are purchased from VWR Scientific Products.

**Table 3: Field Supplies with Vendor names and Catalog Numbers**

| **Item** | **Vendor and Catalog #** |
|---|---|
| Ice | Local Store |
| Cooler | Coleman 58 quart XTREME® COOLER |
| 144" Long Handled Dipper | SCIENCEWARE® F36782-0032 |
| Cubitainers with Caps Level 1 full EPA quality Assurance Treatment (1L) | Eagle Pitcher® EP160-025 |
| Sterile Coliform Water Sample Container (Meets EPA Requirement) | Corning® 1700-100 |
| Laboratory Notebook | |
| Kimwipes (4.5"x8.5") | Kimberly Clark® 34155 |
| Deionized Water | LABCONCO |

- ***Field QC Activities***

1. Coolers will be filled with ice before any sampling event can begin.
2. Samples will be collected from the mid section of the Golf course ponds using the 144" Long Handled Dipper.
3. This sampler will be washed with deionized water three times immediately after sample has been poured into respective sample containers before reuse at other sites.
4. All sample containers used in project will conform to Level 1 EPA quality assurance treatment. No used containers will be brought to the sample site.
5. Extra sample containers will be brought to the field.
6. Sample containers will be labeled and a chain of custody form will be maintained.
7. The PM will accompany students and aid in sample collection and handling

for all sampling events. This will allow the PM to take corrective actions as necessary on site.

- ***Methods for Water Sample Analysis***

Equipment

✓ HACH DR 4000 Spectrophotometer: Calibration for all parameters will follow procedures described in the manufacturer's operation manual.

Methods

✓ **Nitrate**: Measured using Hach method number 8171. Samples to be analyzed in duplicates (10 mL) aliquots and the average to be presented. Two duplicates from each grab sample will be analyzed for each analyte. Method detection limits: 0.1 mg/L $NO_3^-$-N

✓ **Total Phosphorus:** Measured using Hach method 8190 which uses the Phos Ver 3.0 acid persulfate digestion. Samples to be analyzed in duplicates (5 mL) aliquots and the average to be presented. Two duplicates from each grab sample will be analyzed for each analyte. The average of the two duplicates will be presented. Method detection limits: 0.06 mg/L $PO_4^{-3}$

✓ **Total Coliform:** Determined using HACH Method 10029 (USEPA approved). Detection limit is 1 CFU (Colony Forming Unit) of coliform bacteria per 100 mL of sample.

✓ **Chemical Oxygen Demand**: Measured using Hach Method 8000. Measured using Hach method 8190. Samples to be analyzed in duplicates (2 mL) aliquots and the average to be presented. Two duplicates from each grab sample will be analyzed for each analyte. The average of the two duplicates will be presented. Method detection limits:
Low Range COD (0 - 40 mg/L) = 0.2 mg/L COD
High Range COD (0 - 150 mg/L) = 1.1 mg/L COD

- ***Documentation, computer hardware and software, procurement.***

All records relating to the project will be kept by the technical staff responsible for the planning, data collection, and analysis. In addition, all field data sheets will be copied and kept in binders, together will all other project information in the project manager's files. Computer data will be stored both on the shared drive on the Engineering computer server and backed up on the local hard drive of the technical manager. Computer hardware and software maintenance and repair is provided by Rowan University.

- ***Batches and Quality Control Samples***

Many analytical laboratory processes are batch processes, where a batch of samples is used as the frequency of the quality control elements. Two types of batches are used in the laboratory: preparation and instrument batches. A preparation batch (herein referred to as "batch") is defined as a group of 20 or less environmental samples of the same matrix prepared (e.g., extracted or digested) within the same time period (concurrently) or in limited continuous sequential time periods. The batch must be analyzed sequentially on a single instrument.

The instrument batch is a group of 20 or less environmental samples analyzed together within the same analytical run sequence or in continuous sequential time periods. In general, if an instrument is not used for periods of time or shut down (e.g., overnight) then a new instrumental batch must be started. Samples in each batch are of similar matrix (e.g., soil, sludge, liquid waste, water), are treated in a similar manner and use the same reagents. In general, preparation batches should be analyzed together, as a unit, within the same instrument batch. If samples from the same preparation batch are not analyzed within the same instrument batch (e.g., because of dilution requirements or matrix interference) the following is required:

- Samples from the preparation batch must be clearly associated with their corresponding preparation batch QC samples, and appropriate corrective actions must be performed on all samples in the batch, based on the results of the associated preparation batch QC.
- Instrument QC for each instrument batch (initial and continuing calibrations, instrument blank analyses, and tuning, etc.) must meet the established criteria for the method.
- Instrument cleanliness must be proven through the analysis of an instrument blank, the preparation batch blank, or a preparation blank from another batch.

When preparation batches must be split among instruments to meet expedited turnaround times or to meet other project requirements, each instrument batch needs to contain quality control elements equivalent to the quality control elements available in single instrument batch analyses.

Data reported by the laboratory that are found to be associated with batch QC samples that were not extracted concurrently, or were not analyzed in the same sequence on the same instrument relative to the primary sample results, will be rejected. Also, if the batch size is found to exceed 20 samples, the data will be rejected. Failure to incorporate appropriate quality control samples also may result in rejection of data. In order to quantitatively assess the quality of the data, a variety of quality control samples are used. Method blank and laboratory control samples (LCS) uniquely measure the laboratory component of measurement performance. Matrix spikes, matrix spike duplicates, laboratory duplicates, and surrogate spikes measure the matrix component of measurement performance, but also reflect laboratory performance. The laboratory will, at minimum, analyze internal QC samples at the frequency specified by the analytical method.

*Method Blanks.* Method blanks are used to monitor the laboratory preparation and analysis systems for interferences and contamination from glassware, reagents, sample manipulations, and the general laboratory environment. The method blank is an analyte-free matrix to which the reagents are added in the same volumes or proportions as used in sample processing, and which is taken through the entire sample preparation process. One method blank will be prepared for each batch of samples (one per batch, up to a maximum of 20 samples). Some methods do not have a distinct preparation, and for these tests, the instrument blank, which contains reagents used with samples, is considered to be the method blank.

*Instrument Blanks*. Instrument blanks are used to monitor the cleanliness of the instrument portion of the sample analysis process. Instrument blanks consist of the solvent or acid solution of the standard used to calibrate the instrument. With the exception of metals analyses, instrument blanks are analyzed in each instrument every 10 analyses or every 12 hours for GC/MS analyses. Routine metals analyses receive an instrument blank every 10 samples. Instrument blanks are also analyzed on an as-needed basis for troubleshooting.

*Laboratory Control Samples (LCS) and Laboratory Control Sample Duplicates (LCSD).* LCSs are well-characterized, laboratory-generated samples of a known matrix (reagent grade water, reagent sand or other approved matrices) used to monitor the laboratory analytical process independent of matrix effects. LCSs are spiked with a known quantity of specific target analytes, and are taken through the entire sample preparation and analytical process. LCSs are prepared and analyzed with each batch of environmental samples up to a maximum of 20 samples of a similar matrix. LCSs measure laboratory performance regarding the accuracy of the preparation process by measuring spiked target analyte recoveries in a controlled matrix. LCS results, together with matrix spike results, can also establish the presence of matrix effects. For methods where there is no distinct preparation, a continuing calibration standard may be used as the LCS, if it meets all LCS and matrix-matching criteria. LCS/LCSD (laboratory control sample duplicate) are used when not enough sample is available to prepare a site-specific matrix spike and matrix spike duplicate for a batch, or if matrix spikes or sample duplicates from another project are not available. However, this situation will be limited to the maximum extent practicable.

*Matrix Spikes (MS) and Matrix Spike Duplicates (MSD).* Matrix spikes measure matrix-specific method performance. A matrix spike sample is prepared by adding a known quantity or target analytes to a single field sample prior to sample digestion or extraction to establish how well the target analytes can be recovered from the sample matrix. The accuracy of the matrix-specific method may be established by the recovery of the spiked analytes after native concentrations of the spike analytes are subtracted. If an MSD is analyzed, the matrix-specific precision of the method may also be calculated. In general, for organic analyses, an MS/MSD pair is prepared and analyzed; for inorganic analytes, a single MS is prepared and analyzed. For each shipment of samples that is sent to the laboratory, one sample will be provided in sufficient quantity such that an MS (and, for organic analytes, an MSD) can be generated in addition to an aliquot reserved for actual sample analysis. If more than 20 samples are shipped at a time, one sample will be provided in quantities sufficient to generate an MS or MS/MSD for each set of 20 samples. This sample will include sufficient volume such that one reextraction/reanalysis of the MS or MS/MSD pair may be performed if necessary. The sample chosen for matrix spiking purposes will be representative of other samples in the batch.

*Laboratory Duplicates*. Laboratory duplicates are defined as two aliquots obtained from the same sample, which are extracted and analyzed for the purpose of determining matrix specific precision. Laboratory duplicates will be performed for all metals analyses at a rate of one for each batch up to a maximum of 20 samples.

*Internal Standards.* Internal standards are compounds that analytically behave similarly to the target analytes. Internal standards are compounds not found in the sample and are added at the time of instrumental analysis to quantitate results. They are used to correct for injection variability when using mass spectrometry. Control limits on internal standard areas are specified in the analytical method.

- ***Method Detection Limits and Practical Quantification Limits***

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The laboratory shall establish MDLs for each method, matrix, and analyte for each instrument, including confirmation columns that the laboratory plans to use for the project. The laboratory shall revalidate these MDLs on an annual basis. Results less than the MDL shall be reported as the practical quantitation limit (PQL) value and flagged with a "<x", where x is the MDL. The PQL is the lowest level that can be reasonably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The laboratories participating in this work effort will compare the results of the MDL demonstrations to the PQLs for each method. All MDLs will be lower than the relevant PQLs. The laboratories will also verify PQLs by including a standard at or below the PQL as the lowest point on the calibration curve. Results will be reported for values at or above the MDL; however, for those results falling between the MDL and the PQL, a "F" flag will be applied to the results indicating the variability associated with the result.

- ***Data Review and Acceptance Criteria***

The purpose of this section is to describe how data quality will be assessed and the criteria use to define acceptable limits of uncertainty.

*Precision.* Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. Laboratory control samples (LCSs) are used to establish the precision of the analytical method. If the recoveries of analytes in the LCS are within established control limits, then precision is within acceptable limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch; rather the comparison is between the sample and samples analyzed in previous batches. Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is established by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision. The precision measurement is established using the relative percent difference (RPD) between the duplicate sample results. For replicate analyses, the relative standard deviation (RSD) is established.

*Accuracy.* Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery (R) of analytes spiked into a LCS to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation samples will also be used to provide additional information for assessing the accuracy of the analytical data being produced. Both accuracy and precision are calculated for each analytical batch, and the associated sample results are interpreted by considering these specific measurements.

*Representativeness.* Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigative objectives. Representativeness shall be achieved through use of the standard field, sampling and analytical procedures. Representativeness is also established by appropriate program design, with consideration of elements such as proper sampling locations, procedures and topography.

*Completeness.* Completeness is calculated for the aggregation of data for each analyte measured for a particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, establishes the completeness of the data set. The goal for completeness is 100 percent. For instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

*Comparability.* Comparability is the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Historical comparability shall be achieved through consistent use of methods and documentation procedures throughout the project.

Flags will be applied to data points following specific criteria. A “<x”, where x is the MDL, will be used in place of a result when an analysis returns a result less than the MDL. An “F” flag will be displayed with any result between the MDL and PQL. A “B” flag will be displayed with any result in a batch associated with a failed blank (blanks greater than the PQL are considered failures). A “J” flag will be displayed with any result

in a batch associated with a failed duplicate or replicate (duplicates or replicates with RPDs or RSDs greater than 20 % are considered failures. An "M" flag will be displayed with any result in a batch associated with a failed spike (spikes with Rs greater than 15 % are considered failures).

- ***Data Verification and Validation***

Data validation is a process of reviewing data against a set of criteria to identify errors and to flag or qualify suspect data prior to its release. Data validation techniques include reviewing the data and either accepting, rejecting or qualifying the data on the basis of sound criteria established at the beginning of the project by Rowan University. The data validation procedures generally follow those defined in EPA's *Functional Guidelines for Evaluating Organic/Inorganic Analyses*. Data validation will be performed internally, under the direct supervision of Dr. Jahan.

Data verification will be supervised by the PM who will be involved with all aspects of sample collection, chemical analyses and data validation. Data verification evaluates how closely sampling protocols and analytical methods were followed during data generation. Table 4 presents information on a number of common operations which will be used as inputs to data verification.

**Table 4: Records Used as Inputs to Data Verification**

| **Task** | **Common records** | **Source** |
|---|---|---|
| Sample Collection | Field Log, COC form | Sample Analysis Plan (SAP)<br>SOP (Standard Operating Procedure) |
| Sample receipt | COC form | SAP |
| Sample Preparation | | SOP, SAP |
| Sample Analysis | Instrument Logs, Calculation Worksheets | SAP |
| Records Review | Internal Laboratory checklists | SOP, SAP |

The PM will confirm that reported sample results make sense in a number of ways:

a) Check calculations
b) Check input to calculations (such as dilution factors
c) Data qualifiers such as results for field blanks, sample blanks, standards, readings lower than MDL, deviations between duplicates

Specifically, corrective actions will be undertaken if one of the following occurs:

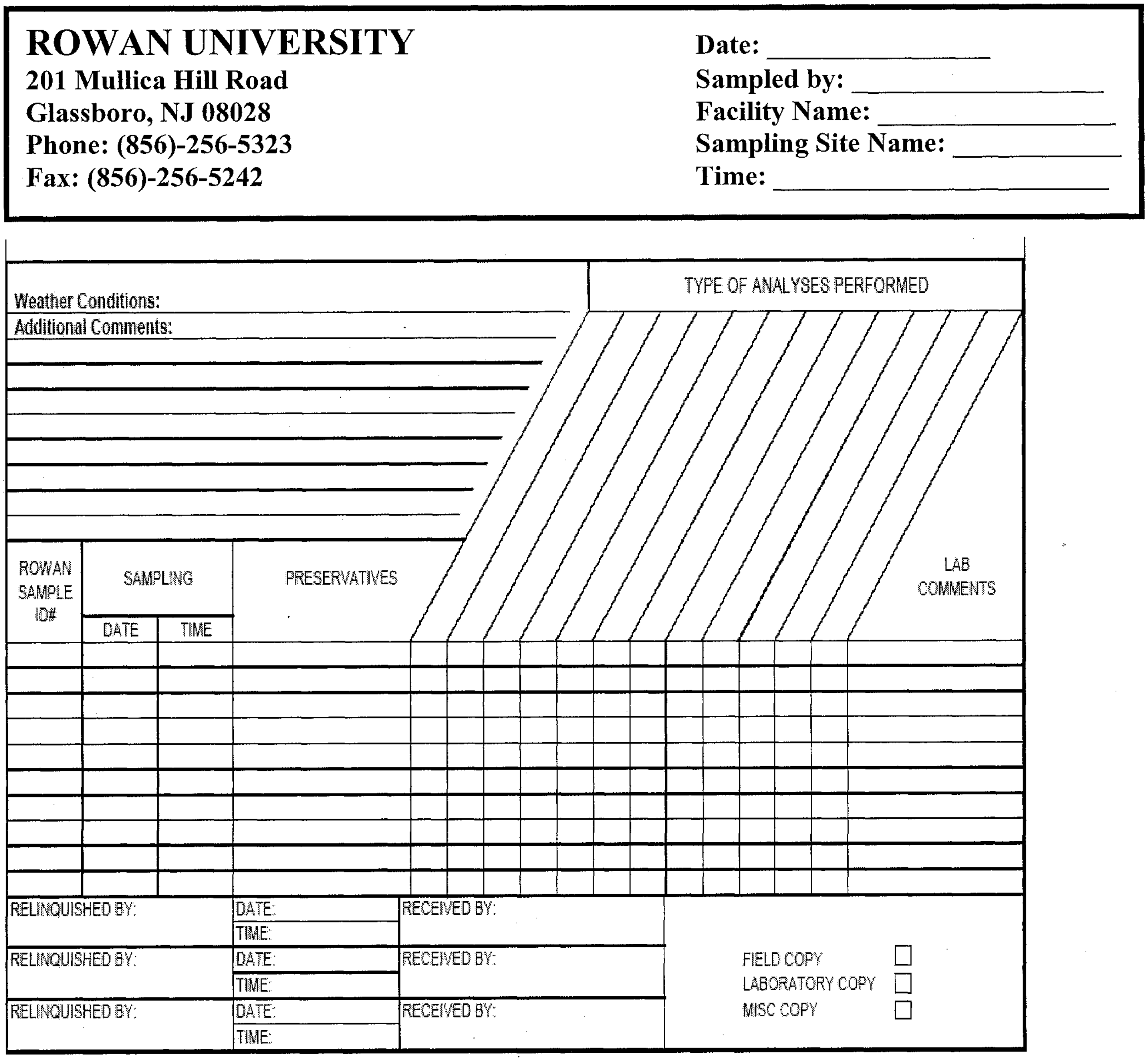
- QC data are outside the acceptance windows for precision and accuracy.
- Blanks contain contaminants above acceptance levels.
- Undesirable trends are detected for spike recoveries or spike recoveries are outside the control limits.
- RPDs between duplicate analyses are consistently outside control limits.

- Deficiencies are detected during QA audits.

The reconciliation process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of the data is essential to verifying that the data are consistently meeting the project DQOs.

Finally the PM will exercise professional judgment in order to determine if there is any need to qualify data which is not qualified based on the QC criteria,

**Sample: Chain of Custody Form**



**ROWAN UNIVERSITY**
**201 Mullica Hill Road**
**Glassboro, NJ 08028**
**Phone: (856)-256-5323**
**Fax: (856)-256-5242**

**Date:** ________________
**Sampled by:** __________________
**Facility Name:** _________________
**Sampling Site Name:** ____________
**Time:** ________________________

Weather Conditions:
Additional Comments:

TYPE OF ANALYSES PERFORMED

| ROWAN SAMPLE ID# | SAMPLING | | PRESERVATIVES | | | | | | | | | | | | | LAB COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | TIME | | | | | | | | | | | | | | |
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|---|---|---|
| RELINQUISHED BY: | DATE:<br>TIME: | RECEIVED BY: |
| RELINQUISHED BY: | DATE:<br>TIME: | RECEIVED BY: |
| RELINQUISHED BY: | DATE:<br>TIME: | RECEIVED BY: |

FIELD COPY ☐
LABORATORY COPY ☐
MISC COPY ☐

## Secondary Data

***Wastewater Effluent Quality Data***

- Evesham Municipal Utility Authority Monitoring Report : provided by EMUA. Sampling conducted by MUA.
- Medford Lakes Utility Authority Monitoring Report: Sampling conducted by MLUA.
- Other effluent data: NJDEP

***Golf Course Fertilizer Application Data***

- Indian Mills Golf Course: Manager, William Torlucci.
- Medford Lakes Country Club: Superintendent, Conrad Dombkiewitz.

***Wastewater Treatment Plant Locations***- Data obtained from NJDEP website.

***Peer Review*** by Dr. Kauser Jahan. Additional assistance and discussion, Dr. Joseph Orlins, Rowan University; Richard Walker, United States Geological Survey.

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- A MULTIFACETED NATURAL RECLAMATION SYSTEM FOR WASTEWATER TREATMENT AND REUSE. Henriette Emond CH2M HILL 825 N.E. Multnomah Street, Suite 1300 Portland, Oregon 97232. Mark Madison, CH2M HILL. David Whitaker, CH2M HILL. Jim Russell, City of Salem, Oregon. Francis Kessler, City of Salem, Oregon

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Florida Reuse Model
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## Distribution List

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