February 2021





Environmental Resource Inventory

for

Howell Township

Monmouth County, NJ



Prepared for

Howell Township

Kratzer Environmental Services

ENVIRONMENTAL RESOURCE INVENTORY

Township of Howell
Monmouth County
New Jersey

Prepared By
Kratzer Environmental Services

For
The Township of Howell, Monmouth County

February 2021

Kratzer Environmental Services

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This report was written by Deborah J. Kratzer and Jill S. Dodds.

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ACKNOWLEDGEMENTS

Funding for this report was provided by The Township of Howell Shade Tree Commission. Special appreciation is extended for the input, review, and support from the Township of Howell Environmental Commission. Sections 5.2 and 7.1.4 were informed by Howell Township's 2008 Environmental Resource Inventory, which was written by Delaware Valley Regional Planning Commission (DVRPC).

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1. INTRODUCTION

1.1 PURPOSE

The Environmental Resource Inventory (ERI) is a compilation of information about the natural resources and environmentally significant features of the Township of Howell. It also covers the addition of man-made features, such as land use, open space, historic sites, point and non-point pollution and contaminated sites. The ERI is an objective description of features and their functions, but not an interpretation or recommendation. It provides baseline documentation for measuring, evaluating, and protecting natural resources. Creating an ERI is an important step in protecting and preserving our natural resources and in ensuring that future development or redevelopment projects will protect public health, safety, and welfare (ANJEC, 2013).

Wild turkeys. Photo credit: L. Doud

Howell Township is a mixture of rural farming community and suburban growth area, with critical habitat for threatened and endangered species as well as a commercial development corridor along Route 9. Smart planning for growth requires that the Township have a thorough accounting of its environmental resources to support a healthy mix of agricultural, commercial, and residential uses in the future. Further, Howell has water resources that are critical to its growing population. The preservation of wetlands and water resources and ecology in riparian areas is critical to the community. Information pertinent to identifying and preserving the township's environmental resources will allow its township officials and citizens to make informed decisions on what Howell's future will look like.

The Municipal Land Use Law requires municipalities' Master Plans to have a land use plan including topography, soil conditions, water supply, flood plains, wetlands, and woodlands. The Environmental Commission has the authority to conduct such research for inclusion in the Master Plan, and then to use this information to help evaluate development applications. The ERI will help support this requirement (Municipal Land Use Law, January 2017).

1.2 METHODS

Ecology is defined as the science of the relationships between organisms and their environments. The relationships between and among the physical factors of the environment, including the air, geology, topography, soils, and water, and the biotic environment, including plants, animals, and decomposers, are a complex web. Humans are a significant part of the ecosystem of the Township of Howell, both affecting and being affected by many physical and biological factors. The cumulative effects of many individual decisions have altered and have the potential to impact the environment and human health.

Assembling an inventory of the Township's environmental and biological infrastructure is the first step in a proactive and ecological approach to protecting and preserving human and ecological health. Analyzing the data, gaining an understanding of the ecological processes involved, and considering the consequences of ignoring them, will help local decision makers, land planners and the community create and maintain an ecologically healthy municipality.

An inventory of what is currently known about the physical and biological environment and the human influence on the environment of Howell Township has been compiled for this document. The most current GIS data have been obtained from the New Jersey Department of Environmental Protection GIS Data Web Site and other sources (see **Appendix A** and **Appendix B)**. A total of about 100 GIS data layers from 20 sources were used for this report's 55 maps.

Further sources include the internet, and federal, state, county and local databases and contacts. All digital inventory data used in this report will be provided to the Howell Township Environmental Commission. The public can also use GIS data by using either the New Jersey Department of Environmental Protection's NJ-GeoWeb website, Rowan University's NJ Map or obtain relevant data layers (most are free on the internet), and use mapping software, such as ArcMap (see **Internet Resources**, at the end of this section).

What is GIS?
"A geographic information system (GIS) is a framework for gathering, managing, and analyzing data.… GIS technology applies geographic science with tools for understanding and collaboration. It helps people reach a common goal: to gain actionable intelligence from all types of data." (ESRI, 2019)

When viewing the digital document (as opposed to a printed copy) maps in PDF, clicking on the tab "Layers" at the left side of the screen will allow users to turn on or off the various data layers. Viewing the separate layers in this way is often helpful, especially for complex maps.

References and related Internet resources (with links) are listed at the end of each section, so that readers may find more information and updates. Please note that Internet sites may change or be temporarily out of service. If an Internet link doesn't work, try using an Internet search engine.

The following chapters present objective information about Howell Township's natural resources, including climate, geology, soils, water, floodplains, wetlands, and forests, and cultural resources such as infrastructure and open space. Environmental concerns in Howell Township include air and water pollution, rare, threatened, and endangered species, and invasive species.

1.3 LIMITATIONS OF THE ERI

It should be noted that the ERI is not meant to replace the primary data sources upon which it is based. Information about GIS data sources is provided in **Appendix B**. The ERI is intended for preliminary assessments of projects and *cannot substitute for on-site testing and evaluations*. Most maps are presented at a scale of about 1:82,500 in order to fit on 8.5 x 11 inch paper. "Zooming in" to better view individual lots is possible, but should not exceed the scale at which the data was created. Most data layers used for this report were created at 1:24,000 scale (with an accuracy of ± 40 feet). Data mapped at 1:100,000, such as the geology data layer, have an accuracy of ± 166.7 feet (Garie, 1998).

Sometimes mapped features don't line up exactly or area differs, since different data producers may have used different methods of acquiring and analyzing the data, used different scales or coordinate systems, and because of differences or errors in the base data.

GIS data layers from NJDEP are used with permission (see the Terms of Agreement in **Appendix A**), with the required "disclaimer" printed on each map that uses their data.

When new or updated information becomes available, or new issues emerge, *updates should be appended to the ERI*.

References: Introduction

Association of New Jersey Environmental Commissions (ANJEC). 2013. The Environmental Resource Inventory: ERI. ANJEC; Mendham, NJ. 12 pages. https://anjec.org/wp-content/uploads/2019/07/ERI-2013.pdf

Garie, Henry L. and Lawrence L. Thornton. September 1998. New Jersey State Agency Partnership GIS Technical Mapping Standards: Enhancing GIS Technology for Multi-Agency Cooperation. Standards Subcommittee State Mapping Advisory Committee: Trenton, NJ.

ESRI. 2019. What is GIS? https://www.esri.com/en-us/what-is-gis/overview

Municipal Land Use Law Chapter 291 Laws of N.J. 1975. NJ Statutes Annotated compiled as 40:55D-1 et. seq. with amendments through the 215th State Legislature, January 2017. http://njpo.org

Internet Resources: Introduction

Aerial photography:

Google Earth[1]: http://www.google.com/earth/index.html (free download)
HistoricAerials.com[2]: https://historicaerials.com (free to use, but maps have watermark unless purchased)

Environmental Education

NJDEP SEEDS: The State Environmental Education Directory Website: https://www.state.nj.us/dep/seeds/index.html

Free online mapping:

NJ-GeoWeb 3.0 (NJDEP): https://www.state.nj.us/dep/gis/geowebsplash.htm
NJ Map: An Interactive Atlas for Ecological Resources, Environmental Education, and Sustainable Communities: https://www.njmap2.com/

GIS Data from New Jersey Department of Environmental Protection

For a complete list of data sources used in this report, see **Appendix B**
NJ GIS Home Page: https://www.state.nj.us/dep/gis/index.html
NJDEP Open Data: https://gisdata-njdep.opendata.arcgis.com/
NJ Geographic Information Network: https://njgin.state.nj.us/NJ_NJGINExplorer/index.jsp

Monmouth County: https://co.monmouth.nj.us/

NJDEP Rules and Regulations (current and proposed): https://www.nj.gov/dep/rules/

Howell Township: http://www.twp.howell.nj.us/

Howell Township Code: https://www.ecode360.com/HO2064?needHash=true

To report an environmental incident impacting NJ: 

[1] Users of Google Earth may also view several years of historic imagery of Howell Township from 1995 through 2019. On the menu bar, click View, then click Historical Imagery and use the slider bar to choose the year.
[2] HistoricAerials.com allows viewing of historic aerial photography between 1931 and 2015.

2. BACKGROUND AND LAND USE

2.1 BACKGROUND

The Township of Howell is located in the southern portion of Monmouth County, New Jersey (**Figure 2.1**). The township shares its borders with six different municipalities, including Freehold, Colts Neck, and Wall Townships in Monmouth County, and Brick, Lakewood, and Jackson Township in Ocean County (NJDEP, December 28, 2012). The Borough of Farmindale is completely within Howell Township. The township spans portions of ten USGS quadrangles, including the SW MARLBORO NJ, SE MARLBORO NJ, NE ADELPHIA NJ, NW FARMINGDALE NJ, NE FARMINGDALE NJ, SE ADELPHIA, SW FARMINGDALE NJ, SE FARMINGDALE NJ, NW LAKEWOOD NJ, and NE LAKEWOOD NJ quadrangles (NJDEP, 1991).

The Preventorium housed children from 1912 and 1962 for the purpose of preventing them from contracting tuberculosis. Photo credit: J. Osborne

Howell Township was established on February 23, 1801 from a portion of the original Shrewsbury Township. At that time, Howell Township also encompassed land area that is the present day Wall, Lakewood and Brick Townships, and the Boroughs of Farmingdale, Manasquan, Belmar, Sea Girt, Brielle, Lake Como, and Spring Lake Heights (Wikipedia, 2020). The township currently encompasses 61 square miles (39,096 acres)[3]. **Figure 2.2** presents the most recent (2015-2017) aerial photography from ESRI.

2.2 DEMOGRAPHY

Howell Township's population grew rapidly between 1930 and 2000, and has slowed in the past two decades (**Figure 2.3**). is estimated at 51,952, which is 862.1 persons per square mile (US Census Bureau, 2019). The township has 18,681 housing units; 90% are single-unit dwellings, 7% are multi-unit dwellings, and 3% are mobile homes, with a 5% vacancy rate (U.S. Census Bureau, 2018). According to the Monmouth County Division of Planning (2018), the average residential property tax in Howell Township for 2016 was $7,493 and the township's net real estate valuation for 2017 was $6.6 billion.

[3] The total acres determined by the ArcGIS coverage differs slightly from the acres provided on tax maps.

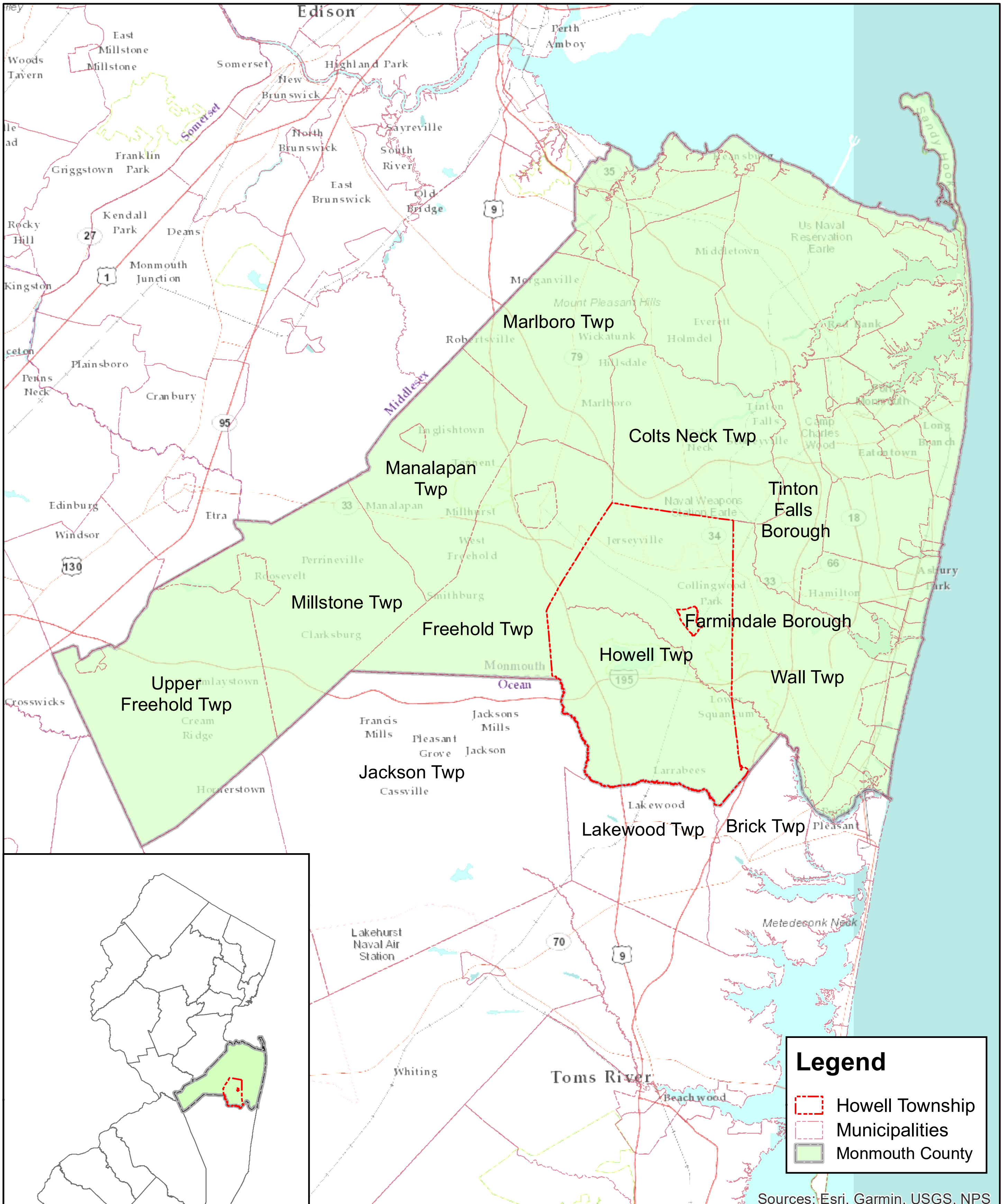

Figure 2.1. Howell Township, Location

0 2 4 8 Miles

N

Data Sources: NJDEP, NJDOT, ESRI

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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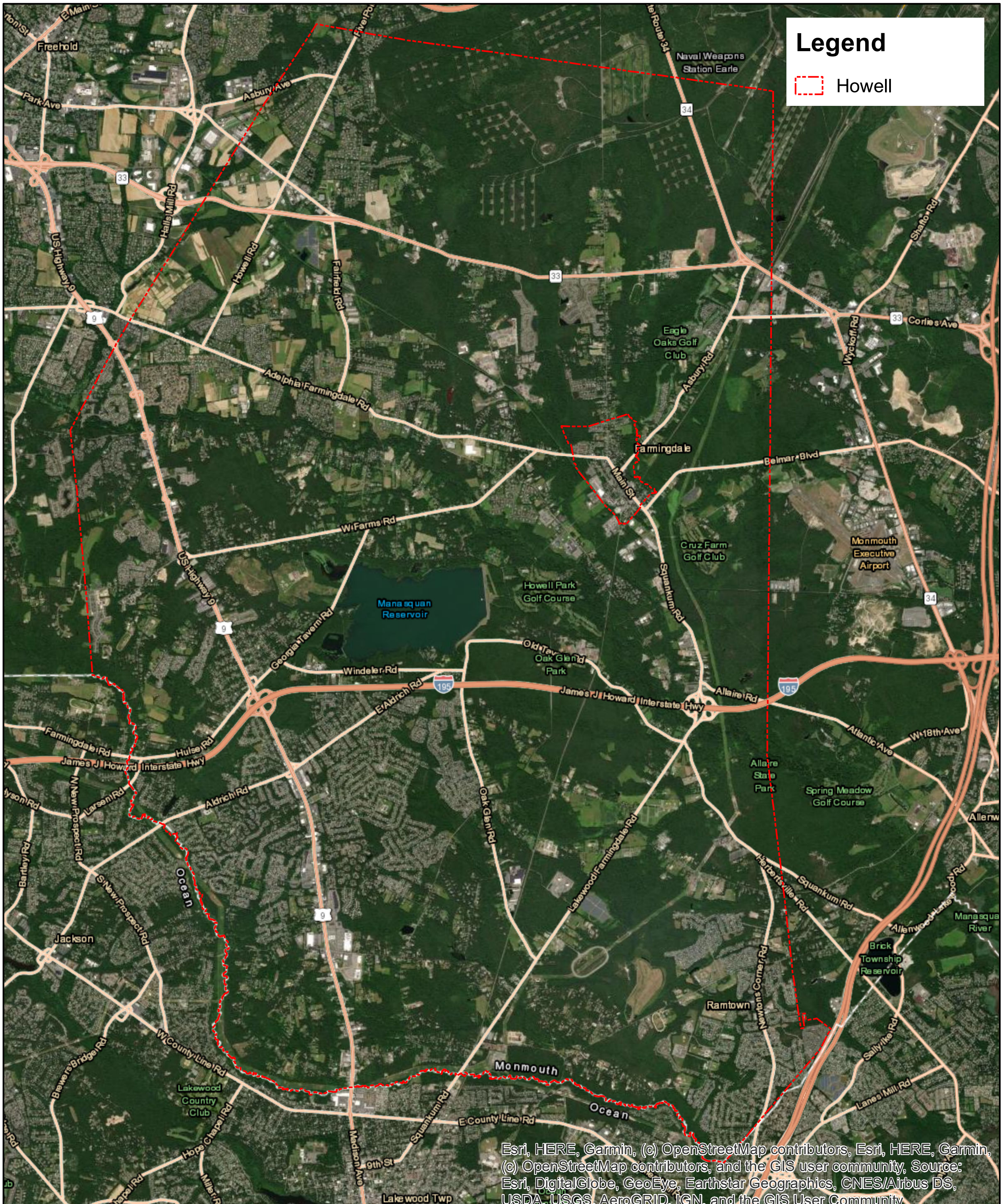

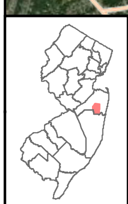

Figure 2.2. Howell Township, Aerial Photography

Note: ESRI's aerial photography is a composite of sources,therefore there is no way to obtain the date for a specific area. According to ESRI, the data is from typically within 3-5 years of currency, for most of the world.

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, ESRI

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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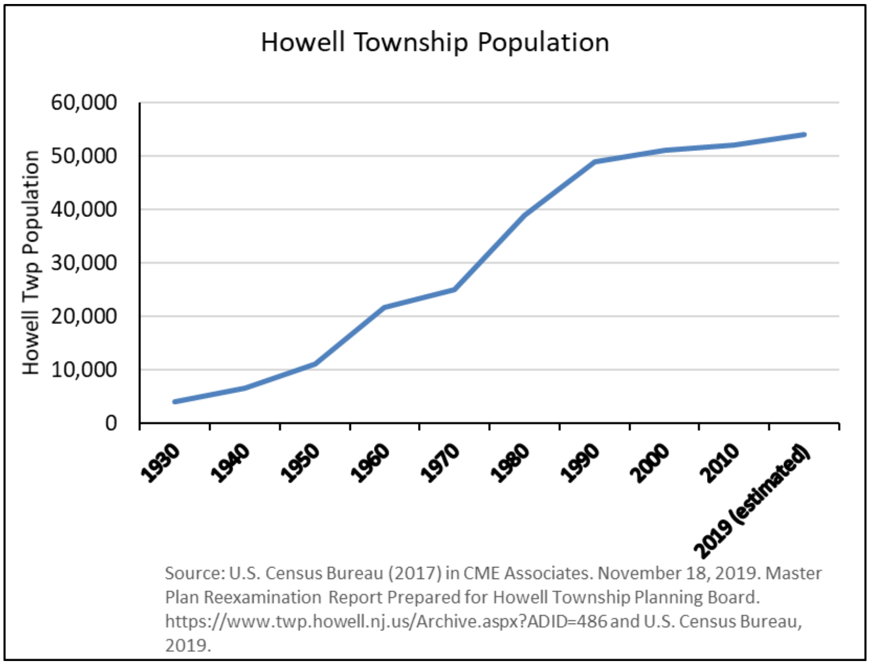


Howell Township Census
51,952 Population
60.3 square miles
862.1 people per square mile
(U.S. Census Bureau, 2019)

3Figure 2.3. Howell Township Population 1930-2019

2.3 LAND USE

The New Jersey Department of Environmental Protection (NJDEP) used aerial photography taken in 1986, 1995, 2002, 2007, 2012 and 2015 to determine land use and land use change. The Land Use Type is the generalized category of six land uses: agriculture, barren, forest, urban, water and wetlands. Definitions are as follows (USGS, 2010):

Agriculture includes all lands used primarily for the production of food and fiber and associated farm structures. In Howell Township this consists of 2,838.25 acres, which are primarily pastureland, cropland, and "other agriculture," a category that includes horse farms.

Forest land is covered by woody vegetation (excluding wooded wetlands, which are included in the wetlands category) and includes overgrown shrubby fields. These areas are capable of producing timber and other wood products, and of supporting many kinds of outdoor recreation. Howell has 7,519.10 acres categorized as forest, which are primarily mature deciduous forest. Forests are important environmentally because they affect air quality, water quality, wildlife habitat and climate.

Any areas periodically covered with surface water are included in the *water* land use type. Howell has 1,016.31 acres covered by surface water, of which 706 acres is the Manasquan Reservoir. *Wetlands* are those areas that are inundated or saturated by surface or ground waters at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. The 13,474.46 acres of wetlands in Howell Township are primarily deciduous forested wetlands, with lesser amounts of mixed deciduous/coniferous forested wetlands and small amounts of shrubby, herbaceous, and disturbed wetlands. Disturbed wetlands, a combined 1,645.95 acres, include formerly natural wetlands that have been altered (sometimes filled) and are now part of rights-of-way, managed recreational areas, and agriculture, but which still show signs of soil saturation on the aerial imagery. These altered wetland areas do not currently support typical wetland vegetation but are vegetated primarily by grasses and other planted vegetation that may be routinely mowed or farmed. Wetlands are further discussed in **Section 7.4** of this report.

Barren Land includes areas being developed or cleared at the time the photos were taken, which total 431 acres.

The *Urban Land* type is characterized by intensive land use where the landscape has been altered by human activities. It encompasses various categories of residential, commercial, educational, and industrial land. The largest portion of Howell Township is in this category, totaling 13,869.8 acres.

The 2015 land use types within the Township of Howell are illustrated in **Figure 2.4** and summarized in **Table 2.1**. Howell Township is approximately 35.4% urban, 34.4% wetlands, 19.2% forest, 7.2% agriculture, 2.6% water and the remaining 1.1% is barren land. Detailed categories of land use/land cover are shown in **Section 8.1** of this report.

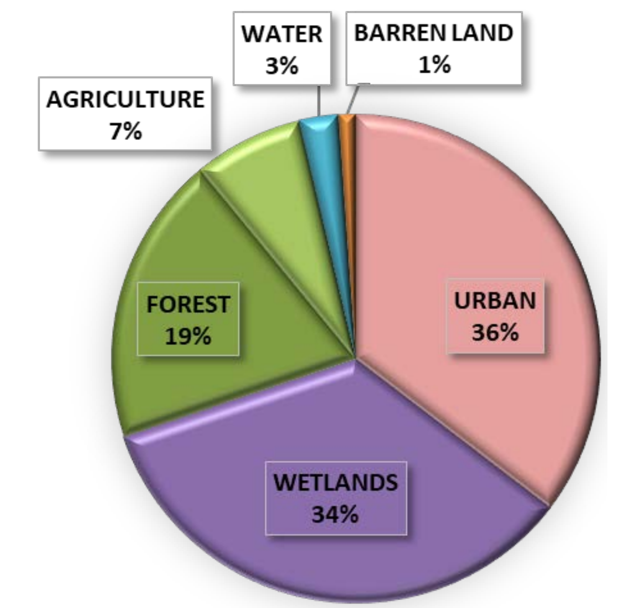
Table 2.1. 2015 Land Use Types

Land Use Type (2015)	Acres*	Percent of Howell Township
AGRICULTURE	2,838.2	7.2%
BARREN LAND	431.0	1.1%
FOREST	7,519.1	19.2%
URBAN	13,869.8	35.4%
WATER	1,016.3	2.6%
WETLANDS**	13,474.5	34.4%
Total:	39,149.0	100.0%

* Acreage from the GIS data may vary from acreage calculated based on tax maps.

Only an official determination from NJDEP, called a "Letter of Interpretation" (LOI) can verify the presence, absence, or boundaries of freshwater wetlands. See **Section 3.5 for more information about wetlands.

Source: NJDEP, 2015; USGS, 2010.



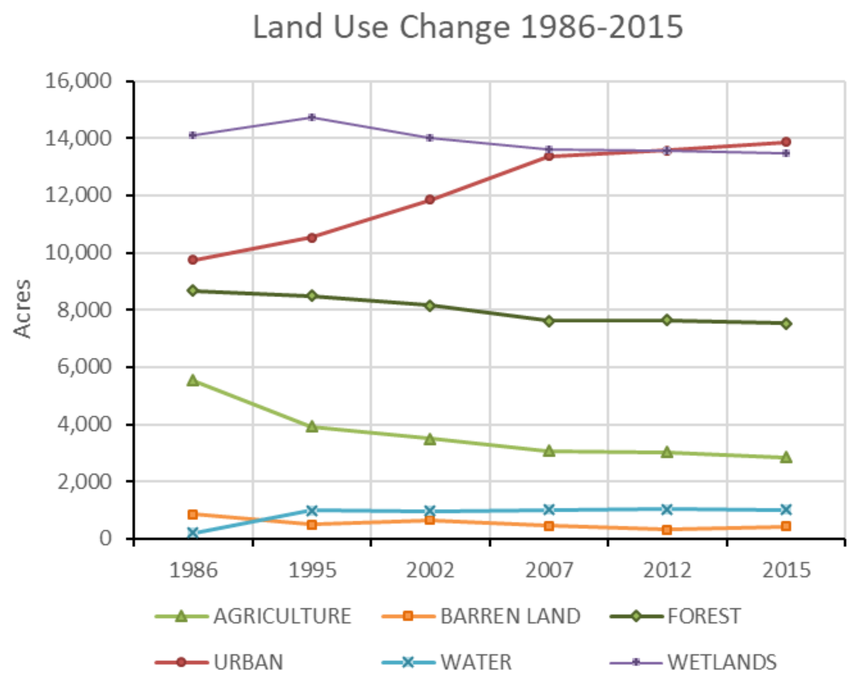
2.4 LAND USE CHANGE

Table 2.2 shows the shifting acreage in each land use type from 1986 through 2015, as well as the total change in percent cover during that time period. **Figure 2.5** highlights the areas that have changed to urban or barren land use types from natural land use types or agriculture over this time period. Both the table and the map illustrate a trend towards more urban land, which has increased by 10.5% during this time frame. A 6.9% decrease in agriculture in which agricultural lands have been primarily transitioned to urban land. In addition, there are fewer acres of natural lands than there were 29 years ago, with forests decreasing by 2.9% and wetlands decreasing by 1.6%. There has also been a 2% increase in area covered by water.

Route 9. Photo credit: J. Osborne

Table 2.2. Changes in Land Use Type*

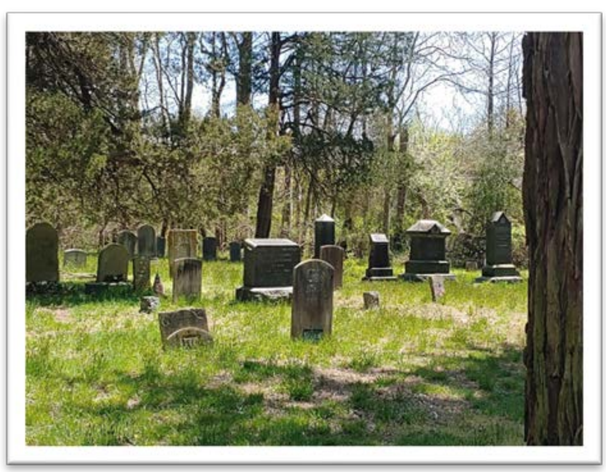
Land Use Type	1986 Acres	1995 Acres	2002 Acres	2007 Acres	2012 Acres	2015 Acres	29 Year Change in Acres	29 Year Change in % of Township
AGRICULTURE	5,532.1	3,926.2	3,499.3	3,073.5	3,025.4	2,838.2	-2,693.9	-6.9%
BARREN LAND	864.9	486.4	644.3	457.1	328.2	431.0	-433.9	-1.1%
FOREST	8,668.2	8,501.1	8,153.4	7,616.7	7,648.7	7,519.1	-1,149.1	-2.9%
URBAN	9,747.5	10,518.4	11,854.8	13,374.3	13,568.3	13,869.8	4,122.4	10.5%
WATER	211.3	980.1	967.5	1,009.8	1,029.3	1,016.3	805.0	2.1%
WETLANDS	14,098.9	14,736.7	14,029.6	13,617.7	13,549.1	13,474.5	-624.5	-1.6%
Total:	39,123.0	39,149.0	39,149.0	39,149.0	39,149.0	39,149.0	26.0	0.1%



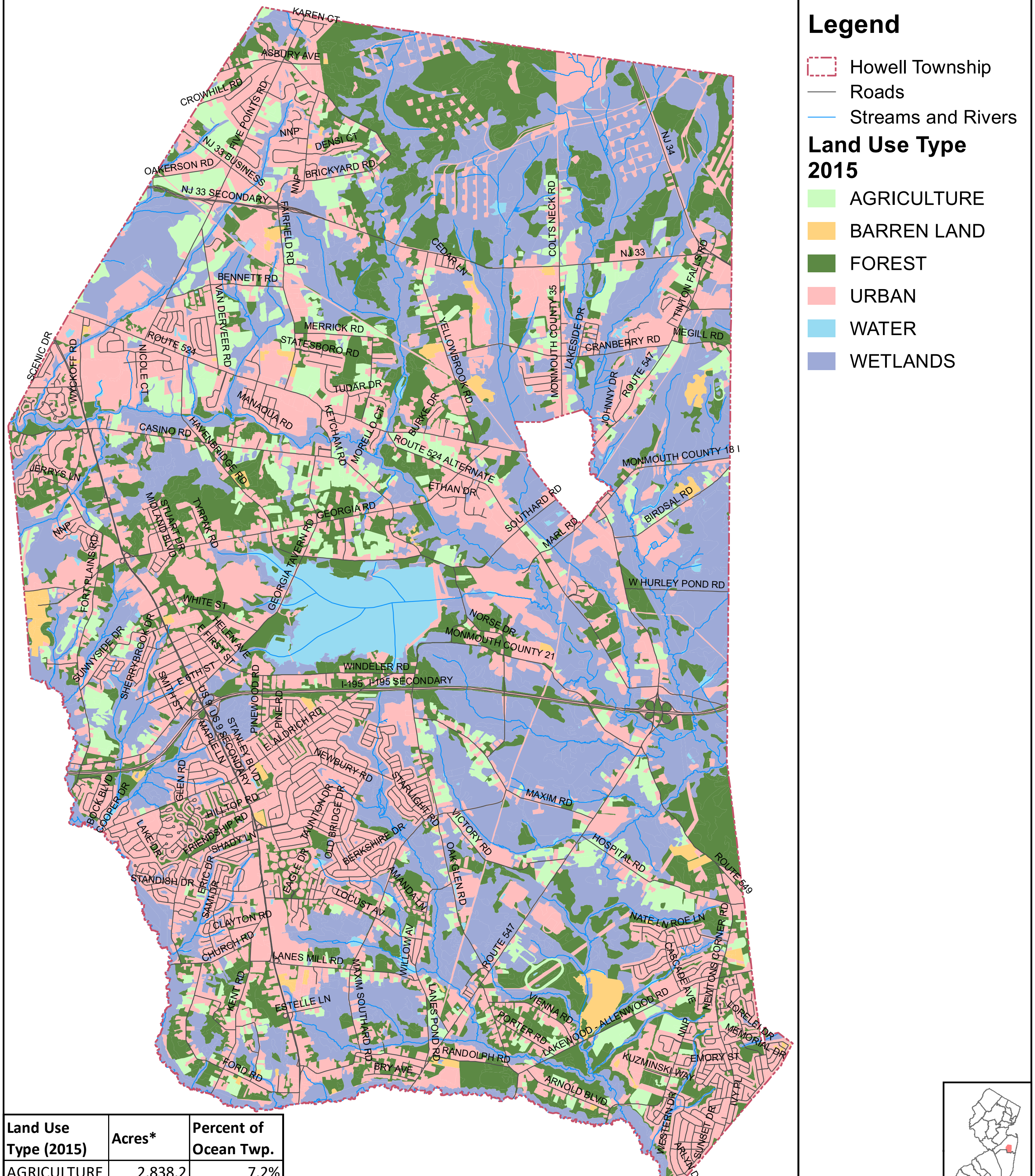
* Acreage from the GIS data may vary from acreage calculated based on tax maps.

Sources: NJDEP, Bureau of Geographic Information Systems (BGIS), January 28, 2019 (2015 land use); February 17, 2015 a and b (2012 land use); July 12, 2010 a and b (2007 land use); March 4, 2008 a and b (2002 land use); and December 1, 2000 (1995/1997 and 1986 land use).

Buddhist Temple, Freewood Acres.
Photo credit: J. Osborne



Quaker burial ground.
Photo credit: J. Osborne



Land Use Type (2015)	Acres*	Percent of Ocean Twp.
AGRICULTURE	2,838.2	7.2%
BARREN LAND	431.0	1.1%
FOREST	7,519.1	19.2%
URBAN	13,869.8	35.4%
WATER	1,016.3	2.6%
WETLANDS	13,474.5	34.4%
Total:	39,149.0	100.0%

* Acreage from the GIS data may vary from acreage based on tax maps.

Source: NJDEP, 2019

Figure 2.4. Howell Township, Land Use Type 2015

Data Sources: NJDEP, NJDOT

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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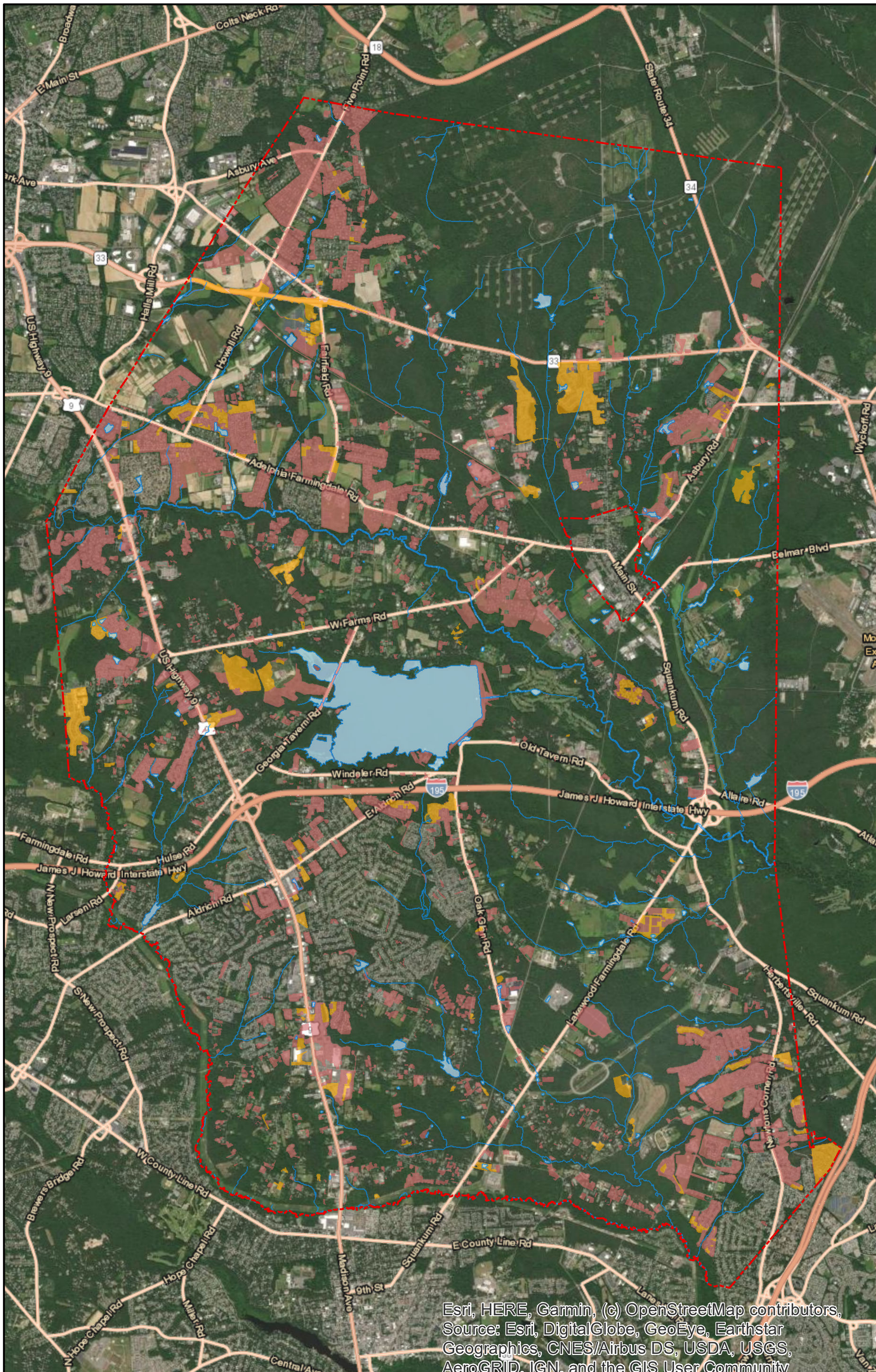

Legend

- Howell Township
- Water
- Streams and Rivers

Change in Land Use to Urban or Barren Land 1986 to 2015

- BARREN LAND
- URBAN

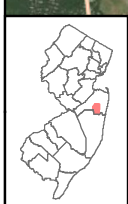

Figure 2.5. Howell Township, Land Use Change

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, ESRI

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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US Geological Survey (USGS). 2010. Edited by NJDEP, Bureau of Geographic Information Systems (BGIS) 1998, 2000, 2001, 2002, 2005, 2007, 2010. NJDEP MODIFIED ANDERSON SYSTEM 2007 derived from: A Land Use and Land Cover Classification System for Use with Remote Sensor Data, USGS Professional Paper 964, 1976. 35 pages. http://www.state.nj.us/dep/gis/digidownload/metadata/lulc07/anderson2007.html

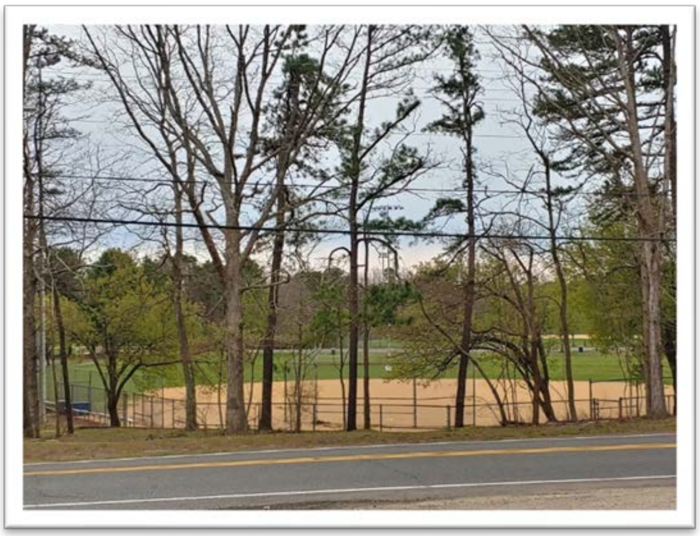
INTERNET RESOURCES: BACKGROUND

Demography

Census Profile Page for Howell Township: https://censusreporter.org/profiles/06000US3402533300-howell-township-monmouth-county-nj/

Land Use

Land Use Chapter from 2016 Monmouth County Master Plan: http://co.monmouth.nj.us/documents/24/MP%20-%20Chapter%202.pdf



Howell Central Little League Baseball Fields.
Photo credit: J. Osborne

3. CLIMATE, METEOROLOGY AND AIR QUALITY

3.1 CLIMATE

Weather station in Howell Township at 40.192056, -74.196238. Photo credit: J. Dodds

The American Meteorological Society defines weather as atmospheric variations on the short-term (minutes to days), including characteristics such as temperature, precipitation, and wind. In contrast, *climate* is defined as meteorological conditions in terms of long-term averages (a month or more) (American Meteorological Society, 2020).

Climate is a major factor in determining the kinds of plants and animals found in an ecosystem. New Jersey has a temperate climate because it has mild average temperatures, four seasons, and rainfall distributed throughout the year. The dominant atmospheric circulation is the prevailing westerlies; the broad, undulating flow of air from west to east across the middle latitudes of North America. Prevailing winds are from the southwest in summer and from the northwest in winter (ONJSC, undated).

In a 2010 report, the New Jersey State Climatologist evaluated more than a century of data from 19 stations around the state in order to chart weather variables over the past century (e.g. min. and max. temperature, precipitation). The weather station nearest to Howell Township that was evaluated for this climate study was the Long Branch/Oakhurst Station[4], which was monitored from 1907 through 2007 (Robinson, 2010; Hartman, 2002). That site is not currently being monitored, but a site within Howell Township has been monitored since 2008[5]. Analysis of this data, plus data for other sites throughout the state, has led the State Climatologist to conclude, a "Preponderance of evidence suggests climate change is occurring and humans are responsible for a significant portion of recent changes." (Robinson, November 18, 2015).

According to the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), the temperature trend (annual average) in Monmouth County is +0.3°F per decade, and the precipitation trend is +0.25 inches per decade for the period of record from 1895 to 2019 (NOAA, January 16, 2020), illustrated in **Figure 3.1.**

[4] The Long Branch weather monitoring station was located northeast of Howell Township in Long Branch City (Lat 40'17" Lon 74'00" and 30' above sea level), Monmouth County.

[5] NJ Weather and Climate Network for Howell, NJ: https://www.njweather.org/station/3397 (Precipitation from 2/2008 to present; temperature from 5/2012 to present)

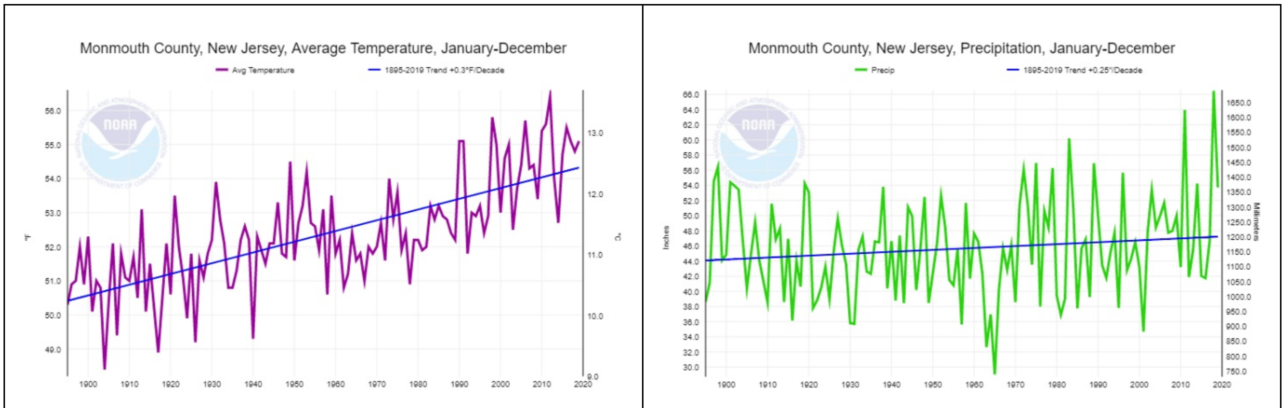


Figure 3.1. Monmouth County Average Temperature and Average Precipitation Trends

Source: NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published January 2020, retrieved on January 16, 2020 from https://www.ncdc.noaa.gov/cag/

6Figure 3.1. Monmouth County Average Temperature and Average Precipitation Trends

NOAA summarizes New Jersey's climate as follows:

- Average annual temperatures have increased by 3°F over the past century.
- Precipitation has been variable, with wetter than average conditions over the past decade.
- Sea level along the New Jersey coast has risen by more than 16 inches over the past century (Runkle et. al., 2017)

In addition, the NCDC calculates state *normals* (three-decade averages) of climatological variables, including temperature and precipitation. The normal maximum temperature for New Jersey has increased between 0.5 to 0.7°F for 1981-2010 compared to the 1971-2000 period. Normal minimum temperature for the state has increased 0.3 to 0.5°F (NOAA, May 16, 2011).

The impacts of climate change in New Jersey may include increasing temperature, changing precipitation patterns (more intense river flooding during winter and spring, and drought during summer and fall), rising sea levels, retreating shores, saltwater intrusion, infrastructure damage, challenges for agriculture and fishing, and increased risks to human health (such as increasing respiratory ailments and diseases such as Lyme disease) (USEPA, August 2016).

Online sea level rise and flood mapping tools are listed in **Internet Resources**.

3.2 PRECIPITATION AND TEMPERATURE

As the prevailing westerly winds shift north and south and vary in strength, they bring wet, dry, hot, and cold airstreams. These influence the weather throughout New Jersey, resulting in highly variable daily weather. The Office of the New Jersey State Climatologist (ONJSC) divides New Jersey into five distinct climate regions. Howell Township straddles the boundary between the Coastal Zone and the Pine Barrens Zone (ONJSC, undated).

Weather in the coastal zone is determined by both continental and oceanic influences. Proximity to the Atlantic Ocean has a moderating effect on air temperatures, resulting in more gradual changes and less extreme fluctuations than elsewhere in the state. Between October and April, the coastal zone is especially prone to storms that track along the coastal plain or offshore, bringing strong winds and heavy rains to the region. The coastal zone is particularly vulnerable to tropical storms and hurricanes, which may account for a significant amount of the regional precipitation in a given year. In addition to rain and wind, damage from high tides is often associated with severe coastal storms.

Further inland, weather in the Pine Barrens zone is influenced by the porous and infertile soils. In the Pine Barrens, differing patterns of solar radiation and drier surface conditions lead to greater fluctuations in temperature and make the region more vulnerable to fire (ONJSC, undated).

The ONJSC's New Jersey Weather and Climate Network maintains weather stations which transmit real-time data and weather forecasts on the Internet. One hundred years of data from the Long Branch/Oakhurst weather station (1908-2017) is summarized in **Table 3.1** which displays monthly average high, low, and mean temperatures, record highs and lows, and average monthly precipitation. Presently, there is an active station along West Farms Road in Howell Township which has been running since January 21, 2008. Current local conditions and forecasts for the area are available at http://www.njweather.org/station/3397.

Current local conditions and forecasts
http://www.njweather.org/station/3397

Measurable precipitation falls in New Jersey on approximately 120 days per year. At the Long Branch/Oakhurst weather station, annual precipitation averaged 48.66 inches (for the period 1908-2017), which is near the higher end of the range of 40 to 51 inches in New Jersey (see **Table 3.1**) (ONJSC, Undated; ONJSC, 2020a).

Rainfall is distributed fairly evenly throughout the year, with February being the driest month. On average, August has the highest precipitation, but conditions may appear drier because evapotranspiration exceeds precipitation (ONJSC, 2020b). The portion of Monmouth County that includes Howell Township averages more than 14 days per year with precipitation one inch or greater, while precipitation levels exceeding two inches are only likely to occur two to three days per year (ONJSC, 2020c).

Table 3.1. Temperature & Precipitation Records from Long Branch, NJ, 1908-2017

Month	Temperature (°F)					Cumulative Average Precipitation
	Avg. High	Avg. Low	Mean	Record High	Record Low	
January	41.2	24.1	32.7	76°F (1950)	-8°F (1984)	4.21 in.
February	43.3	26.3	34.8	78°F (1985)	-12°F (1934)	3.04 in.
March	49.5	32.7	41.1	87°F (1945)	5°F (1943)	4.16 in.
April	58.7	41.4	50.1	92°F (1929)	12°F (1923)	4.39 in.
May	68.1	50.5	59.3	97°F (1925)	29°F (1978)	4.05 in.
June	77.8	60.7	69.3	99°F (1925/34/52/88)	37°F (1938)	3.48 in.
July	82.8	65.9	74.3	106°F (1936)	45°F (1984)	4.77 in.
August	81.3	65.2	73.2	101°F (1948, 2001)	43°F (1976)	5.02 in.
September	75.7	58.0	66.8	98°F (1983)	32°F (1983)	3.62 in.
October	65.6	46.4	56.0	95°F (1941)	24°F (1983)	4.42 in.
November	56.1	38.3	47.2	83°F (1950)	13°F (1929/30)	3.61 in.
December	46.4	29.2	37.8	74°F (1984)	-10°F (1942)	3.89 in.
					Average Annual Precipitation:	48.66 in
Source: ONJSC, 2018a http://climate.rutgers.edu/stateclim_v1/dailynormalsextremes.html						

Snow typically contributes relatively little to the total precipitation in Howell Township (about 10" of snow equals 1" of rain). Records from the Long Branch/Oakhurst station show an average seasonal total of 18-21 inches. However, the annual snowfall totals are highly variable, ranging from 1.0 inches during the winter of 1972-1973 to 64.2 inches during the winter of 1947-1948 (ONJSC, 2020d).

The Monmouth County growing season averages about 181 days, although the season is highly variable within the county due to coastal influences. The average date for the last killing spring frost is April 20th, and the first frost of fall occurs around October 19th (USDA, 1989).

3.3 EXTREME WEATHER

Most areas of New Jersey receive 25 to 30 thunderstorms per year, with fewer storms near the coast than farther inland. In addition, each year between 1 and 10 nor'easters bring strong winds and heavy rains to the state, particularly in the coastal zone. Approximately five tornadoes appear each year in New Jersey (usually relatively weak ones) (ONJSC, undated). Eleven tornadoes have been recorded in Monmouth County since 1950, occurring in 1952, 1955, 1960, 1964(2), 1994, 1997, 2001, 2011 and 2017 (2) and two funnel clouds have also been documented (in 2000 and 2006). During the same period, 56 hail events were recorded throughout the County (NOAA, 2020).

Sledding on Municipal Center Hill.
Photo credit: J. Osborne

Table 3.2 lists some of the highest snow and rainfall received in one month at the Long Branch/Oakhurst weather station for the period 1893 to 2019 (the most recent data available on the Internet) (ONJSC, 2020b and 2020d).

Tropical storms and hurricanes can contribute significant rainfall and can cause flooding, with the added dynamic of high wind. Some of the major storms that have affected eastern Monmouth County are described here. Hurricane Floyd battered New Jersey on September 16, 1999, and the toll was greatest in the northern and central regions of the state. Other noteworthy tropical storms in recent years include Bertha (July 13, 1996), Isabel (September 18-19, 2003), Hanna (September 6, 2008) and Irene (August 27, 2011). Although post-tropical, Superstorm Sandy (October 28-30, 2012) was the costliest natural disaster in New Jersey, and the hardest hit areas were the coastal regions of Monmouth and Ocean Counties (NOAA, 2020). Ten days prior to the storm, eastern Monmouth County had received over two inches of rain in a 24-hour period. Sandy then delivered heavy rain, a record coastal storm surge and hurricane-force wind gusts. Some of the highest wind speeds recorded during that event were in Monmouth County (Robinson, 2012).

Table 3.2. Highest Monthly Precipitation Measured at Long Branch, NJ

Rank	Greatest Monthly Snowfall		Greatest Monthly Rainfall	
	Amount	Date	Amount	Date
1st	34.2"	March 1914	16.17"	July 1938
2nd	32.9"	December 1947	14.24"	October 2005
3rd	32.7"	February 1934	12.07"	June 2013
4th	26.5"	December 1964	11.81"	September 1938
5th	25.7"	February 1967	11.80"	August 1992
6th	24.5"	February 1979	10.49"	December 1974
Source: ONJSC, 2020b and 2020d				

Although the risk of coastal flooding primarily threatens Monmouth County's eastern municipalities, Howell Township could still experience impacts from a Category 4 storm (**Figure 3.2**). The NJ Floodmapper (2019) does not predict any coastal flooding impacts to the township from storms in Categories 1 to 3. Other types of flood risks are discussed in **Section 7.3**.

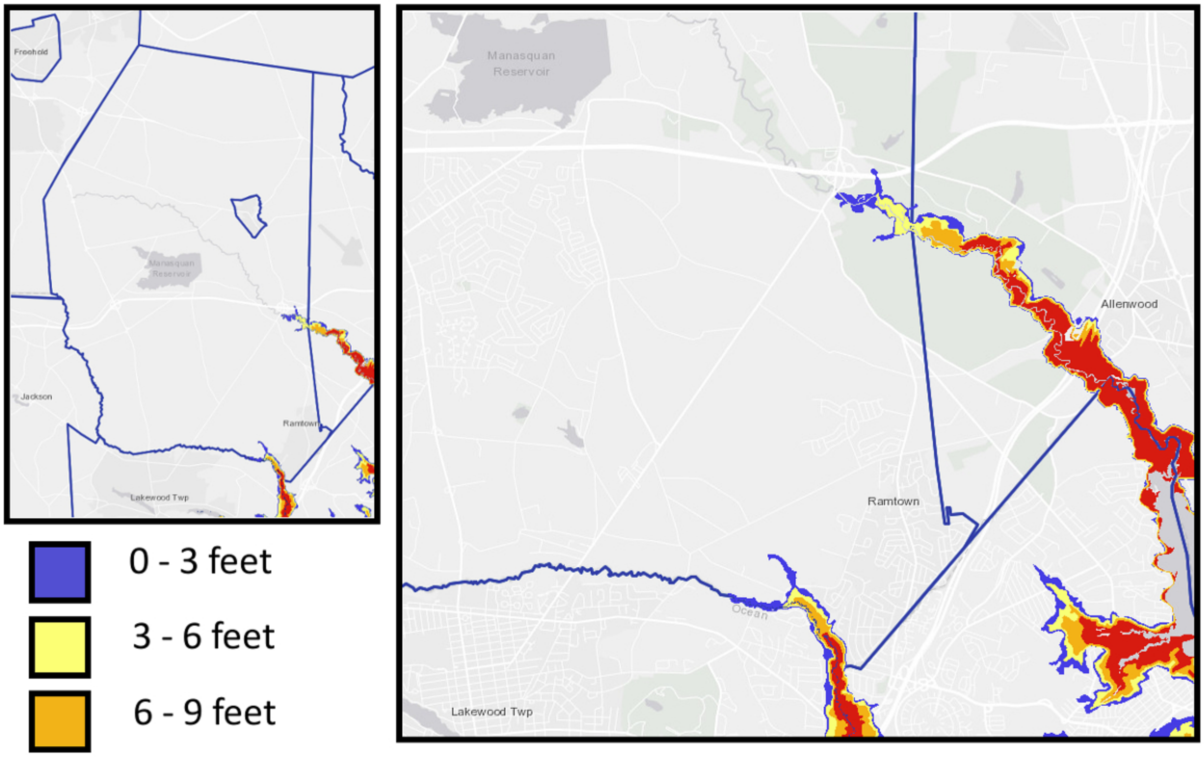


Figure 3.2. Predicted Coastal Flooding Impacts to Howell Township from a Category 4 Storm. Township-wide impacts (left) are limited to the southeastern section of Howell (right). Source: NJ Floodmapper, 2019.

7Figure 3.2. Predicted Coastal Flooding Impacts to Howell Township from a Category 4 Storm

At the other extreme, extended periods of time with less than normal amounts of precipitation result in drought; agriculture suffers, wells can fail, reservoir levels fall, and water supplies can be threatened. NJDEP (2020a) has divided the state into six regions for the purpose of water supply monitoring, and provides information about droughts for each region using indicators of 90-day precipitation, 90-day stream flow, reservoir levels and ground water levels for each region. Howell Township lies within the Coastal North Drought Region.

Table 3.3. Lowest Annual Precipitation*

Rank	Year	Amount (inches)	Deviation from Mean
1st	1988	32.63"	- 14.73"
2nd	1985	34.48"	- 12.88"
3rd	1921	35.73"	- 11.63"
4th	1963	35.83"	- 11.53"
5th	1922	36.16"	- 11.20"
*Recorded at Long Branch, NJ 1907-2019; mean = 47.36 inches			
Source: ONJSC, 2020b			

During a *drought watch*, voluntary water conservation measures are encouraged. During a *drought warning*, measures are taken to manage water supplies in order to avert a *drought emergency*.

A water supply emergency results in mandatory restrictions on water use in order to curtail water demand. New Jersey's longest and most severe drought occurred in the 1960s, extending from June 1961 through August 1966 (Bauersfeld et. al., 1989), and resulted in a major disaster declaration for the state (FEMA, 2017). FEMA (2017) also lists an emergency declaration for the state during the drought of June 1980 to April 1981. The most recent long-term drought of significance began in October 2001, was declared an emergency in March 2002 and ended in January 2003 for north and central New Jersey, while recent drought watches were implemented during 2010 and 2016 (NJDEP, 2019). Local rainfall records from the weather monitoring station in Long Branch indicate that average annual precipitation in the area is 47.36 inches (ONJSC, 2020b). The five years with lowest precipitation, based on long-term data from the Long Branch site, are shown in **Table 3.3**.

3.4 AIR QUALITY

3.4.1 Introduction to Air Quality

The New Jersey Comparative Risk Project (March 2003), funded by the United States Environmental Protection Agency (USEPA) and the NJDEP, combined the efforts of 73 experts to analyze and rank 88 chemical, physical and biological factors ("stressors") according to their relative negative impacts on human health, ecological quality, and socioeconomic conditions (monetary cost). The study ranked several air pollutants among the highest risks to human health, including ground-level ozone, particulate matter, radon[6], secondhand tobacco smoke, and volatile organic compounds (VOCs). Air pollution is estimated to have medium to medium-high socioeconomic impact, and lesser impacts to ecological quality (Steering Committee of the NJ Comparative Risk Project, 2003).

Exposure to air pollution is a widespread problem that occurs throughout the entire state. Airborne pollutants come from a wide variety of sources, including industry, utilities, manufacturing and commercial sources, vehicles, and residential activities (such as oil burning for home heating, and painting houses). On hot summer days, when pollutant levels are worst, winds in New Jersey are usually blowing from the southwest, carrying air pollution from the Washington, Baltimore, and Philadelphia metropolitan areas to New Jersey. In turn, these winds carry the pollution created here to New York, Connecticut and further to the northeast.

After the passage of the Clean Air Act in 1970, the USEPA set National Ambient Air Quality Standards (NAAQS) for six pollutants, known as the *Criteria Pollutants:* nitrogen dioxide, lead, sulfur dioxide, ozone, carbon monoxide, and particulate matter. These pollutants are addressed throughout the country through a planning process and the concentrations of these pollutants in air have been monitored for compliance with the air quality standards. Since 1970, concentrations of these six pollutants have been significantly reduced throughout the country, although there has been a slight increase in particulate matter since 2016 (USEPA, 2019a and 2019b). Areas of the country where air pollution levels persistently exceed the NAAQS are designated *nonattainment*.

New Jersey has never exceeded the NAAQS for nitrogen dioxide (NO_2), and has not exceeded the standard for lead since the early 1970s. As of 2014, Warren County was the only county to exceed the sulfur dioxide (SO_2) standard, but since Pennsylvania's Portland Power Plant shut down its coal-fired units all of New Jersey is in attainment of the SO_2 standard. Portions of the state were previously nonattainment areas for 8-hour carbon monoxide (CO) and for both the particulate matter ($PM_{2.5}$)[7] annual standard of 15 $\mu g/m^3$,[8] and for the 24-hour 35 $\mu g/m^3$ standard (see **Figure 3.3 and Table 3.4**). Monmouth County is also part of the Northern New Jersey-New York-Connecticut nonattainment area

[6] Based on frequency of radon found in homes, Howell Township has Low potential for elevated radon concentrations, i.e. less than 5 percent of tested homes have radon concentrations greater than or equal to 4 pCi/L (NJGS, 2015).

[7] Particulate air pollution is covered in **Section 3.2.3.**

[8] $\mu g/m^3$ = micrograms per cubic meter of air (a microgram is one millionth (10^{-6}) of a gram).

for the Ozone standard (revised in 2015 to 0.071 ppm (see **Figure 3.3 and Table 3.4**) (NJDEP Bureau of Air Quality Planning, April 4, 2019).

Table 3.4. Monmouth County Nonattainment/Maintenance Status for All Criteria Pollutants

NAAQS pollutant	Nonattainment in Years	Redesignation to Maintenance	Classification
1-Hour Ozone (1979)	1992 to 2004	na (old standard)	Severe-17
8-Hour Ozone (1997)	2004 to 2014	na (old standard)	Moderate
8-Hour Ozone (2008)	2012 to 2019	na (old standard)	Serious
8-Hour Ozone (2015)	2018 to 2019	nonattainment	Moderate
Carbon Monoxide (1971)	Freehold only 1992-1995	2/5/1996	Not Classified
PM-2.5 (1997)	2005 to 2012	9/4/2013	Former Subpart 1
PM-2.5 (2006)	2009 to 2012	9/4/2013	Former Subpart 1
*Except for carbon monoxide, information is for Monmouth County as part of the New York-Northern New Jersey-Long Island, NY-NJ-CT nonattainment area Source: USEPA, October 31, 2020a			

The USEPA requires New Jersey to report the emissions from major sources annually. To accomplish this, NJDEP's Emission Statement Rule (N.J.A.C. 7:27-21) requires the annual reporting of emissions from all facilities (stationary sources) for the following air contaminants; carbon monoxide (CO), sulfur dioxide (SO_2), ammonia (NH_3), total suspended particulate matter (TSP), respirable particulate[6] matter (PM_{10} and $PM_{2.5}$), lead (Pb), volatile organic compounds (VOC), oxides of nitrogen (NO_x), carbon dioxide (CO_2), methane (CH_4) and the 36 toxic air pollutants (TAPs) when the annual emissions exceed threshold values (e.g. 5 tons of lead or 100 tons of carbon monoxide) (NJDEP, November 27, 2020). No facilities within Howell Township report any emissions that exceed these levels (NJDEP, November 27, 2020). **Table 3.5** lists all air permit actions within Howell Township in the past five years.

Table 3.5. Air Permit Actions in Howell Township 2015-2020

Facility	PI Number	Activity No:	Document Creation Date
19 PETROLEUM INC 1175 RT 33 W Howell, NJ 07731	A2193	GEN 180001	06/04/2018
BJS WHOLESALE CLUB #371 5371 RT 9 N Howell, NJ 07731	21801	GEN 150001	04/16/2015
BP 905 RT 33 Howell, NJ 07731	A9781	GEN 190001	03/05/2019
CRUZ FARM COUNTRY CLUB 55 BIRDSAIL RD Howell, NJ 07731	H8682	GEN 200001	01/14/2020
EASTERN CONCRETE MATERIALS INC - HOWELL PLANT 86 YELLOWBROOK RD Howell, NJ 07731	20605	GEN 160001 PCP 190002	08/15/2016 07/30/2019
EXXON CO USA-RT 9 EXXON 3-8936 RT 9 & STRICKLAND RD Howell, NJ 07731	A2377	GEN 200001	07/21/2020
GEORGE HARMS CONSTRUCTION CO INC 62 YELLOWBROOK RD Howell, NJ 07731	20513	GEN 170001	01/27/2017
HILLTOP BOOSTER STATION HILLTOP RD & RT 9 Howell, NJ 07731	21277	GEN 200001	04/30/2020
HOME DEPOT STORE #9331990 RT 9 Howell, NJ 07731	21543	GEN 180001	01/17/2018
HOWELL CITGO SERVICE STATION6870 RT 9 Howell, NJ 07731	A9042	GEN 190001	06/18/2019
HOWELL GAS SERVICE STATION 3400 RT 9 Howell, NJ 07731	A2290	GEN 190001	01/17/2019

Facility	PI Number	Activity No:	Document Creation Date
HOWELL MIDDLE SCHOOL SOUTH 220 RAMTOWN GREENVILLE RD Howell, NJ 07731	21270	GEN 200001	11/10/2020
		GEN 190002	10/03/2019
HOWELL SAKER SHOPRITE 4594 RT 9 S Howell, NJ 07731	21906	GEN 190001	07/01/2019
HOWELL TWP BD OF ED DEPT OF TRANSPORTATION 280 OLD TAVERN RD Howell, NJ 07731	21269	GEN 170001	09/20/2017
HOWELL TWP BD OF ED RAMTOWN SCHOOL 216 RAMTOWN-GREENVILLE RD Howell, NJ 07731	20663	GEN 180001	10/05/2018
HOWELL TWP BD OF ED TAUNTON SCHOOL 41 TAUNTON DR Howell, NJ 07731	20664	GEN 180001	10/05/2018
HOWELL TWP BUS GARAGE 1251 RT 9 N Howell, NJ 07731	20499	GEN 180001	10/09/2018
		GEN 200001	10/23/2020
		PCP 190001	06/10/2019
HOWELL TWP DPW 278 OLD TAVERN RD Howell, NJ 07731	H8928	GEN 160001	03/17/2016
		GEN 180001	07/02/2018
		GEN 180002	07/02/2018
		GEN 180003	07/02/2018
HOWELL TWP FIRST AID/OEM ANNEX 51 WINDELER RD Howell, NJ 07731	21877	GEN 180001	07/02/2018
HOWELL TWP HIGH SCHOOL SQUANKUM-YELLOWBROOK RD Howell, NJ 07731	20145	GEN 180001	02/09/2018
		GEN 180002	02/15/2018
HOWELL TWP TOWN HALL 4567 RT 9 - 2ND FL Howell, NJ 07731	21878	GEN 180001	07/02/2018
LIDL STORE 1414 4250 RT 9 Howell, NJ 07731	21929	GEN 200001	10/07/2020
LOWER MANASQUAN PUMP STATION RT 547 & I-195 Howell, NJ 07731	20422	GEN 170001	02/27/2017
LOWES OF HOWELL STORE #1676 4975 RT 9 Howell, NJ 07731	21505	GEN 170001	09/01/2017
LUKOIL SERVICE STATION #57724 3401 RT 9 Howell, NJ 07731	A2002	GEN 200001	05/19/2020
LUKOIL SERVICE STATION #57739 2510 RT 9 Howell, NJ 07731	A9728	GEN 190001	03/28/2019
MICKEY TRUCK BODIES INC 600 OAKERSON RD Howell, NJ 07731	21183	GEN 180001	07/21/2018
MTL - HOWELL SHOP 433 OAK GLEN RD Howell, NJ 07731	21828	PCP 160001	06/01/2016
NEW JERSEY NATURAL GAS CO RT 547 Howell, NJ 07731	20053	GEN 150001	12/08/2015
		GEN 160002	04/08/2016
		GEN 180001	01/23/2018
		PCP 150002	12/01/2015
NEZIBE H SADIK-NEZIHE H SADIK 2001 HWY 9 Howell, NJ 07731	A2239	GEN 150001	09/28/2015
NJAW - HOWELL OPS BUILDING 149 YELLOWBROOK RD Howell, NJ 07731	21927	GEN 200001	07/27/2020
PARKSIDE COMMONS PUMP STATION PARKSIDE COMMONS Howell, NJ 07731	20776	GEN 180001	02/23/2018
PMG #8720 4001 RT 9 Howell, NJ 07731	A2390	GEN 170001	07/21/2017
QUICKCHEK CORP 4253 RT 9 Howell, NJ 07731	A6720	GEN 160002	05/19/2016
		GEN 200001	05/26/2020
RESOURCE ENGINEERING LLC 34 RANDOLPH RD Howell, NJ 07731	21692	PCP 190001	09/16/2019
SHINS CLEANERS & TAILORS INC	L2097	GEN 200001	01/06/2020

Facility	PI Number	Activity No:	Document Creation Date
6477 RT 9 Howell, NJ 07731			
SOUTHARD ELEMENTARY SCHOOL 395 KENT RD Howell, NJ 07731	20385	GEN 180001	10/05/2018
UPPER MANASQUAN PUMP STATION 89 HAVENS BRIDGE RD Howell, NJ 07731	20403	GEN 170001	02/27/2017
WAWA FOOD MARKET #938 RT 9 & KENT RD Howell, NJ 07731	A9636	GEN 180001	11/06/2018
WAWA FOOD MARKET #955 2485 RT 9 Howell, NJ 07731	A9864	GEN 180001	12/18/2018
WELL #5 HOWELL ADDISON RD & NEW PROSPECT RD Howell, NJ 07731	21275	GEN 200001	04/30/2020
YELLOW BROOK ROAD WTP 19 YELLOW BROOK RD Howell, NJ 07731	21276	GEN 160001	02/01/2016
Source: NJDEP, November 22, 2020			

A real-time Air Quality Index (AQI) provides a descriptive rating and a color code (e.g. green=good) for levels of $PM_{2.5}$, O_3, NO_2, SO_2 and CO at twelve sites around the state (https://aqicn.org/map/newjersey/). The station closest to Howell Township is located at Rutgers University in New Brunswick. Another real-time monitoring resource was developed by the U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, National Park Service, tribal, state, and local agencies in order to provide the public with easy access to national air quality information. The nearest station to Howell Township is located at Monmouth University in West Long Branch, and monitors O_3 and $PM_{2.5}$ (AirNow, 2020). See **Internet Resources** for links to current air quality at the sites. The following paragraphs provide more information about ground-level ozone, particulates, air toxics and atmospheric deposition.

Real-time Air Quality Index Visual Map
https://aqicn.org/map/newjersey/

3.4.2 Ground-level Ozone

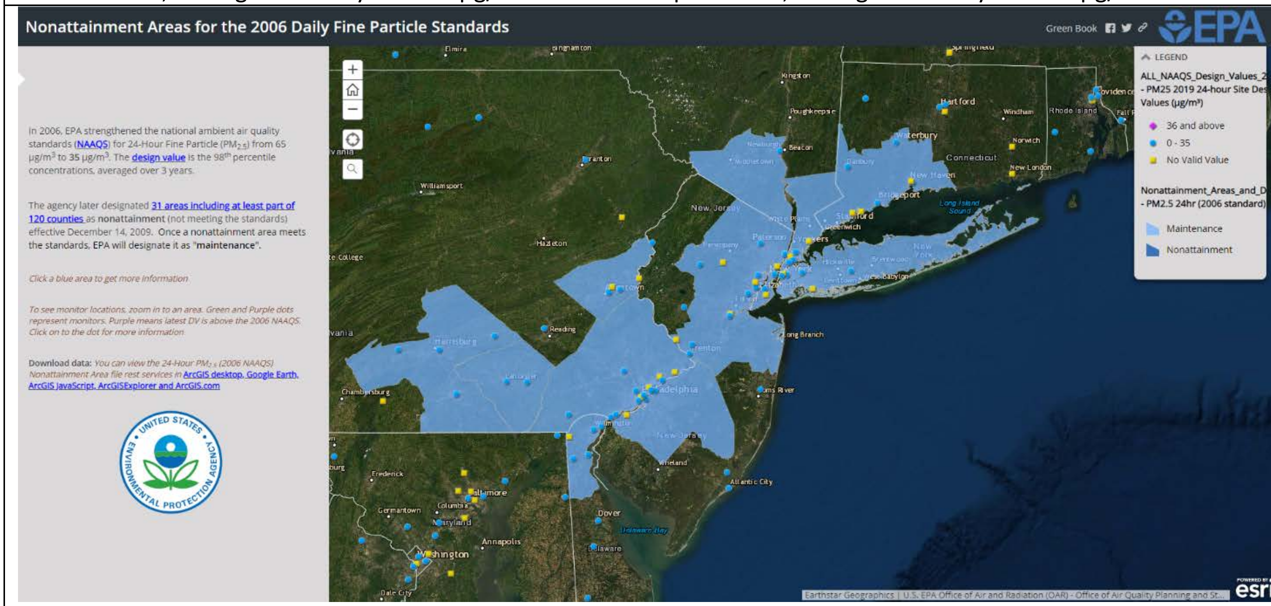
Ground-level ozone (O_3) causes serious adverse health and environmental effects. It forms in the air from volatile organic compounds (VOCs) and nitrogen oxides (NO_x) under conditions of high temperature and bright sunlight. Sources include vehicles, power plants and factories. The hottest days of summer can yield unhealthy levels of ozone.

The National Ambient Air Quality Standards (NAAQS) for ozone were revised in 2008 and again in 2015 because the USEPA determined that the previous standards were inadequate to protect public health. The standard of 0.071 ppm is calculated as an average over 3 years of the annual fourth-highest daily maximum 8-hour concentration (USEPA, December 31, 2019).

The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards. Using the most recent data throughout the state, the USEPA has classified northern New Jersey as being “moderate” and southern New Jersey as “marginal” for non-attainment of the 8-hour ozone NAAQS, as illustrated in **Figure 3.3**. A “marginal” area has a design value of 0.071 up to but not including 0.081 ppm. New Jersey’s 2015 Ozone Summary states that significant further improvements will require reductions in both VOCs and NOx, which will have to be achieved over a large region because levels in New Jersey are impacted by emissions from upwind sources (USEPA, December 31, 2019; NJDEP Bureau of Air Monitoring, 2015).

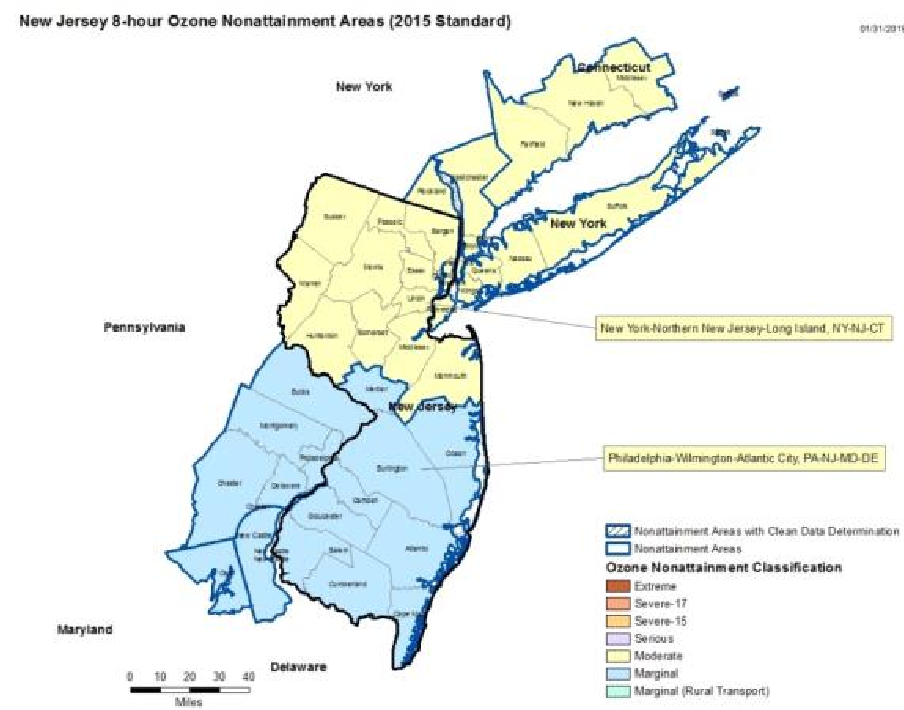
New Jersey Annual Fine Particulate Matter ($PM_{2.5}$) Nonattainment Areas

***Particle Pollution*, $PM_{2.5}$** [as of Dec 14, 2012]
Annual mean, averaged over 3 years=12 µg/m^3 24-hour 98th percentile, averaged over 3 years=35 µg/m^3



Source: USEPA, 2020a

New Jersey 8-Hour Ozone Nonattainment Areas (2015 standard)



***Ozone*, 8-hour**
[83 FR 25776, June 4, 2018]
Primary & secondary: Annual fourth-highest daily maximum 8-hour concentration averaged over 3 years = 0.075 ppm

Figure 3.3. National Ambient Air Quality Standards Nonattainment

Sources: NJDEP Bureau of Air Quality Planning, April 4, 2019 (CO & PM); USEPA, October 31, 2020b (Ozone).

8Figure 3.3. National Ambient Air Quality Standards Nonattainment

3.2.3 Particulates

Particulate air pollution consists of both solid particles and liquid droplets suspended in the atmosphere, usually less than 70 microns in diameter. In addition to human health and environmental effects, particulate matter is a major cause of reduced visibility. Particulate matter smaller than 2.5µ (µ=microns, equal to 0.001 millimeter) diameter ($PM_{2.5}$) are considered *Fine Particulates*, while larger particles are considered *Coarse Particulates*. Coarse Particulates are made up of Total Suspended Particulates (TSP) and Inhalable Particulates (PM_{10}). All sizes are harmful to the environment, but coarse particles smaller than 10 microns (PM_{10}) are inhalable, therefore are considered harmful to human health, while fine particles less than 2.5 microns ($PM_{2.5}$) are even more detrimental to human health. Coarse particle sources include windblown dust and industrial sources, while fine particles come from combustion sources or are formed in the atmosphere from gaseous emissions.

EPA has established National Ambient Air Quality Standards (NAAQS) for fine particles based on daily averages and on annual averages. From 2006 to 2008, an area called "New York-Northern New Jersey-Long Island," (**Figure 3.3**) including Howell Township, exceeded the daily average $PM_{2.5}$ standard. Air quality is slowly improving, and the New Brunswick site's 2019 design value was 18 µg/m^3. The entire New York-Northern New Jersey-Long Island area is now meeting the daily standard, with a current design value for 2017 to 2019 of 23 µg/m^3, therefore Howell is now in a $PM_{2.5}$ maintenance area (USEPA, 2020a).

In December 2012, the EPA revised the annual $PM_{2.5}$ standard from 15.0 µg/m^3 to 12.0 µg/m^3. An area will meet the standard if the three-year average of its annual average $PM_{2.5}$ concentration (at each monitoring site in the area) is less than or equal to 12.0 µg/m^3 (USEPA, November 14, 2018 and December 20, 2016). The annual design value at New Brunswick is 8.1 µg/m^3, therefore Howell Township is within an area attaining the annual $PM_{2.5}$ standard (USEPA, 2020b).

3.2.4 Air Toxics

In 1979, NJDEP adopted a regulation that specifically addressed air toxics emissions. This rule (Control and Prohibition of Air Pollution by Toxic Substances, N.J.A.C. 7:27-17) listed 11 Toxic Volatile Organic Substances (TVOS) and required that sources emitting those TVOS to the air should register with the Department and demonstrate that they were using state-of-the-art controls to limit their emissions (NJDEP Air Toxics in NJ, July 22, 2019a). Under the Clean Air Act Amendments of 1990, USEPA is required to begin to address a list of 188 of these air toxics (known as Hazardous Air Pollutants, or HAPs). NJDEP works with USEPA to implement these various strategies to reduce air toxics throughout the state.

The USEPA prepared a comprehensive inventory of air toxics emissions for the entire country as part of the National-Scale Air Toxics Assessment (NATA) in 1996 and most recently updated NATA in 2014 (released in 2018). The 2014 study update determined that, in New Jersey, on-road mobile sources are responsible for 37% of the toxic emissions; non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, dirt bikes, etc.) account for 31%; nonpoint/area sources contribute 29% (residential, commercial, and small industrial sources); and point sources account for the remaining 3% (USEPA, 2014; NJDEP, July 22, 2019b).

The NJDEP has established four comprehensive air toxics monitoring sites. They are located in Elizabeth, New Brunswick, Chester, and Camden. Pollutant concentrations are trending downward, but many of them still exceed the NJDEP health benchmarks (NJDEP, July 22, 2019c). A risk results analysis conducted in 2014 identified the chemicals of greatest concern both statewide and at the county level. Monmouth County results showed the highest risk ratios for Diesel particulate matter, Formaldehyde, Benzene, Carbon tetrachloride, Acetaldehyde, 1,3 Butadiene and Naphthalene (**Table 3.6**) (NJDEP, January 28, 2020).

Table 3.6. Modeled Air Toxics Concentrations and Sources

Pollutant	Modeled Air Concentration (µg/m³)	Health Benchmark (µg/m³)	Risk Ratio *	% Contribution by Source Category				
				Point Sources	Nonpoint Sources	Onroad Mobile	Nonroad Mobile	Background& Secondary
1,3-Butadiene	0.034	0.033	1	0%	15%	52%	28%	5%
Acetaldehyde	0.88	0.45	2	0%	2%	6%	3%	89%*
Benzene	0.47	0.13	3.6	1%	20%	47%	29%	3%
Carbon tetrachloride	0.55	0.17	3.2	0%	0%	0%	0%	100%
Diesel Particulate Matter	0.56	0.0033	169	0%	0%	53%	47%	0%
Formaldehyde	1.1	0.077	14	1%	3%	4%	4%	88%*
Naphthalene	0.03	0.029	1	2%	27%	40%	19%	12%

*Risk ratio = modeled air concentration divided by health benchmark. Ratios above 1 indicate exceeding the health benchmark. Pollutants with ratios below 1 are not included here.
Source: NJDEP, January 28, 2020

3.2.5 Atmospheric Deposition

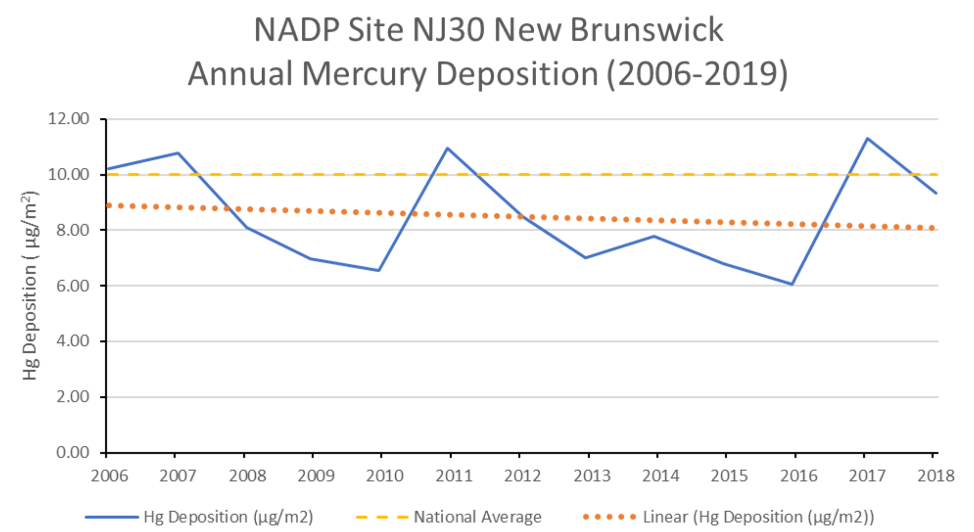
Pollution that is deposited on land or water from the air is called *atmospheric deposition.* Wet deposition is washed from the air by precipitation, while dry deposition refers to particulates that settle out of the atmosphere during dry weather. Sources include motor vehicles, power plants, and incinerators. The major pollutants of concern are sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and volatile organic compounds (VOCs). In addition, the presence of these pollutants changes the pH of the precipitation which can harm plants and aquatic life (trout are particularly sensitive) and deplete nutrients from soils.

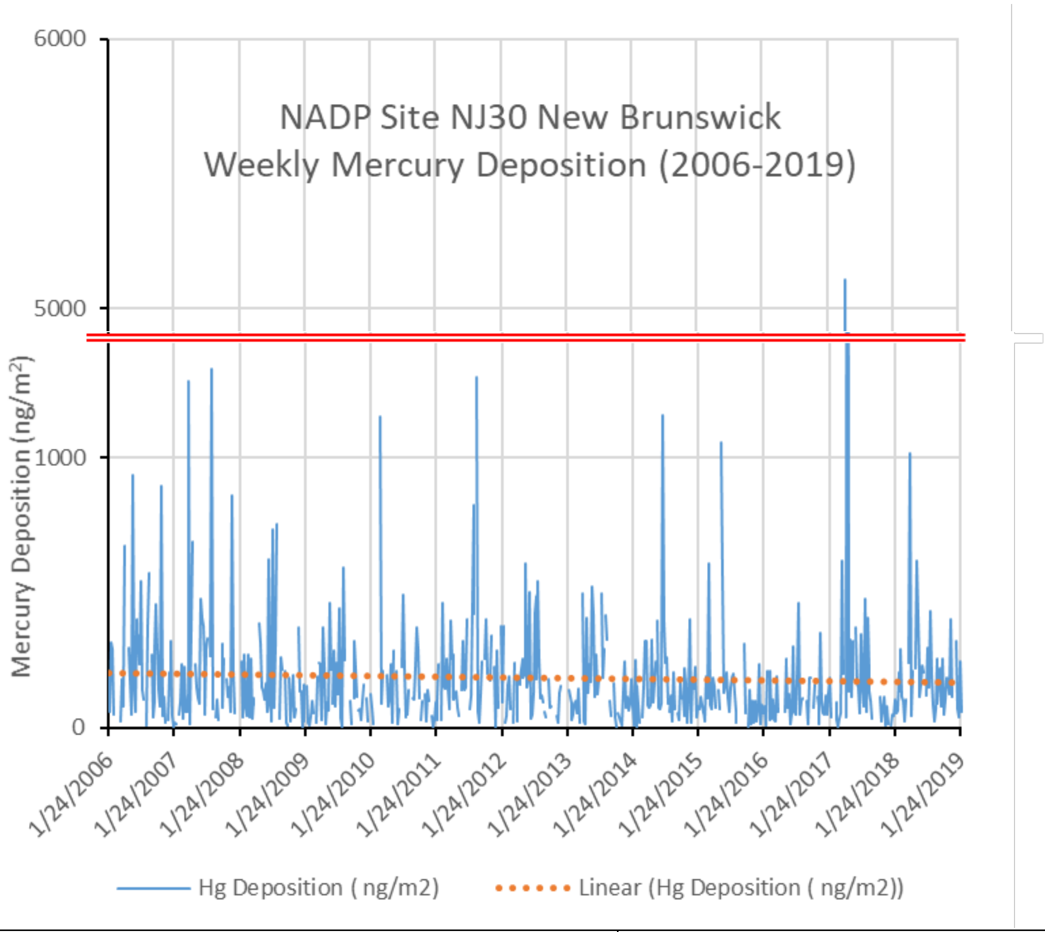
The closest National Atmospheric Deposition Program (NADP) site is located in Cattus Island Park in Ocean County, which has been monitored since December 2012. Results for 2018 show mean pH values of 5.18 (normal rainfall has a pH of about 5.6). This is acidic, but is an improvement from 2014, when pH averaged 5.04 at this site. Recent trends show an increase in the concentrations of a number of elements that were relatively stable from 2013-2015, including sulfate (SO_4), calcium (Ca), Magnesium (Mg), Potassium (K), sodium (Na), and chloride (Cl^-) (NADP, 2019a). No reasons for this apparent increase are presented.

Mercury (Hg) is a highly toxic heavy metal. Human health concerns of mercury include neurotoxicity (low-level exposure is linked to learning disabilities in children) and interference in reproduction, while both methyl mercury and mercuric chloride are listed by EPA as possible human carcinogens. Environmental effects have not been adequately studied, but animals, especially fish-eaters, experience effects similar to humans. The exposure to mercury is not from ambient air, but from deposition of airborne mercury onto surface water, vegetation, and soil, which can then enter the food and water supply. On the basis of preliminary data from the New Jersey Air Deposition Network, the deposition of mercury from the air fluctuates around the national average of 10 $\mu g/m^2/year$. In NJ, the major sources of mercury are steel and iron manufacturing, coal combustion, products (such as broken fluorescent tubes), and municipal and sludge incineration. Mercury persists in the atmosphere up to two years and reaches the surface through atmospheric deposition, where it may persist as methyl mercury in the soil for decades. Mercury is never removed from the environment but accumulates in biological tissue (bioaccumulation) (NJDEP New Jersey Mercury Task Force, December 2001) (see **Section 11.2** for Fish Consumption Advisories).

The NADP has monitoring programs for both atmospheric mercury and mercury deposition. In New Jersey, two sites are currently monitored for mercury as part of the Atmospheric Mercury Network (AMNet): NJ54 Elizabeth Lab and NJ30 New Brunswick. A former site at Brigantine was inactivated in 2015 when the other two sites started up (NADP, 2019b). The Mercury Deposition Network (MDN) provides a long-term record of total mercury (Hg) deposition in precipitation throughout the United States and Canada, including one site in New Brunswick, New Jersey. **Figure 3.4** illustrates weekly the average annual mercury deposition at the New Jersey site for the past thirteen years (NADP, 2020).

In addition to directly measuring mercury in precipitation, a study of mercury in lake sediment cores can be representative of atmospheric deposition over long periods of time. A 2003 study by the NJDEP Division of Science, Research and Technology examined sites throughout New Jersey and demonstrated that, while mercury levels had decreased, they were still present at levels far higher than natural levels (Kroenke et al, 2003; Schuster et al, 2004).





MDN Site NJ30 (New Brunswick) Latitude: 40.4728 Longitude: -74.4226 Date Range Displayed: weekly and annual data collected from 01/17/2006 to 1/22/2019	Average: 184.83 ng/m^2 Maximum: 5,106.48 ng/m^2 on 5/2/2017 Minimum: 2.48 ng/m^2 on 10/27/2015

Figure 3.4. Annual & Weekly Mercury Deposition at Site NJ 30 in New Brunswick

Depositions are calculated by multiplying the precipitation-weighted mean concentration by the precipitation.

Source: NADP, 2020

9Figure 3.4. Annual and Weekly Mercury Deposition at Site NJ30 in New Brunswick

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Internet Resources: Climate, Meteorology and Air Quality

Climate and Meteorology

NJ Weather and Climate Network: Current local conditions and forecasts are available for Howell, NJ: https://www.njweather.org/station/3397 (Precipitation from 2/2008 to present; temperature from 5/2012 to present)

Office of the New Jersey State Climatologist (ONJSC)

- ONJSC Home Page: http://climate.rutgers.edu/stateclim/
- NJ Drought Watch: http://www.njdrought.org/
- Regional Drought Information: https://www.nj.gov/dep/drought/current.html
- Weather and Climate Network Index: https://www.njweather.org/

National Weather Service Forecast Howell, NJ:
https://forecast.weather.gov/MapClick.php?lat=40.2539&lon=-74.0123

National Weather Service National Hurricane Center: https://www.nhc.noaa.gov/

Sea Level Rise

Climate Central Surging Seas Risk Finder: https://riskfinder.climatecentral.org/

NJ Coastal Communities Initiative: http://www.prepareyourcommunitynj.org/

NJ Flood Mapper (an interactive mapping website to visualize coastal flooding hazards and sea level rise):
https://www.njfloodmapper.org/

National Storm Surge Hazard Maps (map application, not real-time):
https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad

Air Quality
Current Air Quality: http://aqicn.org/city/usa/newjersey/rutgers-university/
https://airnow.gov/index.cfm?action=airnow.local_city&mapcenter=0&cityid=380

NJDEP Rules and Regulations (current and proposed): http://www.nj.gov/dep/rules/

Real-time Air Quality Index (AQI): https://aqicn.org/map/newjersey/

United States Environmental Protection Agency Air Topics: http://www.epa.gov/agriculture/air.html

What you can do to reduce air toxics? http://www.state.nj.us/dep/airmon/airtoxics/youcan.htm

4. PHYSIOGRAPHY, TOPOGRAPHY AND GEOLOGY

4.1 Physiography

Physiography, which combines the words "physical" and "geography," is the study of a location in relation to its underlying geology. New Jersey can be divided into four regions, known as *physiographic provinces*, which are areas with a common geologic history and similar sequences of rock types and geologic structures (see **Figure 4.1, inset**).

Allaire State Park exhibits flat topography that is common in Howell Township. Photo credit: J. Dodds

During the Precambrian and Paleozoic Eras, the land that is now New Jersey was at the bottom of the sea, close to the equator. About 400 million years ago, the continents Europe and North America collided; forming the Appalachian Mountains, which at that time reached far higher and were more rugged than the Rocky Mountains are now (Gallagher, 1997).

In New Jersey, the Appalachian Mountains are known as the *Valley and Ridge Province.* This Province is characterized by long, parallel ridges and valleys, and encompasses the northwestern section of New Jersey. High Point, with an elevation of 1,803 feet and the highest point in New Jersey, is located in this Province (NJGS, 2006).

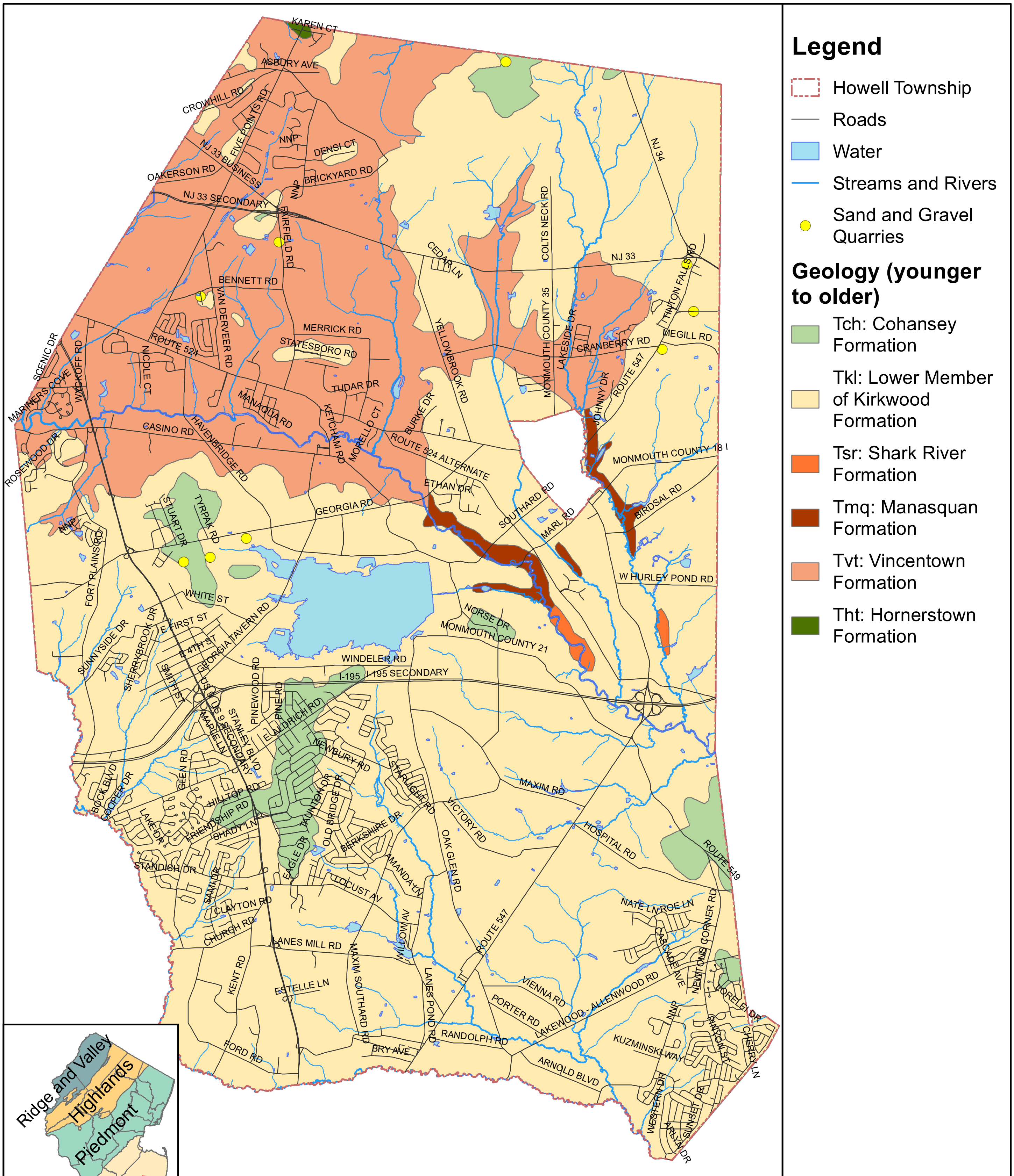
Bordering the Valley and Ridge Province to the southeast, the *Highlands Province* consists of a series of ridges. Metamorphic granite and gneiss rocks 1.2 billion to 900 million years old (the oldest rocks in the state) are resistant to erosion and create a hilly upland. Wawayanda Mountain is the highest point (1,496 feet) in the Highlands. Elevations decrease to the southeast and southwest. The Highlands Province is also characterized by deep, steep-sided valleys carved by streams (NJGS, 2006).

The Highlands Province is separated from the *Piedmont Province* by a series of major faults, where the crystalline rocks of the Highlands touch the much younger sedimentary and igneous rocks of the Piedmont. The Piedmont Province is characterized by gently rolling hills. The rocks of the Piedmont are of Late Triassic and Early Jurassic age, 240 to 140 million years old (NJGS, 2006).

Sediments that eroded from adjacent uplands were deposited along rivers and lakes within the basin, and they became compacted and cemented to form conglomerate, sandstone, siltstone, and shale bedrock. Roughly 200 million years ago, the supercontinent Pangaea broke apart, and the Atlantic Ocean was born. This was accompanied by volcanic activity, which resulted in magma flowing at the surface (forming basalt) or near the surface (forming diabase) (Lucey, 1971).

Overlapping the rock units of the Piedmont Province, the relatively flat terrain of the *Coastal Plain Province* consists of unconsolidated sedimentary formations, such as sands, clays, and marls. These range in age from 90 to 10 million years old (NJGS, 2006). The Coastal Plain Province is sometimes divided into the Inner and Outer Coastal Plains with Howell Township located in the latter.

Within the past two million years, the climate alternated between cool and warm. During periods of glaciation, the glaciers covered northern New Jersey and extended as far south as Perth Amboy, NJ, while the area below that, including what is now Howell Township, became cold tundra. At times, the Coastal Plain was under the Atlantic Ocean, although at other times, the shore may have extended a hundred miles beyond the present shore (White, 1998).



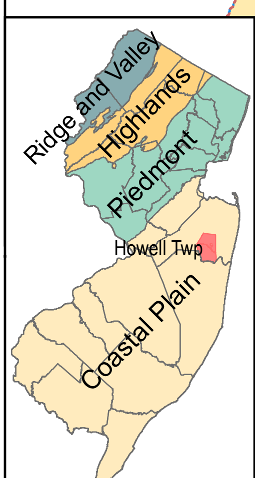


Figure 4.1. Howell Township, Physiography and Geology

0 0.5 1 2 Miles

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Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI
2020

4.2 Geology

Bedrock is the solid rock beneath the soil and surficial rock. However, per convention by the USGS, coastal plain bedrock in New Jersey is considered to be unconsolidated sediments deposited from roughly the time of Cohansey Formation deposition and older (Scott Stanford, personal communication, March 7, 2017; see also NJGS, 2016). Solid crystalline basement rock is found beneath the New Jersey Outer Coastal Plain, but it is difficult to study as it is deep below the surface. Information from scattered well samples taken from Monmouth County indicate that basement rock under the county is predominantly metamorphic schist. The average depth to basement rock in these wells ranged from 600 feet – 1,390 feet (Volkert et al. 1996). The formations considered bedrock geology that outcrop in Howell Township are listed and described in **Table 4.1** and outcrops are illustrated in **Figure 4.1.** Geologic maps created by New Jersey Geologic and Water Survey (aka NJGS) (Sugarman et al., 2018; Sugarman et al., 1996; Sugarman et al., 1991) provide additional details about the geologic formations found in Howell Township, as well as cross section illustrations.

Table 4.1. Characteristics of Geologic Formations Found in Howell Township

Age (million years ago)	Abbreviation Geologic Formation	Lithology (physical character)	Acres Outcrops in Howell Twp.*	% Outcrops in Howell*
Middle Miocene (Serravallian) (12-14 ma)	Tch Cohansey Formation	quartz sand, medium- to coarse grained	1,420	4
Late early Miocene (Burdigalian) (19-21 ma)	Tkl Lower Member of Kirkwood Formation	quartz sand and clay	28,266	72
Middle Eocene (38-48 ma)	Tsr Shark River Formation	silt and clay; glauconite sand to a lesser extent	87	<1
Early Eocene (48-56 ma)	Tmq Manasquan Formation	quartz-glauconite sand, clayey; and fine grained quartz sand or silt	320	< 1
Late Paleocene (56-59 ma)	Tvt Vincentown Formation	quartz sand, medium-grained, clayey; and glauconitic near base; locally a calcarenite or coquina	9,040	23
Early Paleocene (Danian) (62-66 ma)	Tht Hornerstown Formation	glauconite sand, fine- to medium-grained	15	< 1
		Total:	39,149	100.00
*Note: Area and percent represent formations outcropping at the surface. See sources for illustrations of layering of formations.				
Sources: NJGS, 2016; NJGS, May 10, 2007; Sugarman et al., 2018; Sugarman et al., 1996; Sugarman et al., 1991; Geologic dates from https://www.geologypage.com				

Tch Cohansey Formation

The Cohansey Formation is made up of medium to very coarse quartz sand with occasional pebbles. Light brown to dark yellowish-orange, and yellowish-grey to light grey weathered sand contains predominantly orthoquartzite with some feldspar. Because the formation is loose and sandy, it is extensively eroded. However, the upper beds are commonly cemented by iron oxides, and in some areas such as the Vogel pit in Howell, blocks of cemented ironstone 2 to 4 feet thick litter the surface. The sands can contain 2-3% heavy minerals including ilmenite, zircon, sillmanite and kaolinite. The Cohansey sediments were deposited in the middle Miocene (roughly 14 to 12 million years ago) in barrier island and back-barrier tidal flat environments. The maximum thickness is 160 feet. A thin layer of gravel typically caps the Cohansey (Sugarman et al., 2018; Sugarman et al., 1996; Sugarman et al., 1991).

Tkl Lower Member of Kirkwood Formation

The Kirkwood formation is composed of very fine to fine grained quartz sand that is cross-bedded, laminated or massive. The sand is typically orange, yellow, or gray, and overlies dark-gray or brown clay-silt. There is extensive iron oxide banding. Sand consists mostly of quartz with small amounts of feldspar and mica and 2-3% opaque heavy minerals. In the northwest corner of Howell, the formation contains coarse glauconite quartz sand with granules and occasional shark teeth. At the Vogel pit in Howell, the uppermost 8-15' of the formation consists of thick interbeds of fine sand and dark gray clay. The Kirkwood commonly underlies broad gentle slopes and hilltops and is exposed along the Manasquan River. The contact of the upper sand and lower clay silt layers is the source of numerous springs that feed headwaters of tributaries. The unnamed lower member of the Kirkwood Formation is approximately 19-21 million years old. The maximum thickness is 110 feet (Sugarman et al., 2018; Sugarman et al., 1996; Sugarman et al., 1991).

Tsr Shark River Formation

The Shark River Formation consists of coarse to very coarse glauconite sand in a clay-silt matrix. The clay-silt is grayish-olive-green to olive-gray, pale olive and moderate olive-brown in color and is massive to thick-bedded, extensively burrowed and calcareous. The clay-silt grades upward into slightly glauconitic quartz sand that ranges very fine to coarse with granules. Calcareous microfossils are common in lower half of the formation and small, broken mollusk shells are found in the upper half. Layers 1-2 feet thick are cemented with iron oxide and contain fossil casts and molds of *Venicardia antiquata* (a bi-valve mollusk). Glauconite in grape-like clusters is distributed in a dominantly clay-silt matrix. Clay minerals include illite, illite/smectite, kaolinite, and minor amounts of clinoptilolite. The Shark River Formation crops out along the Manasquan River valley below the Kirkwood Formation. Maximum thickness is 160 feet (Sugarman et al., 2018; Sugarman et al., 1991).

Tmq Manasquan Formation

The Manasquan Formation is composed of massive to thick-bedded clay-silt grading upward into very fine quartz sand. It is dusky yellow green to pale olive and grayish-green in color. The formation is extensively burrowed and is calcareous. Cross-bedded layers of very fine sand are occasionally present while fine glauconite sand is generally dispersed throughout the primarily clayey matrix. Clay minerals include illite, illite/smectite and minor clinoptilolite. The Manasquan Formation outcrops in the Manasquan River valley and its tributaries. Maximum thickness is 110 feet (Sugarman et al., 2018; Sugarman et al., 1991).

Tvt Vincentown Formation

The Vincentown Formation is found below the Manasquan Formation. It is made up of slightly micaceous clay-silt, and is massive and finely laminated when not burrowed. The color is grayish-olive-green with thin beds of very fine quartz and glauconite sand. Zones of iron staining and ironstone, pyrite nodules, phosphate pebbles and mica occur locally. The basal 20 feet of the formation at Allaire State Park is a massive, slightly quartzose glauconite sand and the sand coarsens upward from fine-to-medium at the base to medium-to-coarse with granules in the upper sections. Fossils are abundant and include bryozoan, pelecypod and echinoid fragments and microfossils. Clay size minerals in the matrix include illite, illite/smectite, kalinite and calcite. The Vincentown Formation underlies broad, gentle slopes and shallow stream valleys or caps isolated hilltops. The maximum thickness is 80 feet (Sugarman et al., 2018; Sugarman et al., 1996; Sugarman et al., 1991).

Tht Hornerstown Formation

The Hornerstown Formation was deposited in the Early Paleocene (early Danian) time period and is made up of glauconite sand, clay, and traces of fine quartz sand, mica, pyrite, and lignite. The glauconite clay is common in outcrops and often resembles bunches of grapes, with some finer and coarser grained pellets. It contains 1-2% fine to very coarse grained quartz sand, phosphate fragments, pyrite, and lignite. Colors range from greenish black to dark greenish gray; and where weathered it is dusky yellowish-green and moderately reddish-brown. The Hornerstown caps some small isolated hills, underlies broad valleys, and it is often eroded and deposited at the base of slopes (colluviated). Good exposures occur in the Manasquan River valley and its northern tributaries. At Allaire State Park, the Hornerstown formation is only 15 feet thick (Sugarman et al., 1996; Sugarman et al., 1991).

4.3 Elevation and Slope

Topography depicts the relief features of an area. The median elevation of Howell Township's land area is about 100 feet above the ocean at mid-tide. The lowest elevation in the township is about 10 feet along the southeastern boundary of the Township at the North Branch Metedeconk River. The highest elevation is located on Naval Weapons Station Earle at 307 feet above sea level (Monmouth County, 2017; Monmouth County, 2003). **Figure 4.2** shows elevation contours at 10 foot elevation intervals. **Figure 4.3** displays hillshade elevation, or shaded relief, to help visualize the township's topography.

The slope, or gradient, of land is the percent of vertical rise over horizontal distance. Areas where contour lines on the map are spaced close together are *steep slopes*. Where contour lines are spaced farther apart, the slope is less steep.

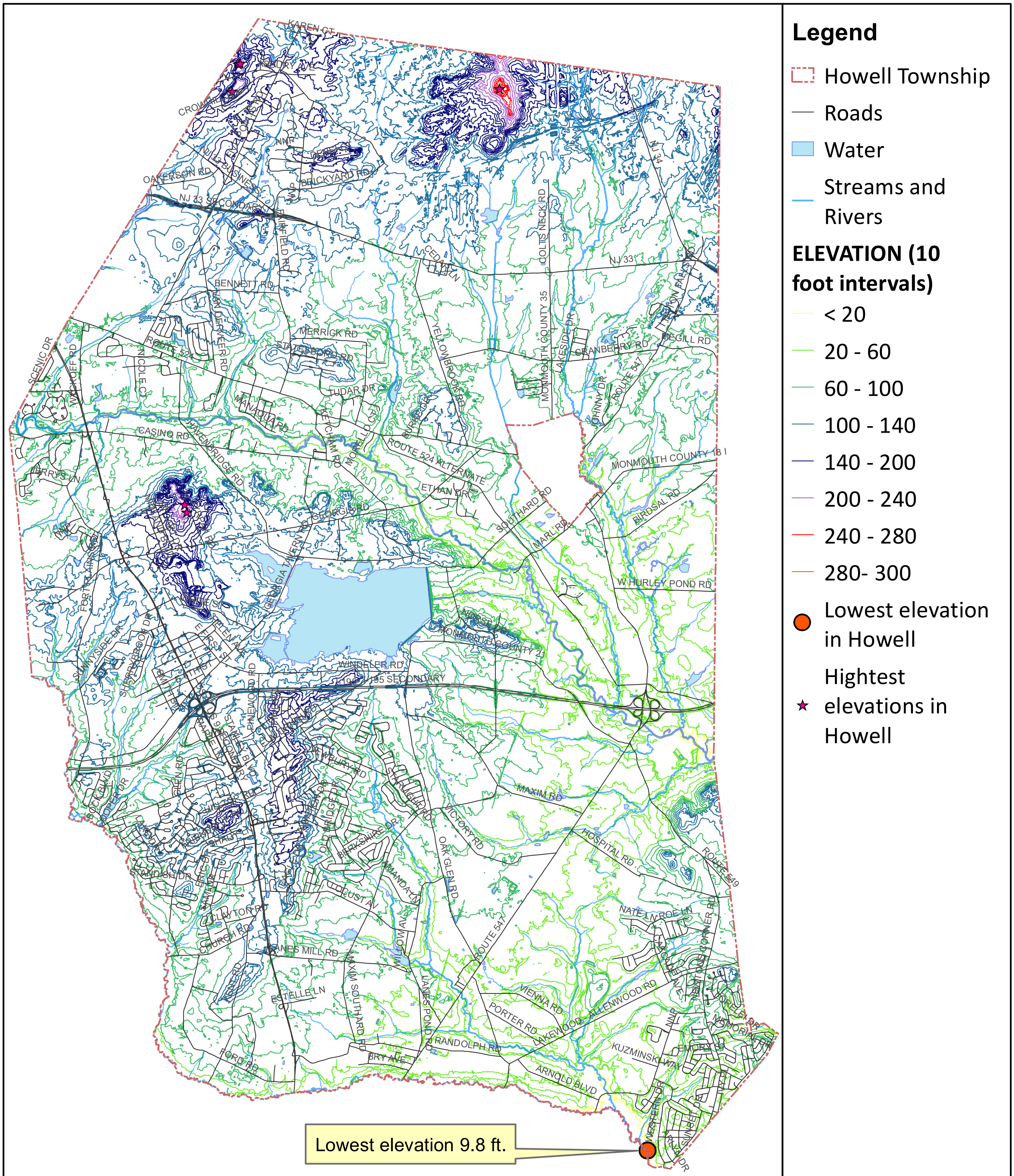
Steep slopes are found in small areas throughout Howell Township. Larger areas of steep slopes occur along waterways; near Crow Hill Road and Asbury Avenue in the northwest corner of the township; in the north on the Naval Weapons Station Earle; and in areas surrounding Manasquan reservoir.

4.4 Surficial Geology

Surficial materials are the recent unconsolidated sediments that overlie bedrock formations, and that are the parent material for soils. Surficial geology deposits in Howell Township consist of materials deposited by the ocean over many millions of years, and are considered to be deposits laid down since the Cohansey Formation. The characteristics of surficial geology types found in Howell Township are provided in **Table 4.2** and illustrated in **Figure 4.4**. The thickness of surficial deposits in the weathered coastal plain formation is discontinuous and less than 10 feet, but ranges from zero to 50 feet thick in the remainder of the municipality. In Howell Township, sea level fluctuations over "recent" millennia were caused by the cycle of glacial/interglacial periods. However, there are no glacial deposits evident in this part of the coastal plain.

Historic Fill

Historic fill is defined by NJDEP as non-indigenous material placed on a site in order to raise the topographic elevation of the site. Large areas (over 5 acres) of historic fill have been mapped by NJDEP, as required by the Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10B-1 et seq.). Some areas of fill are inferred by comparing the extent of swamps and alluvial deposits shown on historical geologic and topographic maps to current maps. Small areas of fill are not mapped. While most urban and suburban areas are underlain by an irregular layer of excavated indigenous soil mixed with various amounts of non-indigenous material, this material generally does not meet the definition of historic fill. Also, there may be historic fill areas that were not detectable on aerial photography or by archival map interpretation, particularly along streams in urban and suburban areas (NJGS, March 14, 2018). Areas of historic fill in Howell Township are shown on **Figure 4.4 outlined in black**.



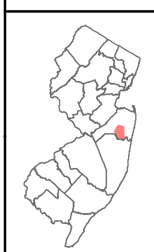


Figure 4.2. Howell Township Elevation

Data Sources: NJDEP, NJDOT, Monmouth County
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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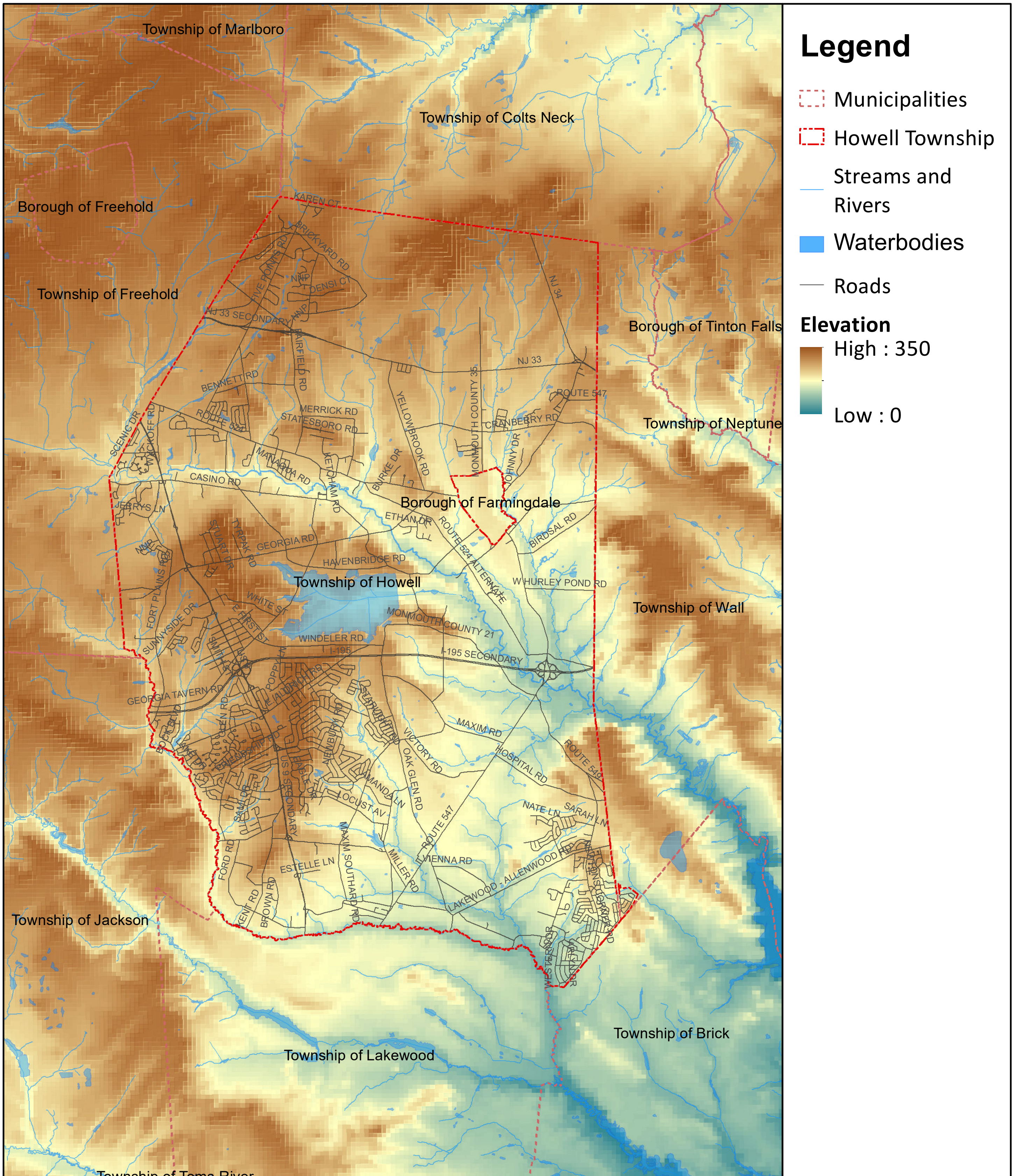

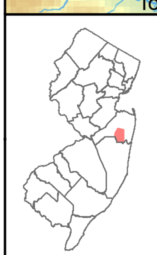

Figure 4.3. Howell Township Hillshade Elevation

(exaggerated to show suble elevation changes)

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, Monmouth County
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Table: 4.2. Characteristics of Surficial Geology Found in Howell Township

Abbreviation Name	Lithology (physical character)	Geologic Age*	Notes	Acres in Howell	Percent of Howell
Qal ALLUVIUM	Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray. As much as 20 feet thick.	Holocene and late Pleistocene	Contains variable amounts of organic matter. Deposited in modern floodplains and channels.	4,449.5	11.4
Qcl LOWER COLLUVIUM	Sand, silt, minor clay and pebble gravel; yellow, yellowish brown, reddish yellow, light gray. As much as 20 feet thick, generally less than 10 feet thick.	late Pleistocene	Forms aprons at the base of slopes on Coastal Plain formations. Graded to lower stream terraces or the modern floodplain.	204.6	0.5
Qcu UPPER COLLUVIUM	Sand, silt, minor clay and pebble gravel; pale brown, yellow, reddish yellow. As much as 20 feet thick.	middle Pleistocene	Forms aprons at the base of slopes on Coastal Plain formations. Graded to upper stream terraces.	4,978.9	12.7
Qe EOLIAN DEPOSITS	Windblown fine sand and silt; very pale brown, yellowish brown. As much as 15 feet thick.	late Pleistocene, locally of early to middle Pleistocene and Pliocene age on uplands	Form sand sheets and, locally, dunes.	174.5	0.4
Qs SWAMP AND MARSH DEPOSITS	Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick.	late Pleistocene and Holocene	Deposited in modern freshwater wetlands.	7.5	0.0
Qtl LOWER STREAM TERRACE DEPOSITS	Sand, pebble gravel, minor silt and cobble gravel; reddish brown, yellowish brown, reddish yellow. As much as 30 feet thick.	late Pleistocene, late Wisconsinan	Forms nonglacial stream terraces with surfaces 5 to 20 feet above modern floodplains. Terraces grade to late Wisconsinan glaciofluvial deposits in the Delaware, Millstone, and Raritan valleys.	1,234.2	3.2
Qtu UPPER STREAM TERRACE DEPOSITS	Sand and pebble gravel, minor silt and cobble gravel; yellow, reddish yellow, yellowish brown. As much as 20 feet thick.	middle to late Pleistocene	Form nonglacial stream terraces 20 to 50 feet above the modern floodplain. Topographic position and weathering characteristics are similar to Illinoian glaciofluvial deposits. Terraces grade to, or are onlapped by Cape May Formation, unit 2.	16,818.3	43.0

Abbreviation Name	Lithology (physical character)	Geologic Age*	Notes	Acres in Howell	Percent of Howell
Qwcp WEATHERED COASTAL PLAIN FORMATIONS	Exposed sand and clay of Coastal Plain bedrock formations. Includes thin, patchy alluvium and colluvium, and pebbles left from erosion of surficial deposits.	Chiefly Pleistocene, locally Miocene and Pliocene.		8,817.0	22.5
Tbh BEACON HILL GRAVEL	Sand, clayey sand, pebble gravel, minor cobble gravel; reddish yellow to yellow. Locally iron-cemented. Feldspathic gravel clasts and sand are weathered to clay. As much as 30 feet thick.	late Miocene	Occurs as erosional remnants of a former fluvial plain, capping the highest hills and uplands in the Coastal Plain. Base of the deposit grades from about 320 feet in northern Monmouth County to 190 feet in southwestern Ocean County.	2.2	0.0
Tg UPLAND GRAVEL	Sand, clayey sand, pebble gravel, minor cobble gravel; yellow to reddish yellow. Locally iron-cemented. As much as 20 feet thick.	Pliocene-early Pleistocene	Includes fluvial and minor colluvial deposits in erosional remnants capping hilltops and interfluves. On grade, in places, to the Pensauken Formation.	2,135.0	5.5
TQg UPLAND GRAVEL, LOWER PHASE	Sand, clayey sand, and pebble gravel, minor silt; yellow to reddish yellow. As much as 20 feet thick.	late Pliocene-middle Pleistocene	Includes fluvial and minor colluvial deposits in erosional remnants capping lower uplands and interfluves. Grades in places to the Cape May Formation, unit 1.	58.2	0.1
Tuc UPLAND COLLUVIUM	Sand, clayey sand, pebble gravel, minor silt; white, yellow, reddish yellow. As much as 15 feet thick.	Pliocene-early Pleistocene	In erosional remnants on sloping interfluves and ridgetops, graded to upland gravel deposits.	269.1	0.7
			Total	39,149.0	100.0

*Note on Geologic time periods:

Pliocene: 5.3 to 2.6 million years ago
Pleistocene: 2.6 million years ago – 0.012 million years ago
Holocene: 0.012 million years ago – present
Wisconsin glaciation: 21,000 years ago

(Walker et al., 2018 and Witte, March 1998)

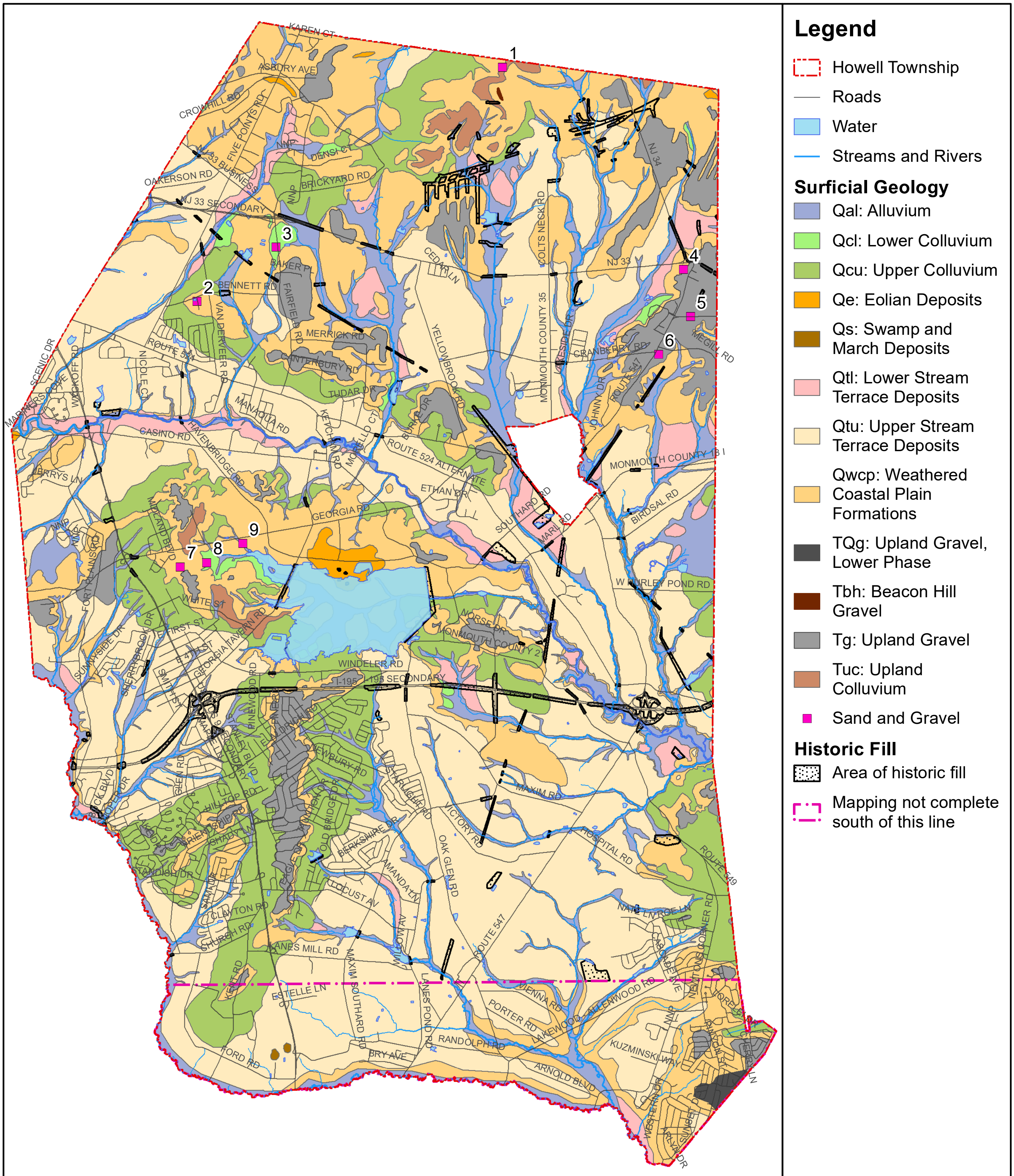
Sources: NJGS, January 1, 2006; Stanford, 2000a and b; Stanford, 1992

Sand and Gravel Surficial Mining & Quarrying

According to the New Jersey Geological Survey, there were 9 sand and gravel operations in Howell Township in 2006 (NJGS, December 12, 2006). An examination of tax records and aerial imagery shows most of these are no longer active (see **Table 4.3** and **Figure 4.4**).

Table: 4.3. Sand and Gravel Characteristics of Surficial Geology Found in Howell Township

Map Label	Owner (former or current)	Products (former or current)	Location	Block and Lot	Current Use
1	U.S.N.A.D. Naval Weapons Station Earle	Sand *1-2 ft. of white sand overlying yellow sand.*		B_183 L_72	Naval Weapons Station Earle; doesn't appear recently quarried (aerial imagery)
2	Various Gumani Court	Sand & gravel *Several gravel pits, quartz pebbles, some ironstone.*		B_165	Residential (tax class); doesn't appear recently quarried (aerial imagery)
3	Holgate Property Associates (former)		Fairfield Rd	B_168 L_19.07	solar panels on site and doesn't appear recently quarried (aerial imagery)
4	Schneider, C&G C/O Collingwood Ent	Sand *0-2 ft, yellow clay, 2-9 ft. fine white sand.*	Hwy 33	B_185 L_2	Vacant land (tax class); Forest (aerial imagery)
5	Rosano Howell Land, Llc	Sand & gravel, concrete aggregate	Asbury Avenue	B_230 L_5	Commercial (tax class); active quarry
6	Private owner	Sand & gravel *5-6 ft. of gravel with very little sand.*	255 Asbury Road	B_228 L_3	Farm (tax class); doesn't appear recently quarried (aerial imagery)
7	Pinnacle Materials, Inc.	Sand & gravel	West Farms Rd	B_130 L_59	Vacant land (tax class); looks slightly overgrown
8	Herbert Sand (former) appears to be same site as Pinnacle		West Farms Rd	B_130 L_59	Vacant land (tax class)
9	Howell Sand and Gravel (former); Howell Twp. (current)	Sand & gravel, masonry material	West Farms Rd	B_130 L_71.01	Green Acres (tax class)
Sources: NJGS, December 12, 2006; New Jersey Conservation Blueprint, 2020; ESRI World Imagery					



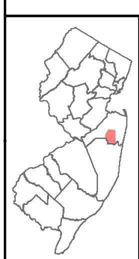


Figure 4.4. Howell Township, Surficial Geology

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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The Geology of New Jersey (NJ Geological Survey): http://www.state.nj.us/dep/njgs/index.html

The Paleontology Portal: http://www.paleoportal.org

The Physiographic Provinces of NJ (NJ Geological Survey): https://www.state.nj.us/dep/njgs/enviroed/infocirc/provinces.pdf

5. SOILS

5.1 SOIL SURVEY MAPS

Evesboro sand (0 to 5 % slope), which is found in 10% of Howell Township. Photo credit: J. Dodds

The *soil* is the unconsolidated mineral material on the immediate surface of the earth which serves as the medium for growth of land plants. The characteristics of each soil type have developed over time (usually many thousands of years) under the influence of the parent material (the bedrock that has broken down into small fragments to form the soil), climate (including moisture and temperature regimes), macro- and microorganisms, and topography. Soil is a basic resource for food production, in addition to its essential role in collecting and purifying water before it enters the ground water (Soil Science Society of America, 2020). However, soil itself can be a pollutant as dust in the air or as sediment in water.

The US Department of Agriculture Natural Resources Conservation Service (USDA NRCS) is the science-based agency which provides technical assistance regarding the conservation and management of soil, water, and other natural resources to private landowners, local, state, and federal agencies, and policy-makers (USDA NRCS, 2020a).

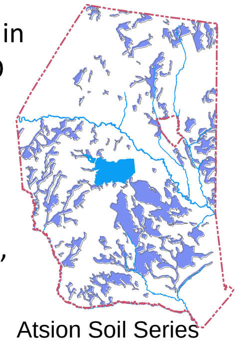
One of these technical services is the soil survey. A *soil survey* is an inventory of the country's soil resources to determine soil characteristics and capabilities and to provide interpretations to help people understand soils and their uses. Soil surveys help to identify the best ways to protect soil and water quality through the use of conservation practices, and to identify which sites are suitable (and the degree of suitability) for various land uses (e.g. septic systems, roads, agriculture) (USDA NRCS, 2020a).

The objective of soil mapping is to separate the landscape into segments that have similar use and management requirements. Therefore, this data set is not designed for use as a primary regulatory or management tool, but may be used as a broad scale reference source. According to the Soil Survey Geographic Database (also known as SSURGO) information, field investigations and data collection were carried out in sufficient detail to name map units and to identify accurately and consistently areas of about 5 acres. As with other GIS data sets, enlargement of the maps to a scale greater than the accuracy of the data can cause misinterpretation of the data. Onsite sampling, testing, and detailed study of specific sites is essential for determining intensive uses, and for managing farms and wetlands (USDA NRCS, 2020b).

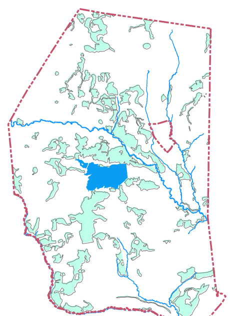
5.2 SOIL SERIES AND MAP UNITS

Soil characteristics vary from place to place in slope, depth, drainage, erodibility, and other characteristics that affect management. A *soil series* is a basic unit of soil classification consisting of soils that are essentially alike, except that they may differ in surface texture, stoniness, slope, or some other attribute. A *map unit* is the area delineated on a soil map, representing an area dominated by one major kind of soil, and is named according to the classification of the dominant soil or soils. However, soils are natural systems, with natural variability, and the range of some observed properties may extend beyond the limits defined for the class. In addition, small areas of contrasting soils may not be visible on the maps. The databases included with the soils data describe the characteristics of each soil map unit. The NRCS has included both estimated and measured data on the physical and chemical soil properties and soil interpretations for engineering, water management, recreation, agronomic, woodland, range, and wildlife use of the soil (USDA NRCS, 2020a). There are 61 soil map units found in the Township of Howell, representing 25 soil series (**Figure 5.1**).

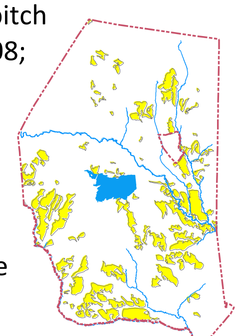
The map unit descriptions and the total area for each unit are summarized in **Table 5.1** and briefly described in **Appendix C** using the most recent SSURGO available (USDA NRCS, September 15, 2019). The five most abundant soil series make up 64% of the township, and are briefly described below.


Atsion Soil Series

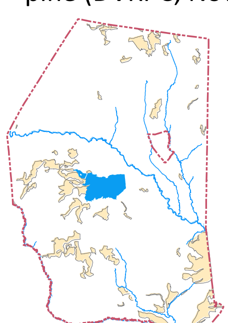
Atsion sand is the most common soil series in Howell Township, covering about 18% of the township. This soil is found on coastal plains, flats, and low hills, with a slope ranging from 0 to 2%. Atsion sands are poorly drained, highly organic, and hydric. This series is designated as a Farmland of Unique Importance because it is suitable for the production of cranberries and blueberries. Forested areas are dominated by pitch pine, black gum, and red maple, with an understory of highbush blueberry, sweet pepperbush, sheep laurel and greenbrier (DVRPC, November 2008; USDA NRCS, September 15, 2019).


Evesboro Soil Series

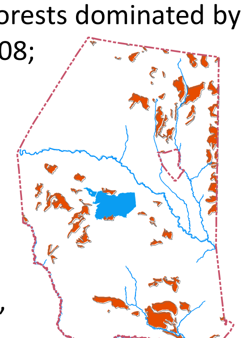
The **Evesboro series** is found in about 17% of the township's soils. These deep, excessively drained sandy soils formed from eolian and fluviomarine sediments. They range from 0 to 25% slopes and are found on coastal plains, knolls, and low hills. The steeper slopes are highly susceptible to erosion. They have very little organic matter are not good agricultural soils, but according to the 2008 NRI (DVRPC, November 2008), if they are irrigated and limed, these soils can be used to grow fruits and vegetables, such as peaches, grapes, sweet potatoes, pumpkins, and melons. Wooded areas have been repetitively cut for wood products. The native vegetation on Evesboro sands consists predominantly of black oak, white oak, red oak, yellow poplar, and chestnut oak, along with hickories, pitch pine, Virginia pine, loblolly pine, scrub oak and blackjack oak (DVRPC, November 2008; USDA NRCS, September 15, 2019).


Klej Soil Series

The **Klej series** comprises about 13% of the township's soils, and is found on coastal plain depressions and flats from 0 to 5% slopes. A thin top layer of unconsolidated sandy marine deposits is highly organic, over clayey estuarine deposits very low in organic matter. Klej loamy sands are deep and somewhat poorly drained. In Howell Township, these soils are Farmland of Statewide Importance and are often used for corn, soybeans, hay, and other crops. Wooded areas are dominated by mixed oaks, sweetgum, red maple, pond pine and loblolly pine (DVRPC, November 2008; USDA NRCS, September 15, 2019).


Lakewood Soil Series

About 8.5% of the soils in Howell Township are in the **Lakewood series**. These sandy soils can be found on coastal plain flats and depressions ranging from 0 to 5% slopes, and on low hills from 5 to 10% slopes. Lakewood soils formed from fluviomarine deposits and are very deep and excessively drained. These soils are not classified as Prime Farmland and are predominantly covered in forests dominated by pitch pine, black oak, and white oak (DVRPC, November 2008; USDA NRCS, September 15, 2019).


Lakehurst Soil Series

The **Lakehurst series** rounds out Howell Township's top 5 most common soil series, comprising about 7.4% of the township's area. These deep, moderately well-drained, sandy, fluviomarine soils are located on flat coastal plains and dunes up to about 5% slope. According to the 2008 NRI (DVRPC, November 2008), Lakehurst soils are highly

Eolian = wind deposition
Fluviomarine = river/sea boundary deposition

acidic unless they are limed, and areas once farmed have been converted to other land uses. Forests on these soils are dominated by pitch pine, shortleaf pine, black oak, and white oak, with an understory of lowbush blueberries and scrub oak (DVRPC, November 2008; USDA NRCS, September 15, 2019).

5.3 SOIL QUALITY

Soil is arranged in horizontal layers called horizons. These horizons have technical designations largely useful for soil scientists to distinguish one soil series from another. The descriptions in the NRCS soil survey are done using soil in its native state where possible, so a soil profile which has been disturbed may not match the written description for the series. This is the way the degree of disturbance is assessed—by comparing the soil in its native condition to the profile observed at a specific site. For example, the upper horizon is often an *A horizon*, commonly known as "*topsoil*." An A horizon typically exhibits increased organic matter, reduced clay percentage, a more granular structure of the soil aggregates, and a lower bulk density than the *B horizon* below it. If the A horizon is removed (a common practice in construction), this is evident to a trained observer and the soil would be described as having the A horizon missing. The material on the new surface does not automatically become an A horizon merely as a result of its position. It is possible over time for the newly exposed surface to acquire the characteristics of an A horizon, however this is not automatic and is highly management dependent. In technical writing, particularly in guidance documents intended for post-construction remediation, the use of the term "topsoil" should be used with caution if at all because there is no legal definition of topsoil and the materials available in commerce are highly variable in quality (Muldowney, 2011).

Soils vary naturally in their capacity to function. *Soil quality* is defined as the capacity of a specific kind of soil to function to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. *Inherent* or *intrinsic soil qualities* or characteristics of the soil are determined by factors of soil formation (climate, parent material, topography, time, and biota). These are properties which cannot be altered by management except by actually replacing the present material with a different material altogether. An example of an inherent property is the percentage of sand in the soil's composition. Inherent soil quality is used to evaluate the suitability of soils for specific uses (buildings, roads, agriculture, septic systems, etc.). One measure of quality is soil particle size: A loamy soil will have higher water holding capacity than a sandy soil, and therefore will have a higher inherent quality for storing water (USDA NRCS, 2020c).

Contrasting with intrinsic soil properties are management-dependent soil properties, also known as *dynamic soil qualities*. As the term suggests, these can be altered significantly (for better or for worse) by the management of a specific parcel of land, and changes can have significant consequences for overall environmental quality. Dynamic quality is determined by soil characteristics that are affected by human use and management practices, including physical, chemical, and biological properties. Soil quality or health may be evaluated by either comparison to a reference condition that represents full capacity of a soil for a specific function, or to a baseline for the management-dependent soils properties (such as before and after a land use change) (USDA NRCS, 2020c).

Degradation of soil quality occurs in many forms. Significant issues are cutting and filling, compaction, excess salt content and organic matter content. *Cutting and filling* operations actually remove, bury, or invert existing horizons such that they no longer behave in a hydrologically coherent way, with precipitation and gases readily able to enter the soil surface and transmit to horizons lower in the profile. *Compaction*, the increase of bulk density as a result of compression from the surface, is another common form of soil degradation. Compaction can be avoided by not working soil at too high a moisture content. Even foot traffic on a near saturated soil can result in lasting damage which does not resolve itself naturally. A compacted soil can have runoff characteristics more similar to pavement than to the soil in good condition (Muldowney, 2011).

Excess salt content often results from deicing salts but sometimes from fertilizer preparations. It is especially common on roadside verges. Sodium salts are especially damaging to soils because sodium causes the clays to disperse. Prevention is the only practical solution, by using less road salt or by using

Table 5.1. Soils: Key Characteristics of Soil Types Found in Howell Township

Map Unit Symbol	Map Unit Name	Landform	Water Table Depth (Min, Apr-Jun) (inches)	Flooding	Hydrologic group *	Natural drainage class•	Hydric (% of components)	Farmland**	Hazard of off-road or off-trail erosion	Hazard of erosion on roads & trails	Frost Action	Septic Suitability (NJ)	Reason for Septic Limit◆	Approx. Acres in Howell Twp.	Percent of Howell Twp.
AdnA	Adelphia loam, 0 to 2 percent slopes	coastal plains, flats, low hills	30	None	C	Moderately well drained	5	P	slight	slight	Mod	somewhat limited	DAZS	1.95	0.005
AtsA	Atsion sand, 0 to 2 percent slopes, Northern Coastal Plain	coastal plains, flats, low hills	2	None	A/D	Poorly drained	95	U	slight	slight	Low	very limited	hydric, DAZS	758.09	1.94
AtsAO	Atsion sand, 0 to 2 percent slopes, Northern Tidewater Area	coastal plains, flats, low hills	2	None	A/D	Poorly drained	95	U	slight	slight	Low	very limited	hydric, DAZS	6,407.01	16.39
BerAt	Berryland sand, 0 to 2 percent slopes, frequently flooded	flood plains on coastal plains, depressions on coastal plains, drainageways on coastal plains	0	Frequent	A/D	Very poorly drained	100	-	slight	slight	High	very limited	hydric, flood, DAZS	643.18	1.64
CokC2	Collington sandy loam, 5 to 10 percent slopes, eroded	knolls on coastal plains, hillslopes	-	None	B	Well drained	0	SI	moderate	moderate	Mod	not limited	-	24.71	0.06
DocB	Downer loamy sand, 0 to 5 percent slopes, Northern Coastal Plain	low hills on coastal plains	-	None	A	Well drained	5	SI	slight	slight	Low	not limited	-	340.27	0.87
DocBO	Downer loamy sand, 0 to 5 percent slopes, Northern Tidewater Area	flats on coastal plains, depressions, drainageways, deflation flats	-	None	A	Well drained	5	SI	slight	slight	Mod	not limited	-	324.64	0.83
DocC	Downer loamy sand, 5 to 10 percent slopes, Northern Coastal Plain	coastal plains, flats, broad interstream divides	-	None	A	Well drained	0	SI	slight	moderate	Mod	not limited	-	126.33	0.32
DocCO	Downer loamy sand, 5 to 10 percent slopes, Northern Tidewater Area	coastal plains, low hills, knolls, flats	-	None	A	Well drained	0	SI	slight	moderate	Mod	not limited	-	73.95	0.19
DoeAO	Downer sandy loam, 0 to 2 percent slopes, Northern Tidewater Area	flats on coastal plains	-	None	A	Well drained	0	P	slight	slight	Mod	not limited	-	76.59	0.20
DoeB	Downer sandy loam, 2 to 5 percent slopes, Northern Coastal Plain	coastal plains, fluviomarine terraces, knolls, low hills	-	None	A	Well drained	0	P	slight	slight	Mod	not limited	-	200.21	0.51
DoeBO	Downer sandy loam, 2 to 5 percent slopes, Northern Tidewater Area	coastal plains, flats, low hills	-	None	A	Well drained	0	P	slight	slight	Mod	not limited	-	296.61	0.76
DouB	Downer-Urban land complex, 0 to 5 percent slopes	coastal plains, urban land	-	None	A	Well drained	0	-	slight	slight		not limited	-	138.14	0.35

Map Unit Symbol	Map Unit Name	Landform	Water Table Depth (Min, Apr-Jun) (inches)	Flooding	Hydrologic group *	Natural drainage class•	Hydric (% of components)	Farmland**	Hazard of off-road or off-trail erosion	Hazard of erosion on roads & trails	Frost Action	Septic Suitability (NJ)	Reason for Septic Limit◆	Approx. Acres in Howell Twp.	Percent of Howell Twp.
EkaAr	Elkton loam, 0 to 2 percent slopes, rarely flooded	coastal plains, flats, drainageways	6	Rare	C/D	Poorly drained	95	SI-D	slight	slight	Mod	very limited	hydric, flood, DAZS, RH, RS	419.01	1.07
EveB	Evesboro sand, 0 to 5 percent slopes	flats on coastal plains	-	None	A	Excessively drained	10	-	slight	slight	Mod	not limited	-	4,205.97	10.76
EveC	Evesboro sand, 5 to 10 percent slopes	coastal plains, knolls, low hills	-	None	A	Excessively drained	0	-	slight	moderate	Mod	not limited	-	838.87	2.15
EveD	Evesboro sand, 10 to 15 percent slopes	coastal plains, knolls, low hills	-	None	A	Excessively drained	0	-	slight	moderate	Mod	not limited	-	638.19	1.63
EveE	Evesboro sand, 15 to 25 percent slopes	coastal plains, knolls, hillslopes	-	None	A	Excessively drained	0	-	slight	severe	Mod	not limited	-	225.50	0.58
EvuB	Evesboro-Urban land complex, 0 to 5 percent slopes	coastal plains, urban land	-	None	A	Excessively drained	0	-	slight	slight		not limited	-	625.84	1.60
FapA	Fallsington loams, 0 to 2 percent slopes, Northern Coastal Plain	coastal plains, flats, depressions, drainageways, swales	5	None	C/D	Poorly drained	85	SI-D	slight	slight	High	very limited	hydric, DAZS, ECH, ECS	404.23	1.03
FrfB	Freehold loamy sand, 0 to 5 percent slopes	flats on coastal plains, depressions	-	None	B	Well drained	5	P	slight	slight	High	not limited	-	155.55	0.40
FrfC	Freehold loamy sand, 5 to 10 percent slopes	coastal plains, low hills, knolls	-	None	B	Well drained	0	SI	moderate	moderate	Mod	not limited	-	8.42	0.02
FrkB	Freehold sandy loam, 2 to 5 percent slopes	coastal plains, knolls, low hills	-	None	B	Well drained	5	P	slight	slight	Mod	not limited	-	468.41	1.20
FrkC	Freehold sandy loam, 5 to 10 percent slopes	coastal plains, knolls, low hills	-	None	B	Well drained	0	SI	moderate	moderate	Mod	not limited	-	161.02	0.41
FrkD	Freehold sandy loam, 10 to 15 percent slopes	coastal plains, knolls, low hills	-	None	B	Well drained	0	-	severe	moderate	Mod	not limited	-	41.32	0.11
FrkD2	Freehold sandy loam, 10 to 15 percent slopes, eroded	coastal plains, knolls, low hills	-	None	B	Well drained	0	-	severe	moderate	Mod	not limited	-	0.49	0.001
FrkE2	Freehold sandy loam, 15 to 25 percent slopes, eroded	coastal plains, knolls, low hills	-	None	B	Well drained	0	-	severe	severe	Mod	not limited	-	21.91	0.06
FroA	Freehold loam, 0 to 2 percent slopes	coastal plains, knolls, low hills	-	None	B	Well drained	5	P	slight	slight	Mod	not limited	-	83.72	0.21

Map Unit Symbol	Map Unit Name	Landform	Water Table Depth (Min, Apr-Jun) (inches)	Flooding	Hydrologic group *	Natural drainage class•	Hydric (% of components)	Farmland**	Hazard of off-road or off-trail erosion	Hazard of erosion on roads & trails	Frost Action	Septic Suitability (NJ)	Reason for Septic Limit◆	Approx. Acres in Howell Twp.	Percent of Howell Twp.
HbmB	Hammonton loamy sand, 0 to 5 percent slopes	coastal plains, depressions, flats	30	None	B	Moderately well drained	15	SI	slight	slight	Mod	somewhat limited	DAZS	321.72	0.82
HboA	Hammonton sandy loam, 0 to 2 percent slopes	coastal plains, flats, depressions	30	None	B	Moderately well drained	15	P	slight	slight	High	somewhat limited	DAZS	305.78	0.78
HboB	Hammonton sandy loam, 2 to 5 percent slopes	coastal plains, flats, drainageways	30	None	B	Moderately well drained	5	P	slight	slight	High	somewhat limited	DAZS	362.30	0.93
HocA	Holmdel sandy loam, 0 to 2 percent slopes	depressions on coastal plains	27	None	C	Moderately well drained	5	P	slight	slight	High	somewhat limited	DAZS	285.20	0.73
HocB	Holmdel sandy loam, 2 to 5 percent slopes	coastal plains, knolls, low hills	27	None	C	Moderately well drained	5	P	moderate	moderate	Mod	somewhat limited	DAZS	14.87	0.04
HumAt	Humaquepts, 0 to 3 percent slopes, frequently flooded	coastal plains, flats	6	Frequent	A/D	Poorly drained	100	-	slight	slight	Mod	very limited	hydric, flood, DAZS	1,549.67	3.96
KemA	Keyport sandy loam, 0 to 2 percent slopes	knolls on coastal plains	24	None	D	Moderately well drained	5	P	slight	slight	Mod	very limited	RH, RS	238.14	0.61
KemB	Keyport sandy loam, 2 to 5 percent slopes	depressions on coastal plains, flats	30	None	D	Moderately well drained	10	P	moderate	moderate	High	very limited	RH, RS	269.46	0.69
KemC	Keyport sandy loam, 5 to 10 percent slopes	knolls on coastal plains	24	None	D	Moderately well drained	10	SI	moderate	moderate	Mod	very limited	RH, RS	15.70	0.04
KkgB	Klej loamy sand, 0 to 5 percent slopes	depressions on coastal plains	18	None	A/D	Somewhat poorly drained	10	SI	slight	slight	Mod	very limited	DAZS	4,839.90	12.38
KkgkB	Klej loamy sand, clayey substratum, 0 to 5 percent slopes	flats on coastal plains	21	None	A/D	Somewhat poorly drained	10	SI	slight	slight	High	not limited	-	224.73	0.57
KrhB	Kresson loam, 2 to 5 percent slopes	coastal plains	12	None	C/D	Somewhat poorly drained	5	SI-D	slight	slight		very limited	DAZS	96.74	0.25
LakB	Lakehurst sand, 0 to 5 percent slopes	flats on coastal plains, dunes	30	None	A	Moderately well drained	10	-	slight	slight	Low	somewhat limited	DAZS	2,902.22	7.42
LasB	Lakewood sand, 0 to 5 percent slopes	flats on coastal plains, depressions	-	None	A	Excessively drained	5	-	slight	slight	Low	not limited	-	3,038.52	7.77
LasC	Lakewood sand, 5 to 10 percent slopes	low hills on coastal plains	72	None	A	Excessively drained	5	-	slight	moderate	Low	not limited	-	278.06	0.71
MakAt	Manahawkin muck, 0 to 2 percent slopes, frequently flooded	flood plains on coastal plains, depressions on coastal plains, drainageways on coastal plains	0	Frequent	A/D	Very poorly drained	100	U	slight	slight	High	very limited	hydric, flood, DAZS	838.50	2.14

Map Unit Symbol	Map Unit Name	Landform	Water Table Depth (Min, Apr-Jun) (inches)	Flooding	Hydrologic group *	Natural drainage class•	Hydric (% of components)	Farmland**	Hazard of off-road or off-trail erosion	Hazard of erosion on roads & trails	Frost Action	Septic Suitability (NJ)	Reason for Septic Limit◆	Approx. Acres in Howell Twp.	Percent of Howell Twp.
PegB	Pemberton loamy sand, 0 to 5 percent slopes	depressions on coastal plains	30	None	B	Moderately well drained	5	SI	slight	slight	High	somewhat limited	DAZS	433.21	1.11
PhbC	Phalanx loamy sand, 5 to 10 percent slopes	marine terraces on coastal plains	72	None	A	Well drained	0	-	slight	moderate	Low	somewhat limited	ECS	62.01	0.16
PHG	Pits, sand and gravel	gravel pits	-	None	-	Well drained	0	-	not rated	not rated	-	not rated	-	200.86	0.51
SacB	Sassafras sandy loam, 2 to 5 percent slopes, Northern Coastal Plain	flats on coastal plains, depressions, swales	-	None	B	Well drained	4	P	slight	slight	High	not limited	-	134.57	0.34
SacBO	Sassafras sandy loam, 2 to 5 percent slopes, Northern Tidewater Area	flats on coastal plains, fluviomarine terraces	-	None	B	Well drained	0	P	slight	slight	Mod	not limited	-	94.31	0.24
SacC	Sassafras sandy loam, 5 to 10 percent slopes, Northern Coastal Plain	fluviomarine terraces on coastal plains, flats on coastal plains	-	None	B	Well drained	4	SI	moderate	moderate	Mod	not limited	-	74.16	0.19
SacD	Sassafras sandy loam, 10 to 15 percent slopes	knolls on coastal plains, low hills	-	None	B	Well drained	0	SI	severe	moderate	Mod	not limited	-	39.92	0.10
SacE	Sassafras sandy loam, 15 to 25 percent slopes	hillslopes on coastal plains	72	None	B	Well drained	0	-	severe	severe	Mod	not limited	-	4.25	0.01
SafA	Sassafras loam, 0 to 2 percent slopes	fluviomarine terraces on coastal plains, flats on coastal plains	-	None	B	Well drained	4	P	slight	slight	Mod	not limited	-	143.54	0.37
ShrA	Shrewsbury sandy loam, 0 to 2 percent slopes	flats on coastal plains	6	None	B/D	Poorly drained	6	SI-D	slight	slight	High	very limited	hydric, DAZS	447.19	1.14
ThgB	Tinton loamy sand, 0 to 5 percent slopes	flats on coastal plains	-	None	A	Well drained	0	SI	slight	slight	Mod	not limited	-	743.36	1.90
ThgC	Tinton loamy sand, 5 to 10 percent slopes	coastal plains, low hills, knolls	-	None	A	Well drained	0	SI	moderate	moderate	Mod	not limited	-	157.23	0.40
ThgE	Tinton loamy sand, 10 to 25 percent slopes	low hills on coastal plains	-	None	A	Well drained	0	-	severe	severe	Low	not limited	-	25.50	0.07
UdaB	Udorthents, 0 to 8 percent slopes	low hills on uplands, fills, cuts (road, railroad, etc.)	-	None	D	Well drained	0	-	moderate	moderate	Low	not limited	-	1,071.96	2.74
UdauB	Udorthents-Urban land complex, 0 to 8 percent slopes	low hills on uplands, urban land	-	None	D	Well drained	0	-	moderate	moderate	-	not limited	-	466.88	1.19
WATER	Water	water	-	-	-	-	-	-	-	-	-	not rated	-	865.57	2.21

Map Unit Symbol	Map Unit Name	Landform	Water Table Depth (Min, Apr-Jun) (inches)	Flooding	Hydrologic group *	Natural drainage class•	Hydric (% of components)	Farmland**	Hazard of off-road or off-trail erosion	Hazard of erosion on roads & trails	Frost Action	Septic Suitability (NJ)	Reason for Septic Limit◆	Approx. Acres in Howell Twp.	Percent of Howell Twp.
WoeB	Woodstown sandy loam, 2 to 5 percent slopes, Northern Coastal Plain	coastal plains, flats, depressions, broad interstream divides, fluviomarine terraces	24	None	C	Moderately well drained	7	P	slight	slight	Mod	very limited	DAZS	397.96	1.02
WogA	Woodstown loam, 0 to 2 percent slopes, Northern Coastal Plain	coastal plains, flats, broad interstream divides	24	None	C	Moderately well drained	7	P	slight	slight	Mod	very limited	DAZS	448.68	1.15

* Hydrologic Group definitions in **Table 5.3**.

• Natural Drainage Class defnitions in **Table 5.4**

****Farmland: U**=Unique; **P**=Prime; **SI**=Statewide Importance; **SI-D**=Statewide Importance, if Drained. Definitions in **Table 5.5**.

◆ **Septic System Limitation Interpretation (NJ):**

DAZS= Depth to apparent zone of saturation; **DPZS**= Depth to perched zone of saturation; **ECH**=Excessively coarse horizon; **ECS**=Excessively coarse substratum; **Flooding**=Not Permitted – Flooding; **Hydric**=Not Permitted - Hydric Soil; **RH**= Restrictive horizon; **RS**= Restrictive substratum

Source: USDA NRCS, September 16, 2019

Note: The information in this map is from the SSURGO soils data Soil Service Area (SSA) Monmouth County, New Jersey SSA Version 13 (9/16/2019), indicating the dominant soil condition but does not eliminate the need for onsite investigation.

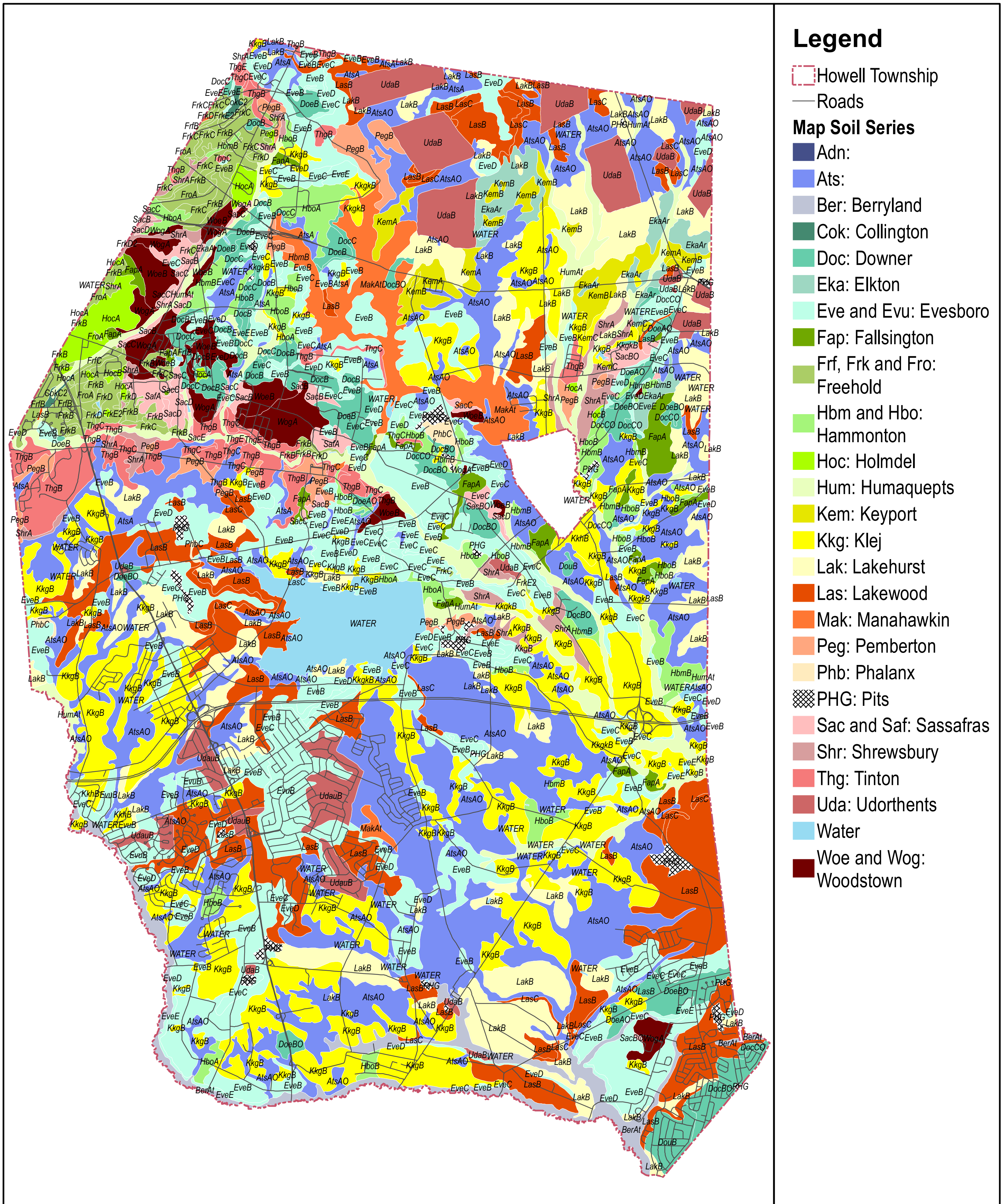


Figure 5.1. Howell Township, Soil Map Series

Data Sources: NJDEP, NJDOT, NRCS

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI
2020

alternative deicers. Compared to sodium chloride, for example, calcium chloride is less harmful to plants and soil (Muldowney, 2011; Wikipedia, January 25, 2020).

Organic matter content is another dynamic soil property. Rutgers New Jersey Agricultural Experiment Station (see **Internet Resources**) provides a chart for interpretation of organic matter percentages in New Jersey soils. Soils with a high organic content are better able to resist other forms of degradation than soils with depleted organic matter. The amount of organic matter in the upper horizons of a soil is a measure of carbon storage. Soil is the largest terrestrial reservoir of carbon and has the greatest potential for long term storage if degraded soils are managed in a way that builds up carbon. Silt loams (which aren't found in Howell Township) than loams (like Woodstown), sandy loams (like Freehold) or loamy sands (including Klej) are able to store more carbon in the form of organic matter than sandier soil. Keeping soil in good condition reduces runoff, produces cleaner runoff, requires less irrigation, grows more robust plantings, and sequesters more atmospheric carbon than a damaged soil (Muldowney, 2011).

5.4 SOIL CHARACTERISTICS

Soil properties contained in the NRCS soil survey and listed in **Table 5.1** are *intrinsic* soil properties. These are properties which cannot be altered by management except by actually replacing the present material with a different material altogether. Most of the following characteristics are interpretations based on measured soil properties, which are periodically updated. In addition, the general rating class is presented for each map unit, but smaller areas with contracting characteristics may be present. Onsite investigation may be needed to validate these interpretations and to confirm the identity and qualities of the soil on a given site.

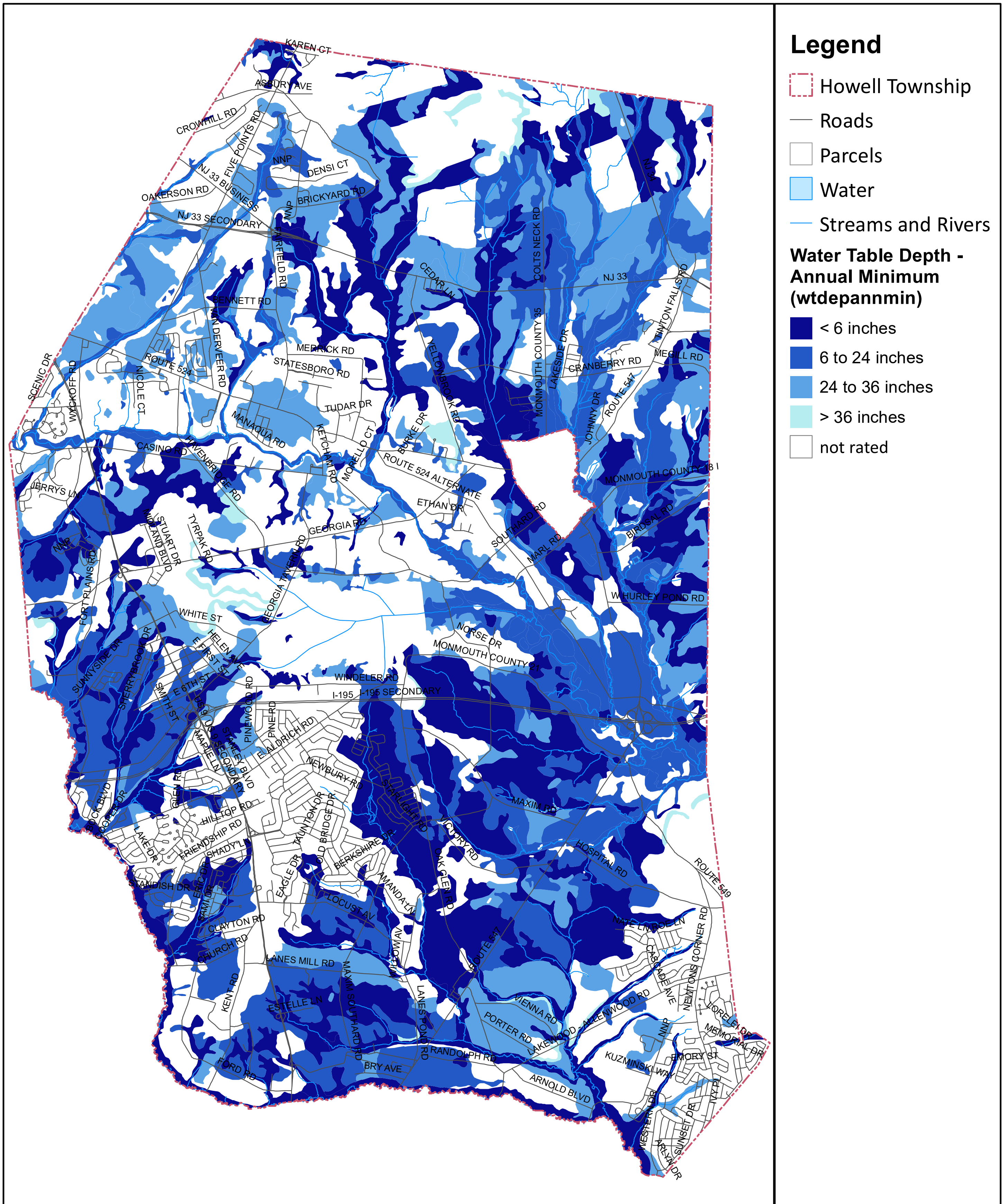
5.4.1 Depth to Bedrock

According to NJDEP (1999), *bedrock* is defined as "any solid body of rock, with or without fractures, which is not underlain by soil or unconsolidated rock material." The *depth to bedrock* is the distance from the land surface to bedrock. Depth to bedrock is an important factor when determining the suitability of land for building roads, foundations, and septic systems. Crystalline bedrock outcrops (depth to bedrock equals zero inches) are absent in Howell Township (as discussed previously, pre-Mesozoic basement rock is found deep under the ground). The soils in Howell Township have a depth to the root-restrictive layer exceeding five feet.

5.4.2 Depth to Seasonal High Water Table

The *depth to seasonal high water table* (SHWT) is the distance between the ground surface and the top of the water surface in the saturated part of a water bearing zone. A SHWT of less than one foot severely constrains development, and a SHWT between 1 and 3 feet also provides obstacles to development. This is sometimes caused by a clay layer that impedes infiltration, resulting in a perched water table. On-site investigation will often reveal that these areas are actually wetlands or floodplains. High water tables impact the effectiveness of septic systems, and the freeze/thaw cycles cause frost heaving, which damages structures and roads.

Eight of the soil units in Howell Township fall into the first category, with SHWTs of less than a foot. Those include the Manahawkin muck and Humaquepts, among others. Together they comprise 29% of the soil cover in the township. Another 16 units, which collectively comprise 28% of the township's total soil cover, have SHWTs that range between 1.2 and 2.6 feet. The remaining 43% of the soil cover in Howell Township has a minimum depth to seasonal high water table exceeding three feet (see **Table 5.1 and Figure 5.2**).



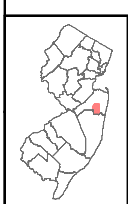


Figure 5.2. Howell Township, Soils - Depth to Seasonal High Water Table

Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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5.4.3 Hydrologic Soil Group

The *hydrologic soil grouping* describes a group of soils having similar runoff potential under similar storm and cover conditions (how much water would runoff compared to the rate that water would infiltrate into the ground). The definitions of the hydrologic soil groups are shown in **Table 5.2**.

Thirty nine percent of Howell Township falls into Class A, 7% into Class B, 3% is Class C and 5% is Class D (**Table 5.1 and Figure 5.3**). The remaining 46% of the township soil map units have been assigned to multiple hydrologic soil groups. Dual ranks are indicative of soils that respond differently under varying hydrological conditions. In those cases, the first letter applies to the soil when it is in a drained condition (seasonal high water table at least two feet below the soil surface), and the last letter shows how the soil functions when the water table is higher (USDA - NRCS, May 2007).

Table 5.2. Hydrologic Soil Grouping

Class	Definition
A	High infiltration rates. Soils are deep, well to excessively drained sands and gravels.
B	Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils that have moderately course textures.
C	Slow infiltration rates. Soils with layers impeding downward movement of water, or soils that have moderately fine or fine textures.
D	Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.
Source: USDA NRCS, May 2007	

5.4.4 Soil Drainage Class

Soil Drainage Class is a code identifying the natural drainage condition of the soil and refers to the frequency and duration of periods when the soil is free of saturation or partial saturation during soil formation. It does not refer to saturation due to recently altered drainage (manmade or natural). The categories are described in **Table 5.3**. Approximately 25% of Howell Township has soils that are excessively drained, 15% are well drained, 15% that are moderately well drained, 13% that are somewhat poorly drained, 26% that are poorly drained, and 4% are very poorly drained. The remaining 2% is covered with water (see **Table 5.1 and Figure 5.4**).

Table 5.3. Drainage Class Definitions

Excessively drained — Water is removed very rapidly. Soils are commonly coarse textured and have very high saturated hydraulic conductivity or are very shallow.
Somewhat excessively drained — Water is removed from the soil rapidly. Soils are commonly coarse textured and have high saturated hydraulic conductivity or are very shallow.
Well drained — Water is removed from the soil readily but not rapidly. Water is available to plants throughout most of the growing season in humid regions. Wetness does not inhibit root growth for significant periods during most growing seasons. The soils are mainly free of, or are deep or very deep to, redoximorphic features related to wetness.
Moderately well drained — Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence is commonly moderately deep. The soils are wet for only a short time within the rooting depth during the growing season but long enough that most mesophytic crops are affected.
Somewhat poorly drained — Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided.
Poorly drained — Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface long enough during the growing season that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow depth. Free water at shallow depth is common.
Very poorly drained — Water is removed from the soil so slowly that free water remains at or very near the surface during much of the growing season. Internal free water occurrence is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown.

Source: USDA NRCS, Soil Science Division Staff, 2017

5.4.5 Hydric and Flooded Soils

Hydric soils are those soils that are wet long enough to periodically produce anaerobic conditions, thereby influencing the growth of plants. For delineation of hydric soils, the ponding event must last longer than seven days. There are eight hydric soils map units found within Howell Township that are generally hydric greater than or equal to 85% of the time, including Atsion sand (AtsA and AtsAO), Berryland sand (BerAt), Elkton loam (EkaAr), Fallsington loams (FapA), Humaquepts (HumAt), Manahawkin muck (MakAt) and Shrewsbury sandy loam (ShrA) (see **Table 5.1**). Collectively these map units comprise 28% of the township. Approximately 53% of the township has soils that are less commonly hydric, while 16% of the township has soils that are not hydric (see **Table 5.4** and **Figure 5.5**). The presence of hydric soils, when confirmed with on-site soil evaluations, is one of the three factors considered in determining if an area is a wetland subject to regulations. Wetlands are covered in **Section 7.4**.

Table 5.4. Hydric Soils

Percent of Map Unit is Hydric	Acres	Percent of Howell Township
0	6,364	16
4 to 15%	20,756	53
85 to 100%	11,020	28
not rated	866	2
Total	**39,102**	**100**

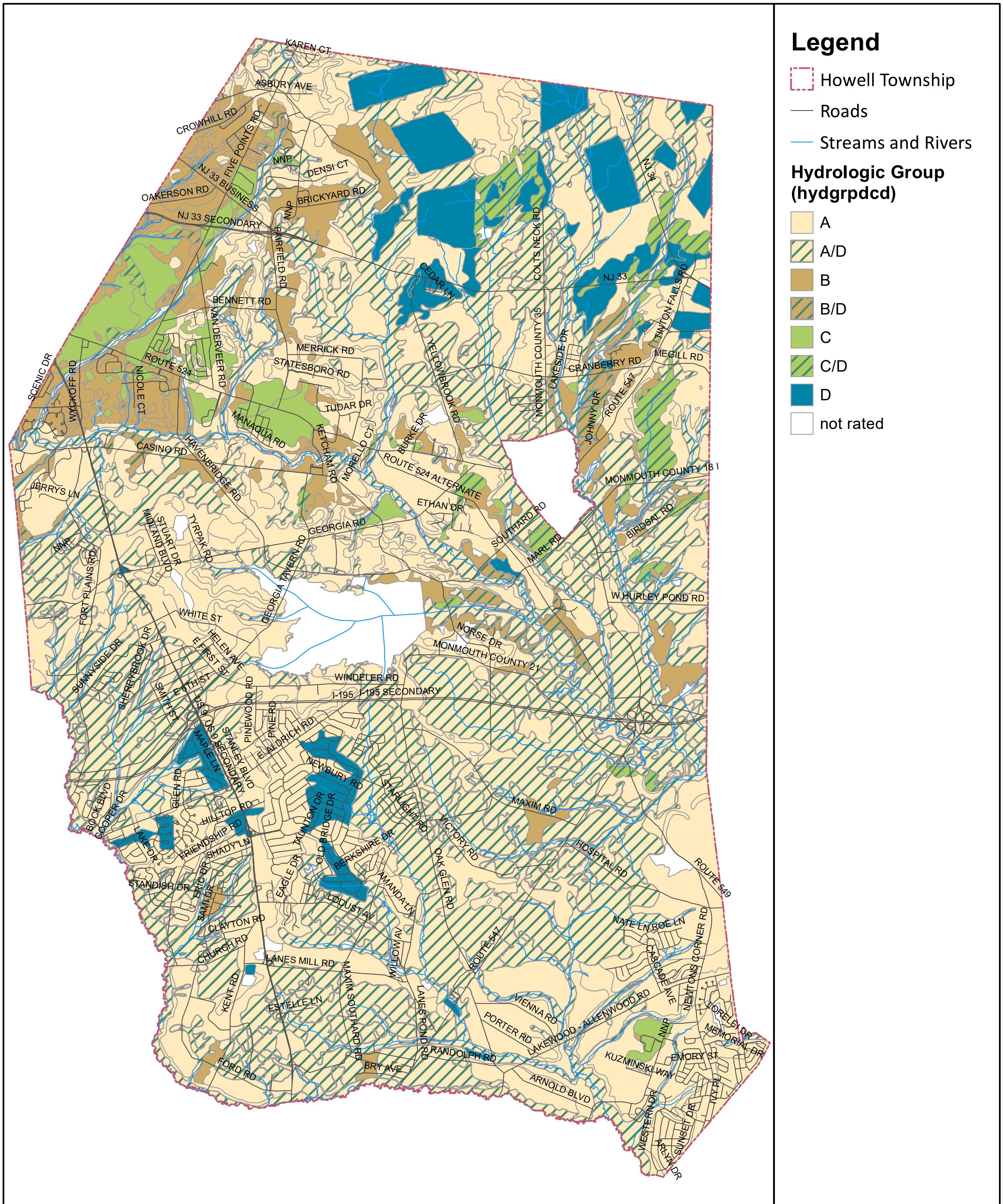
Annual flood frequency is a descriptive term used to describe the frequency of flooding that is likely to occur in a year. **Frequent** is > 50% chance of flooding in a given year; **occasional** is 5 to 50%; **rare** is 0 to 5% chance of flooding. In Howell Township, Berryland sand (BerAt), Humaquepts (HumAt) and Manahawkin muck (MakAt) soils are frequently flooded, Elkton loam (EkaAr) soils are rarely flooded, while the remaining soil types are not flooded (see **Table 5.1**). Flood zones are covered in **Section 7.3**.

5.4.6 Hazard of Erosion

Erosion hazard is accelerated erosion in excess of natural rates, usually as a result of anthropogenic activities, including roads, trails, and other actions that expose the soil surface (Soil Science Society of America, 2020).

The ratings in the “Potential Erosion Hazard - Road / Trail” interpretations indicate the hazard of soil loss from unsurfaced roads and trails. The ratings are based on soil erosion factor K, slope, and content of rock fragments. A hazard rating of SLIGHT indicates that little or no erosion is likely; MODERATE indicates that some erosion is likely; and SEVERE indicates that significant erosion is expected. Roads and trails with MODERATE erosion hazard may require occasional maintenance, and simple erosion control measures are needed. Significant erosion is expected on soils with SEVERE erosion hazard, and roads or trails on these soils require frequent maintenance and costly erosion-control measures (USDA NRCS, No Date(a)). Less than 1% of Howell Township’s soils are rated SEVERE hazard of soil erosion on roads and trails, 11% are rated MODERATE, and 85% are rated SLIGHT. Nearly 3% is either water or not rated (see **Table 5.1** and **Figure 5.6**).

The ratings for the “Erosion Hazard (Off-Road, Off-Trail)” interpretations indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities where 50 to 75% of the soil surface has been exposed by construction, logging, grazing, mining, or other kinds of disturbance soil surface. The ratings are based on slope and soil erosion factor K. A rating of SLIGHT indicates that erosion is unlikely under ordinary climatic conditions; MODERATE indicates that some erosion is likely and that erosion control measures may be needed; SEVERE indicates that erosion is very likely and that erosion



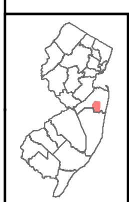


Figure 5.3. Howell Township, Soils - Hydrologic Soil Grouping

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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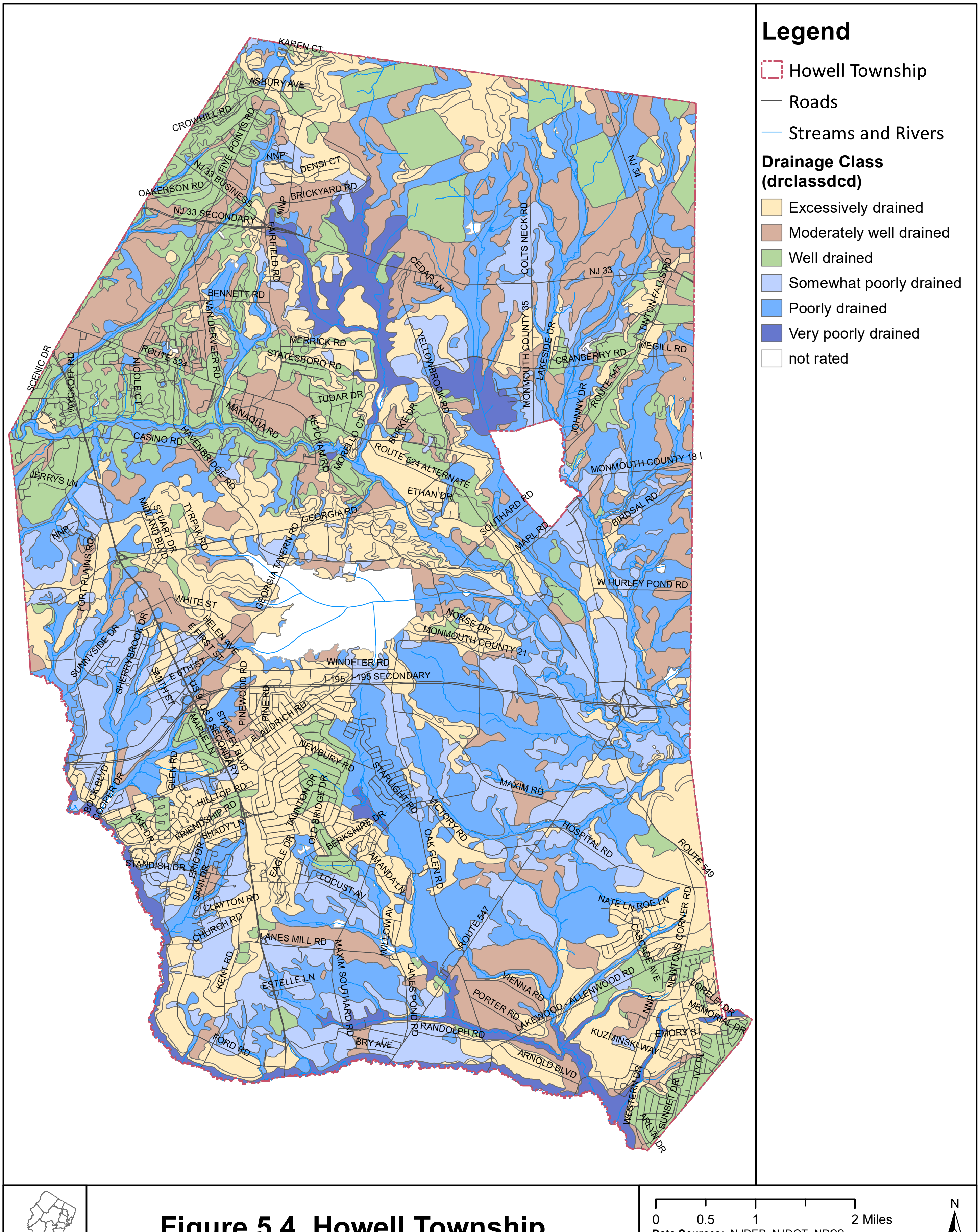

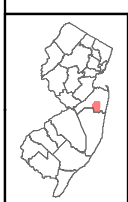

Figure 5.4. Howell Township, Soils - Drainage Class

Data Sources: NJDEP, NJDOT, NRCS

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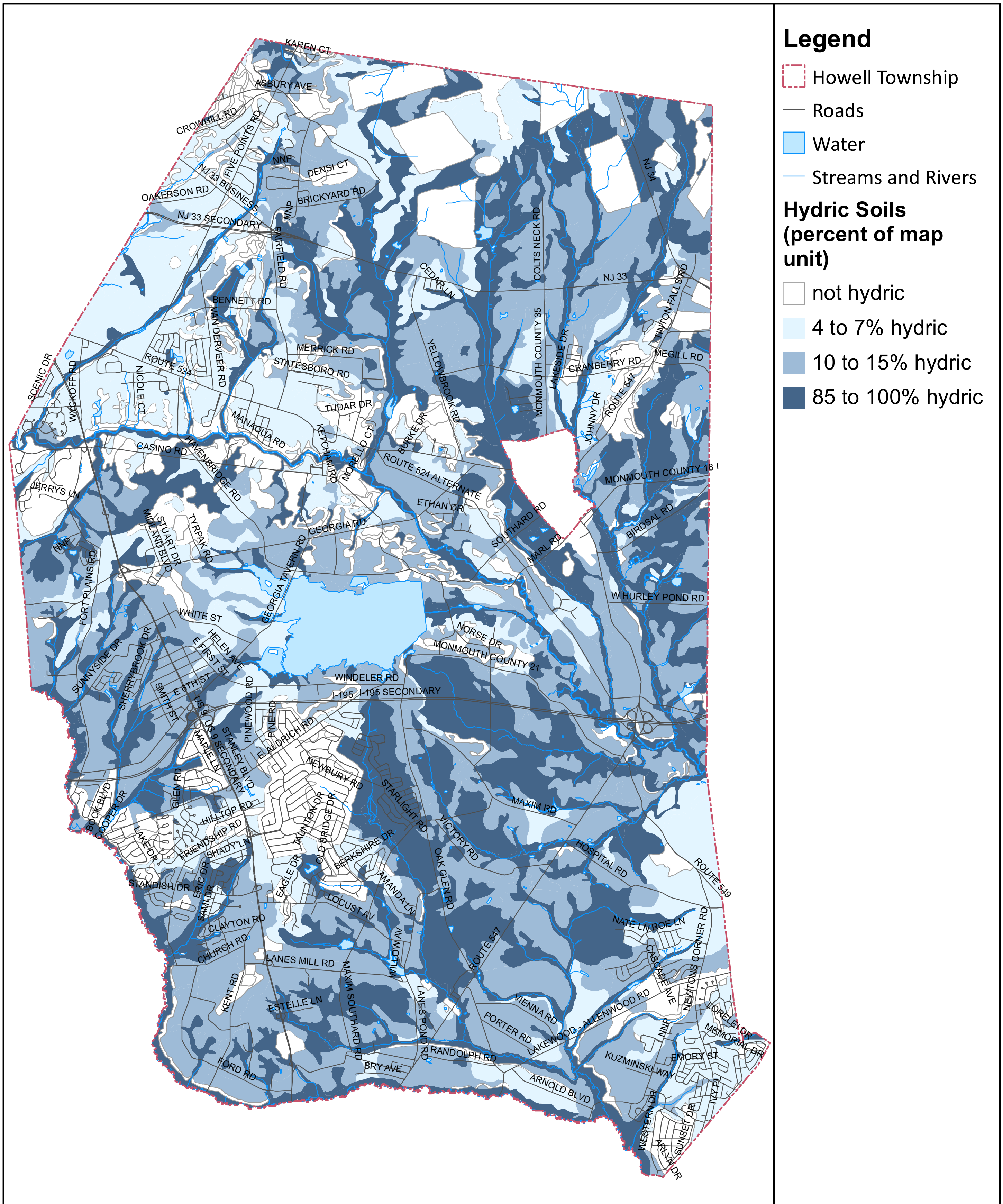

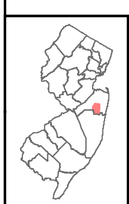

Figure 5.5. Howell Township, Soils - Hydric Rating (NJ)

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS

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control measures, including revegetation of bare areas, are advised; and VERY SEVERE indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion control measures are costly and generally impractical (USDA NRCS, No Date(B)).

In Howell Township, 91% of the area is rated SLIGHT, 6% is MODERATE, and less than 1% is rated SEVERE, while nearly 3% is either water or not rated (see **Table 5.1** and **Figure 5.6**).

5.4.7 Farmland Suitability

New Jersey uses standard categories of soil quality developed by the USDA to rank the relative value of land for farming purposes, as described in **Table 5.5** (NJ SADC/CADB, 2003). Howell Township has 3,978 acres of Prime Farmland Soils (10% of the township), including the Freehold and Woodstown soils. An additional 11,887 acres (30%) is classified as Farmland of Statewide Importance, including Klej and Freehold soils, while 1,367 acres (4%) would be included in this category, if drained. Twenty percent of the municipality (8,003 acres) has soils of unique importance, including Atsion sand and Manahawkin muck. In total, 21,258 acres (54%) of Howell has soils suitable for farmland (see **Table 5.5** and **Figure 5.7**).

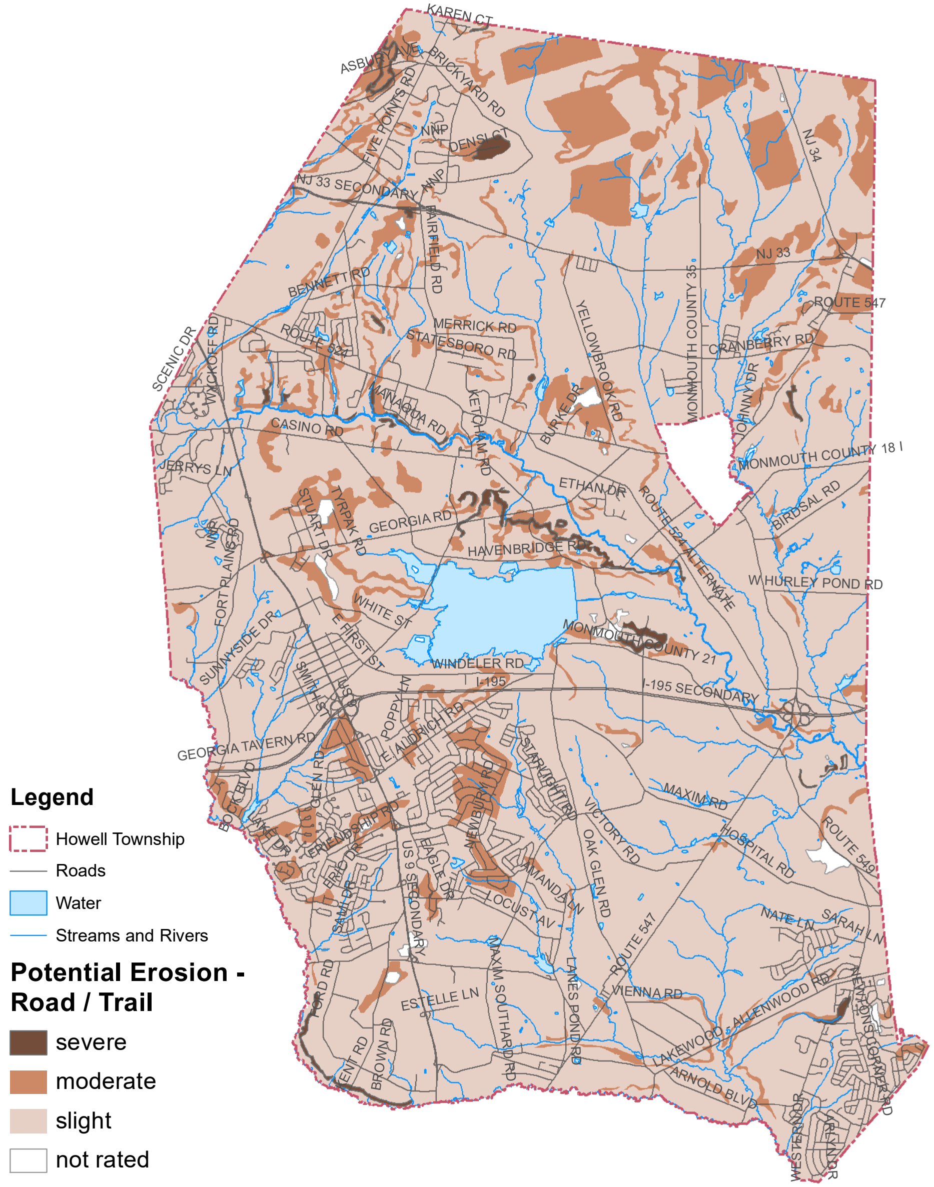
Table 5.5. Farmland Rating Classes

Classification	Description
Prime	This land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed according to acceptable farming methods. Soils are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.
Statewide	Soils of Statewide Importance are nearly Prime, and economically produce high yields of crops when treated and managed according to acceptable farming methods. Some may produce yields as high as Prime Farmland if conditions are favorable.
Local	Farmland of Local Importance includes those soils that are not prime or of statewide importance and are used for the production of high value food, fiber, or horticultural crops.
Unique	These are soils with severe limitations which are used to produce special crops (e.g., cranberry bogs)
Source: NJ SADC/CADB, 2003	

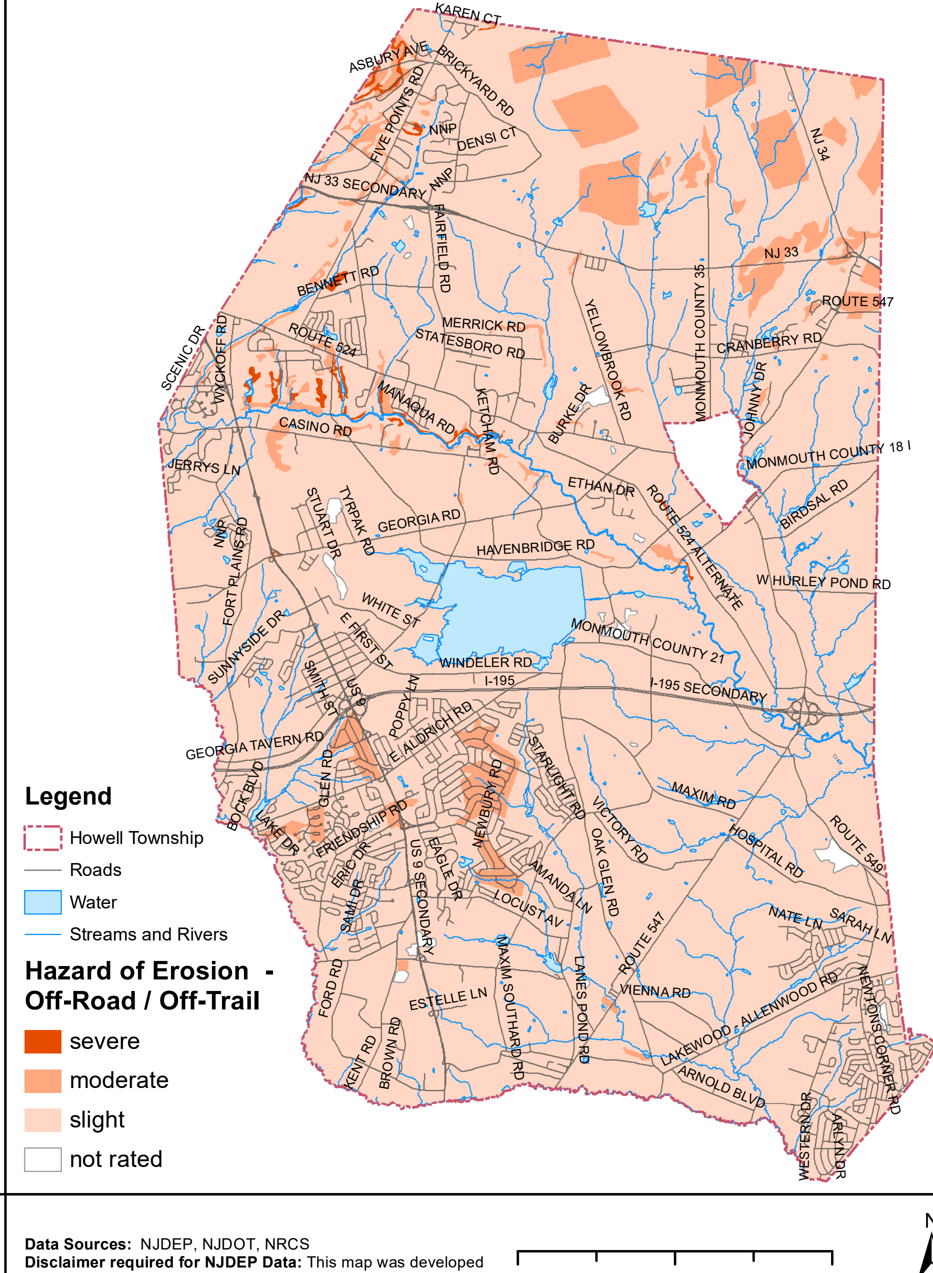
5.4.8 Potential Frost Action

Soils vary in their susceptibility to mechanical weathering by which frost action, salt-crystal growth, absorption of water, and other physical processes break down a rock into smaller fragments, without changing chemically (Soil Science Society of America, 2020). *Potential Frost Action* is an interpretation rating of the susceptibility of the soil to frost heaving. Thirty-eight percent of Howell is rated low potential frost action, 44% is moderate, and 12% is high. The remaining 6% is either not rated or water (see **Table 5.1** and **Figure 5.8**).

Potential Erosion Hazard - Road / Trail



Erosion Hazard - Off-Road / Off-Trail



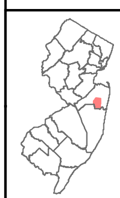


Figure 5.6. Howell Township, Soils - Hazard of Erosion

Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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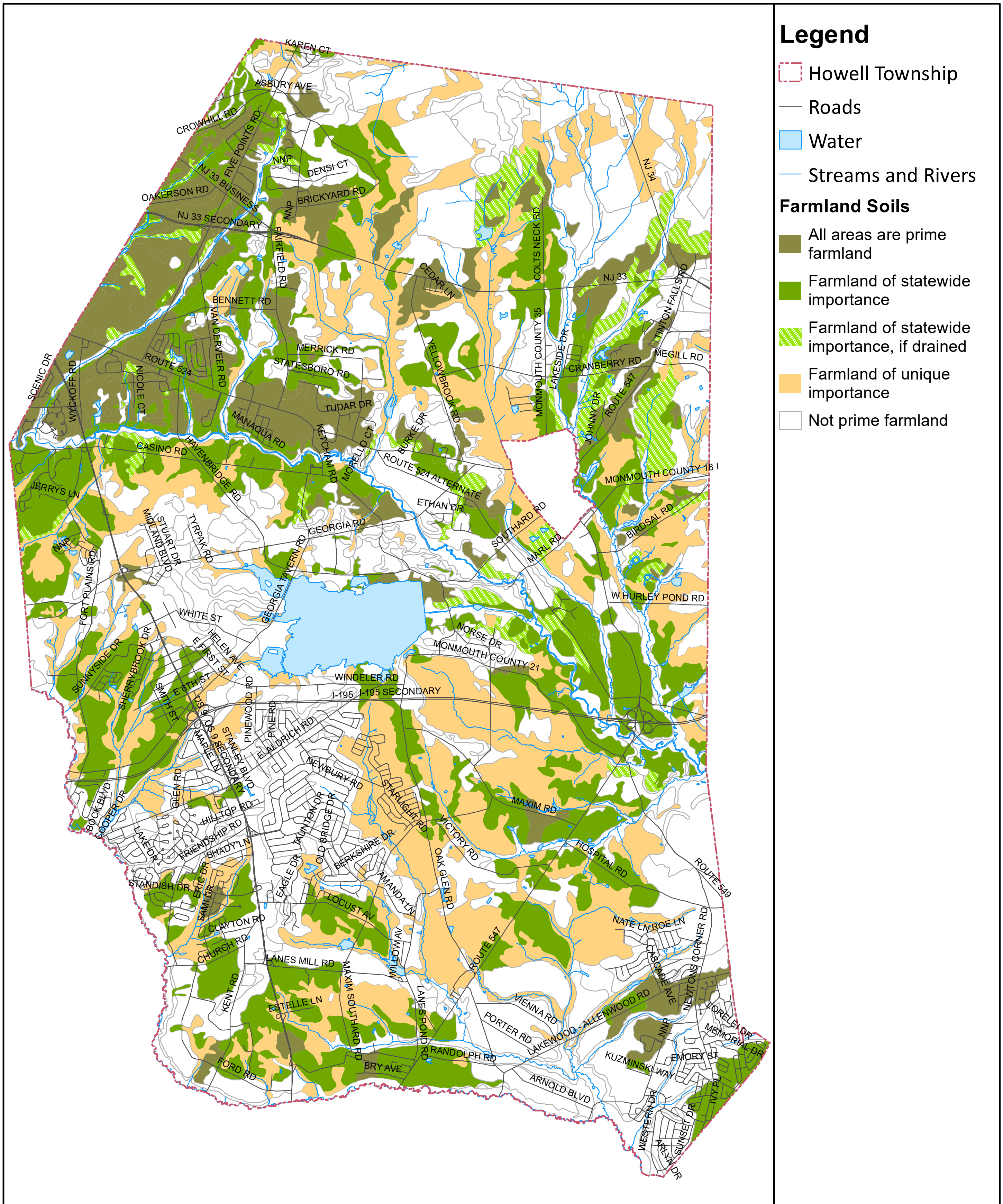

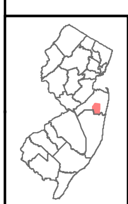

Figure 5.7. Howell Township, Soils - Agricultural

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS

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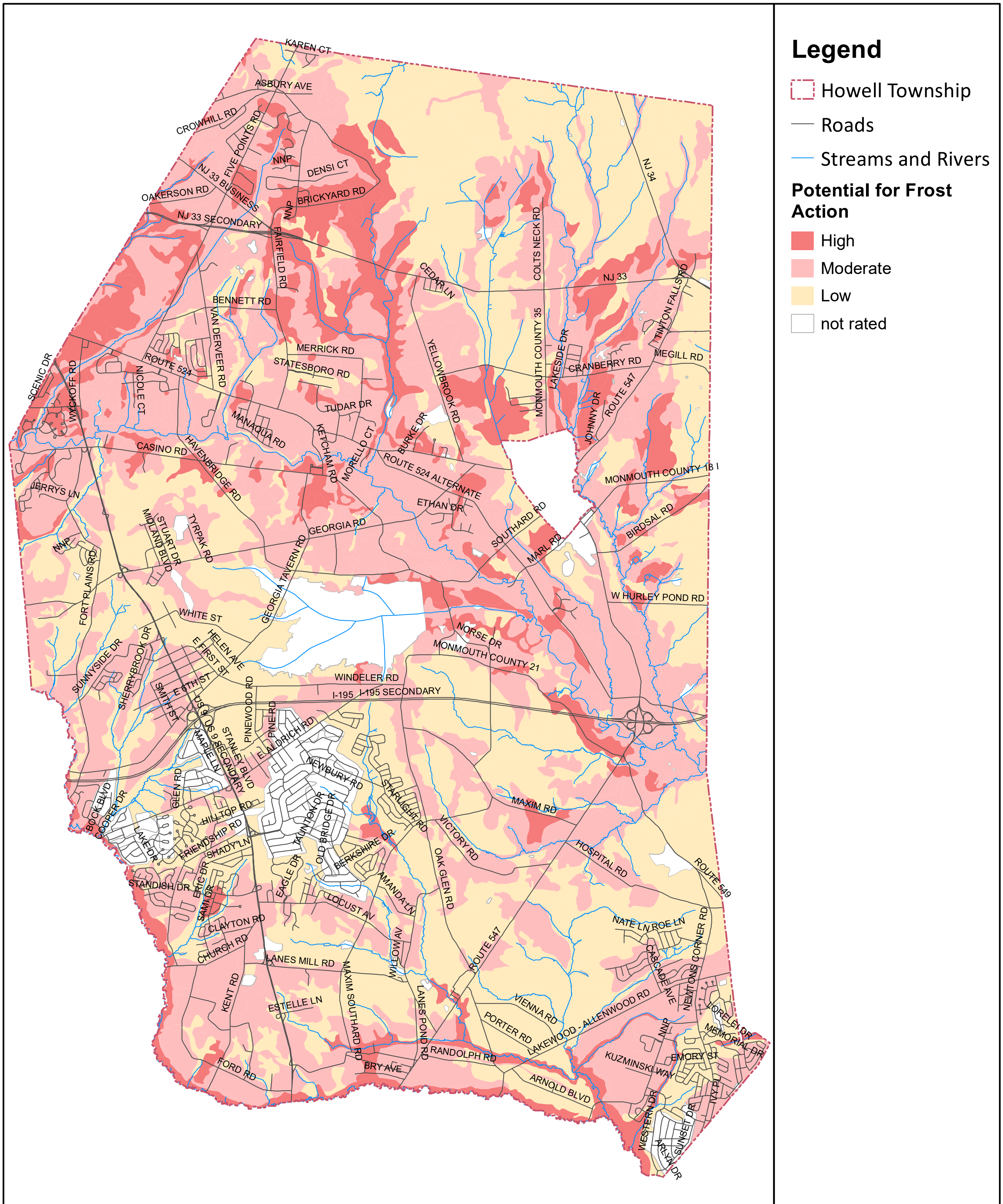

Figure 5.8. Howell Township, Soils - Potential Frost Action

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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5.4.9 Septic Suitability (NJ)

The NRCS SSURGO database provides an interpretation of limitations of each soil for *septic suitability*. The interpretation shown in **Figure 5.9** is based on the N.J.A.C. 7:9A Standards for Individual Subsurface Sewage Disposal Systems, Subchapter 10 Disposal Fields (NJDEP, 2012). Soil characteristics which may affect the functioning of the system, and therefore limit septic field suitability, include massive rock (i.e. hydraulically restrictive rock); excessively coarse horizons or substrata; hydraulically restrictive horizons; and zones of saturation. Construction of septic systems in ground subject to surface flooding are prohibited. In cases where there is the possible presence of freshwater wetlands in a proposed subsurface sewage disposal system site, the applicant must adhere to the Freshwater Wetlands Protection Act, N.J.S.A. 13:9B-1 et seq. In addition, steep slopes may also be unsuitable for septic systems, although this isn't an issue in Howell Township (NJDEP, 2012).

Figure 5.9 illustrates the general suitability of the soil for septic tank absorption fields, based on the soil characteristics. As with all the soil characteristics, on-site testing is necessary for site-specific decision making. The dominant condition for 45% of the township is very limited for septic suitability, while 12% of the area is somewhat limited, and 40% is not limited. The remaining 3% is either not rated or is water (see **Table 5.1** and **Figure 5.9**) (see also **Section 11** for Sewer Service Areas).

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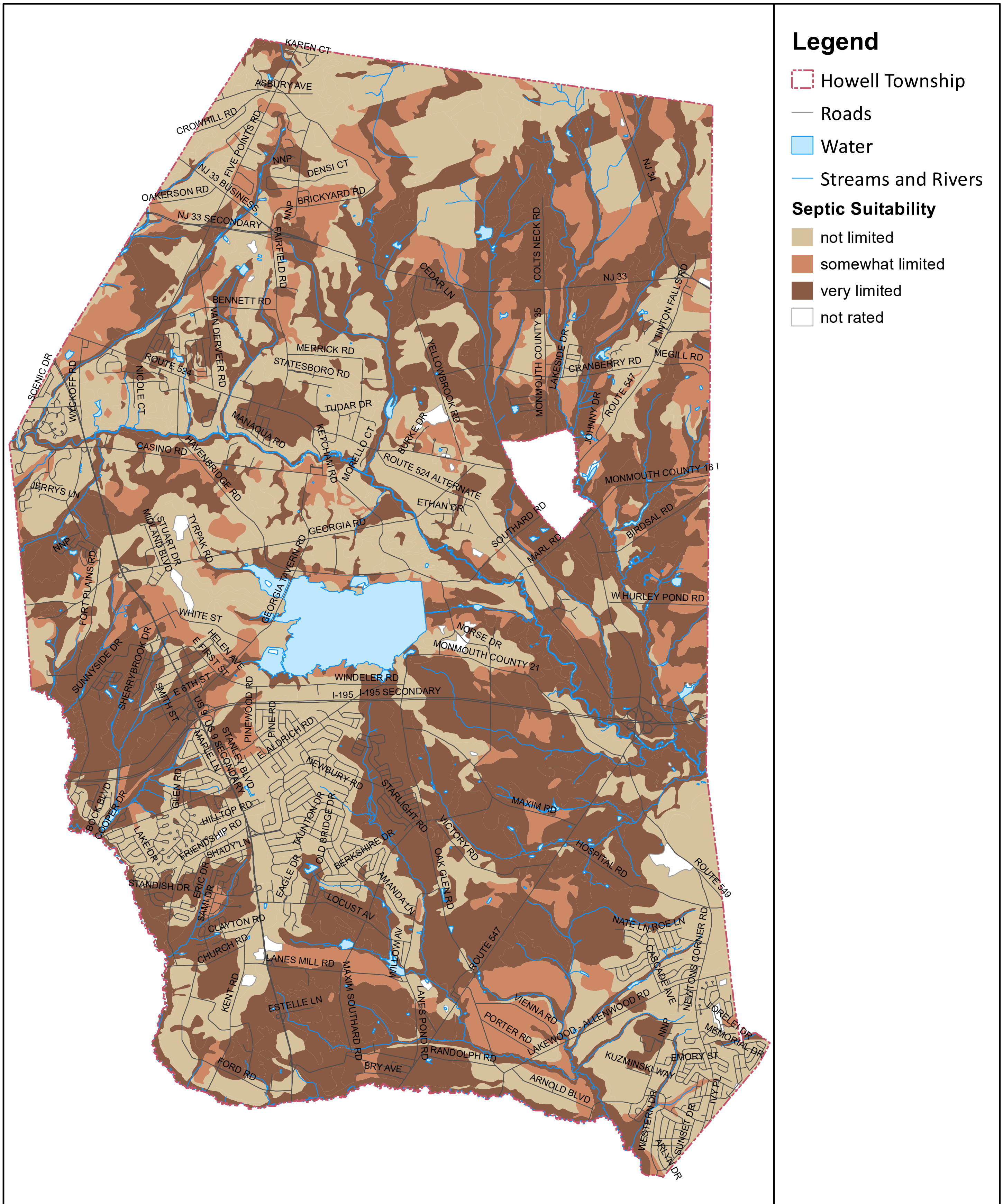

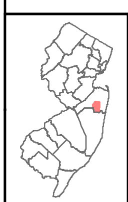

Figure 5.9. Howell Township, Soils - Septic Suitability (NJ)

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS

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Internet Resources: Soils

NRCS New Jersey Office: http://www.nj.nrcs.usda.gov/

NRCS Soils Website: Helping People Understand Soils: http://soils.usda.gov/

NRCS Soil Data Mart (download soils data for GIS): http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

NRCS Soils Online Study Guide: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nj/home/?cid=nrcs141p2_018928

NRCS Web Soil Survey (online soils mapping): http://websoilsurvey.nrcs.usda.gov/app/

Rutgers New Jersey Agricultural Experiment Station Soil Testing Laboratory Interpretation of Organic Matter Levels in New Jersey Soils: https://njaes.rutgers.edu/soil-testing-lab/organic-matter-levels.php

6. GROUND WATER

6.1 Ground Water

Ground water is that portion of water beneath the land surface that is within the zone of saturation (below the water table) where pore spaces are filled with water. An *aquifer* is a water-bearing rock or geologic formation (including sediments such as unconsolidated sands) where water is present in usable quantities. Water is constantly recycled through the *hydrologic cycle*, also known as the *water cycle*, illustrated in **Figure 6.1**. Precipitation falls on the ground and some travels on the surface of the land (called *surface runoff*), entering streams (where it can be seen as high flows after rain events), and eventually making its way back to the ocean. Some of the water from precipitation enters the ground but remains in the shallow layers where it is available for use by plants, and returns to the atmosphere through *transpiration* by plants, while some water re-enters the atmosphere directly through *evaporation* from surface water. Evaporation and transpiration combined are known as *evapotranspiration*. The water that migrates below the root zone travels underground and exits the system as stream flow, known as *ground water baseflow* or *ground water recharge*. Ground water baseflow can be calculated by measuring stream flow during dry weather conditions. A smaller portion of the water penetrates deeper into the ground and enters (or recharges) the saturated zone of the fractured bedrock or other geologic formation, called the *aquifer,* where most wells obtain their water.

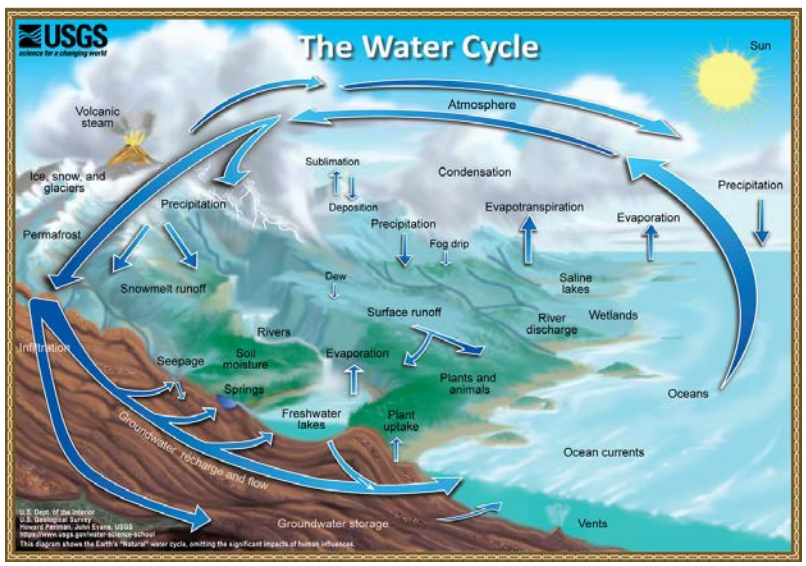

Figure 6.1. The Water Cycle

Source: Perlman and Evans, USGS, October 16, 2019

Pollutants can enter water as it travels the water cycle. Surface runoff can pick up chemicals and sediment on its way, depositing these pollutants in waterways. This is especially true of “uncontrolled surface runoff” on soils that are vulnerable to erosion (see **Section 11.2.3**). Water seeping into the soil can be cleansed of many pollutants by natural soil processes. However, if the pollutant is one that is resistant to break-down, or if the pollutant doesn’t get exposed to the soil long enough (such as by entering a bedrock fracture or by entering the ground water through sub-surface disposal), pollutants can spread underground and pollute sources of drinking water.

Movement of ground water is usually quite slow, on average, ranging from about one foot per day to perhaps ½ inch per month. Therefore, in some areas, it might take days for water to travel from the point where it enters the ground, to a point of discharge into a stream, or it might take millennia (Heath, 1983). Movement of water through an aquifer of unconsolidated sediment depends in part on the pore size between particles as well as the size and uniformity of the actual particles. Water is stored in and moves through connected pore spaces and larger particles of uniform size can more readily transmit water. Because hydraulic conductivity can be high, surficial (water table) aquifer systems of unconsolidated sediments may be susceptible to contamination (USGS, 2016).

6.2 Aquifers

An understanding of the water cycle emphasizes the connections between surface and ground water. The Township of Howell relies on a combination of water from surface waters and from public and individual wells fed by ground water. The water is part of the natural water cycle, and is susceptible to human impacts and the influence of climate and geology.

The density of housing and impervious surfaces can impact aquifers and may result in reduced recharge, lowered yields, increased interference (wells interfering with each other), and degradation of ground water quality. In any aquifer, if the rate of water use exceeds the recharge rate, well yields will decrease. Furthermore, these changes can alter stream flow dynamics resulting in higher flows after storm events and lowered flows between events. In coastal areas, increased rates of ground water use may also result in saltwater intrusion into freshwater aquifers and wells. An in-depth study that would provide such a detailed analysis of aquifer conditions in Howell Township has not been done.

Aquifers are typically described as being unconfined or confined. *Unconfined* aquifers are those aquifers where the ground water is directly connected to the atmosphere through the pores of the aquifer. *Confined* aquifers are water-bearing formations that are separated from the surface by a layer of rock or soil through which water cannot move (Dunne and Leopold, 1978).

The Kirkwood Cohansey outcrops as the upper aquifer in Howell Township, described below and summarized in **Table 6.1.** The map in **Figure 6.2** shows the outcrops of confining layers and the unconfined (water table) aquifer, while **Figure 6.3** illustrates an underground cross-section cut across New Jersey from northwest (on the left) to the southeast (on the right). The aquifers in Howell Township are described below, including the Potomac-Raritan-Magothy which does not outcrop in Howell Township, but supplies a portion of the township's public water.

The recharge area (where precipitation or snowmelt enters the ground) for unconfined (surficial) aquifers is local, usually above the aquifer. In contrast, the recharge area for confined aquifers can be a distance away, wherever that aquifer eventually intersects with the surface of the ground. Due to the interconnected nature of the coastal plain groundwater supply, the NJDEP water supply plan for the confined aquifers of the coastal plain explores options for ensuring adequate freshwater supply as demand continues to increase in the coming years (NJDEP, October 5, 2017; also see **Section 13.4**).

6.2.1 Kirkwood-Cohansey Aquifer System

The Kirkwood-Cohansey aquifer is composed of sand and gravel with lenses of silt and clay and generally occurs under water-table conditions. This aquifer system extends from Monmouth County to the Delaware Bay and from the Delaware River to the Atlantic Ocean. The aquifer is 60 – 180 feet thick, and is underlain by confined Kirkwood aquifers. Water occurs in primary intergranular porosity and permeability with well yields ranging from 5 – 700 gallons/minute, though yields can go as high as 1,500 gallons/minute. Leakage from unconfined to confined parts provides water. Water quality is fresh, acidic, highly corrosive, and low in dissolved solids. Confined aquifers commonly have less corrosive water. Iron and manganese levels can be elevated, and brackish and salty water may occur in coastal areas (USGS, January 14, 2013; Herman, et al., 1998).

6.2.2 Composite Confining Unit (ccu and ccua)

Composite confining units are composed of silt and clay with localized confining sand lenses. Confining units include the Shark River, Manasquan, Hornerstown, and Tinton Formations, and the lower part (Sandy Hook Member) of the Red Bank Formation. Localized water-table aquifers (ccua) composed of massive quartz sand outcrop as the Vincentown Formation and the upper part (Shrewsbury Member) of the Red Bank Formation. These aquifers grade into confining units southeastward in the subsurface where the quartz sands become more glauconitic and silty. Water quality is generally good, but iron and manganese levels may be locally elevated. Calcium-bicarbonate type waters dominate (Herman, et al., 1998).

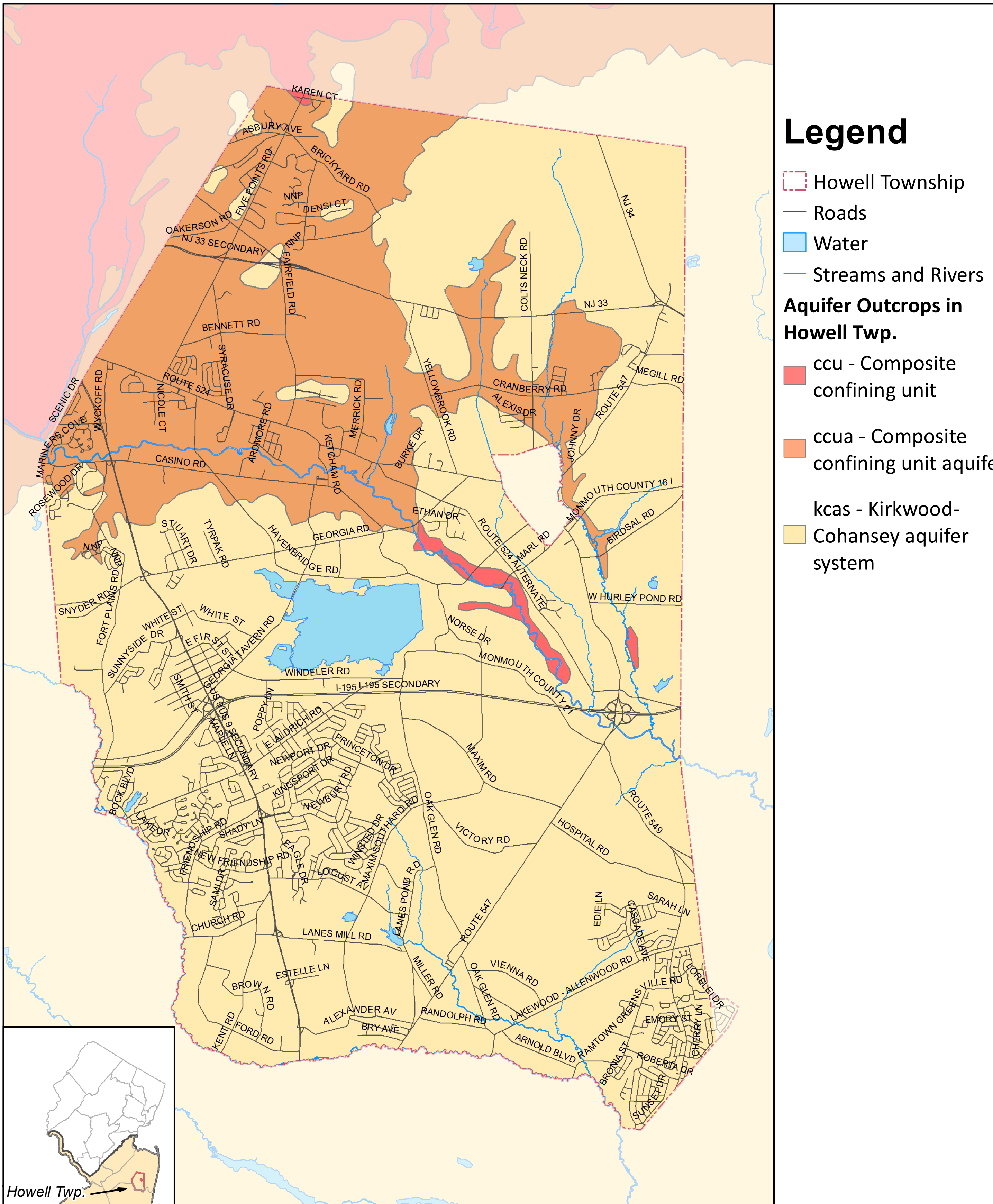

Figure 6.2. Howell Township, Aquifers and Sole-Source Aquifeer

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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6.2.3 Potomac-Raritan-Magothy

The Potomac-Raritan-Magothy confined aquifer is composed of interbedded sand, gravel, silt, and clay separated into lower, middle, and upper aquifers. The P-R-M is highly productive and is the most used confined aquifer in the coastal plain. It extends throughout the coastal plain and attains a maximum thickness of 4,100 ft. Water occurs in primary intergranular porosity and permeability. Water quality is fresh, moderately hard, near-neutral pH, and commonly has elevated iron and manganese levels. Salinity increases with depth and towards the coastline. Calcium and magnesium levels decrease, and sodium and potassium levels generally increase to the southeast. Calcium-bicarbonate type waters dominate (USGS, January 14, 2013; Herman, et al., 1998).

Table 6.1. Aquifer Characteristics

Abbreviation	Geologic Formation Name	Aquifer Rank	Acres at surface in Howell Twp.	Percent of Howell Twp. Surface
ccu	Composite confining unit	E-D	296.73	1%
ccua	Composite confining unit aquifer	C-B	9,174.32	23%
kcas	Kirkwood-Cohansey aquifer system	B-A	29,677.87	76%
prma	Potomac-Raritan-Magothy aquifer system	A	Occurs at depth in Howell	
		Total:	39,148.92	100%
*Aquifer Rank is from NJGS GIS data. It is based on High Capacity Wells (such as water-supply, irrigation, and industrial-supply wells sited and tested for maximum yield. Many of the wells have boreholes exceeding the standard six-inch diameter for domestic wells. State Rank is best viewed on a relative basis, with "A" yielding the most water, and "E" the least. Median High Capacity Wells Yield (in gpm): [A] > 500; [B] 251 to 500; [C] 101 to 250; [D] 25 to 100; [E] <25				
Source: NJGS, May 21, 1998				

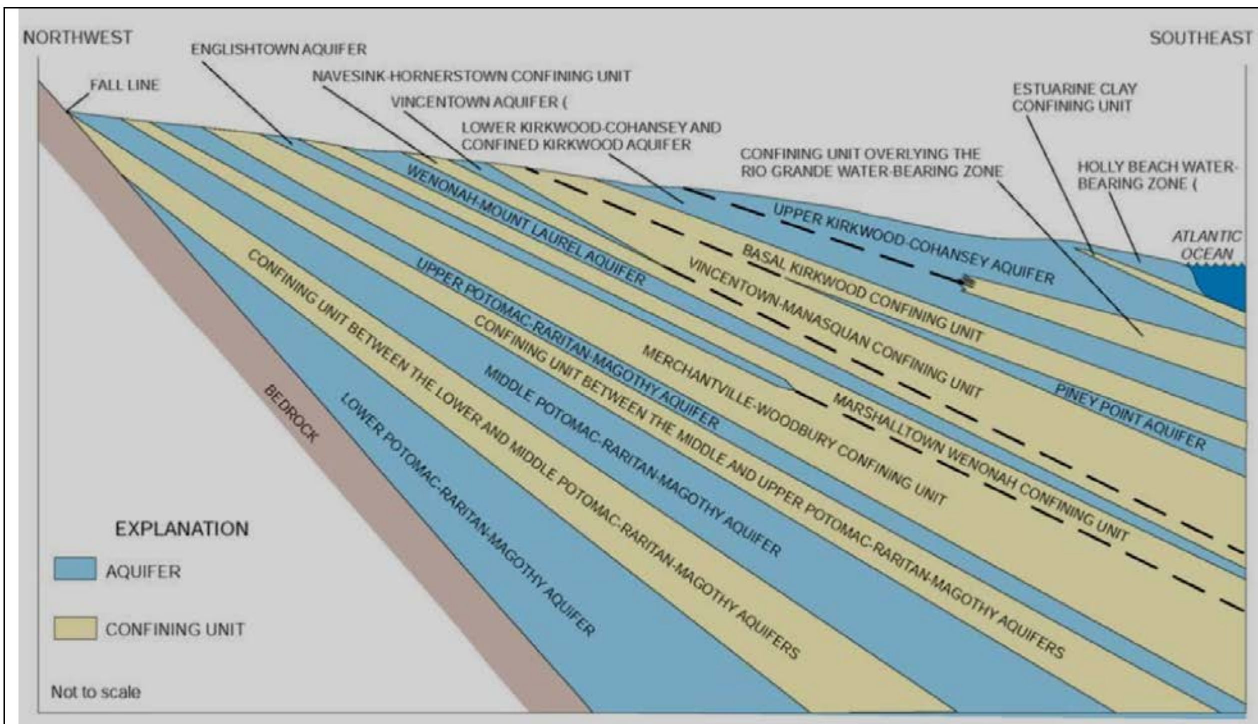


Figure 6.3. Generalized Cross Section of New Jersey's Coastal Plain Aquifer System

Source: Charles et al., 2011 in NJDEP, October 5, 2017. Not to scale.

6.3 Sole-Source Aquifer

The Safe Drinking Water Act (SDWA) of 1974 contains a provision in Section 1424(e) that provides for designating an aquifer that is the sole or principal drinking water source for an area and that, if contaminated, would create significant hazard to public health. As defined by the U.S. Environmental Protection Agency (EPA), s*ole-source aquifers* (SSA) are those aquifers that contribute more than 50% of the drinking water to a specific area and the water would be impossible to replace if the aquifer were contaminated. Once designated, no Federal financial assistance may be approved for any project that may contaminate the aquifer through a recharge zone so as to create a significant hazard to public health (US EPA, August 1992). Therefore, the EPA must review any federally-funded project in an area that could affect ground water in a sole-source aquifer, including the *aquifer's recharge zone* (the area through which water recharges the aquifer) and its *stream-flow source zone* (the upstream area that contributes recharge water to the aquifer).

> "Nearly all surface-water features (streams, lakes, reservoirs, wetlands, and estuaries) interact with ground water. Thus, effective land and water management requires a clear understanding of the linkages between ground water and surface water as it applies to any given hydrologic setting." (Winter et al., 1998)

The Kirkwood-Cohansey Aquifer System met the technical requirements for SSA designation, and Notice of approval was published in the Federal Register 57 FR 39201, August 28, 1992. It covers much of the Inner and Outer coastal plain. The Kirkwood-Cohansey SSA in New Jersey is shown in **Figure 6.2** (lower left inset) (Hoffman, 1998) and includes water-bearing units that supply Howell Township's water

6.4 Ground Water Recharge Areas

Ground water recharge is defined as water added to an aquifer (for example, precipitation that seeps into the ground deep enough to enter the saturated zone of the fractured bedrock). A g*round water recharge area* is the land area that allows precipitation to seep into the saturated zone. These areas are generally at topographically high areas with discharge areas at lower elevations, commonly at streams or other water bodies (i.e. the ground water returns to surface water). In general, ground water divides[9] coincide with, or are slightly offset from surface water divides (Lewis-Brown and Jacobsen, 1995) (watersheds are described in **Section 7.1** and shown in **Figure 7.1**). Most ground water flows through the shallow layers of soil and weathered bedrock to the nearest stream. A smaller percentage penetrates deeper and recharges the aquifer.

Recharge rates are expressed in terms of the amount of precipitation that reaches the aquifer per unit of time (e.g. inches/year during a drought year is used in **Figure 6.4**). New Jersey receives an average of about 40 to 51 inches of precipitation per year (lowest along the southeast coast and highest in the north-central parts of the state) (ONJSC, no date). Many factors affect the amount of recharge that will occur in a given area, including climate (e.g. the amount, intensity, and form of precipitation, and the effect of wind, humidity, and air temperature on evapotranspiration), soil, surficial geology, and vegetation factors. In addition, recharge of ground water varies seasonally. During the growing season, precipitation is intercepted by plants and returned to the atmosphere through transpiration (part of the hydrologic cycle). Likewise, evaporation is higher during the warmer months. Together, these are known as evapotranspiration. Therefore, most recharge occurs during late fall, winter, and early spring, when plants are dormant and evaporation rates are minimal (Heath, 1983). Relative to land use, recharge rates in forests are much higher than those in urban areas (Heath, 1983). This is because urban

[9] A ground water divide is a line on a water table where on either side of which the water table slopes downward. It is analogous to a drainage divide between two drainage basins on a land surface.

areas have large areas covered with impermeable surfaces, hastening runoff to surface water, instead of allowing precipitation to percolate into the ground.

To ensure that water is available during all weather conditions for human consumption as well as ecosystems dependent on water, the NJDEP established the Planning Threshold, or *dependable yield,* to be used for planning purposes. *Dependable yield* is defined as "the water yield maintainable by a ground-water system during projected future conditions, including both a repetition of the most severe drought of record and long-term withdrawal rates without creating undesirable effects." The Statewide Water Supply Plan acknowledges the need to plan for a repeat of the most severe drought on record which was in the early 1960's, as well as "demand-driven" droughts (potential water shortages during relatively short periods that technically may not "officially" qualify as droughts, and droughts due to climate change (NJDEP, October 5, 2017). Robert Canace, formerly of the NJ Geological Survey, suggested that 20% of the estimated recharge should be used for planning purposes, representing the portion of recharge actually available for use during drought conditions (Canace, 1995).

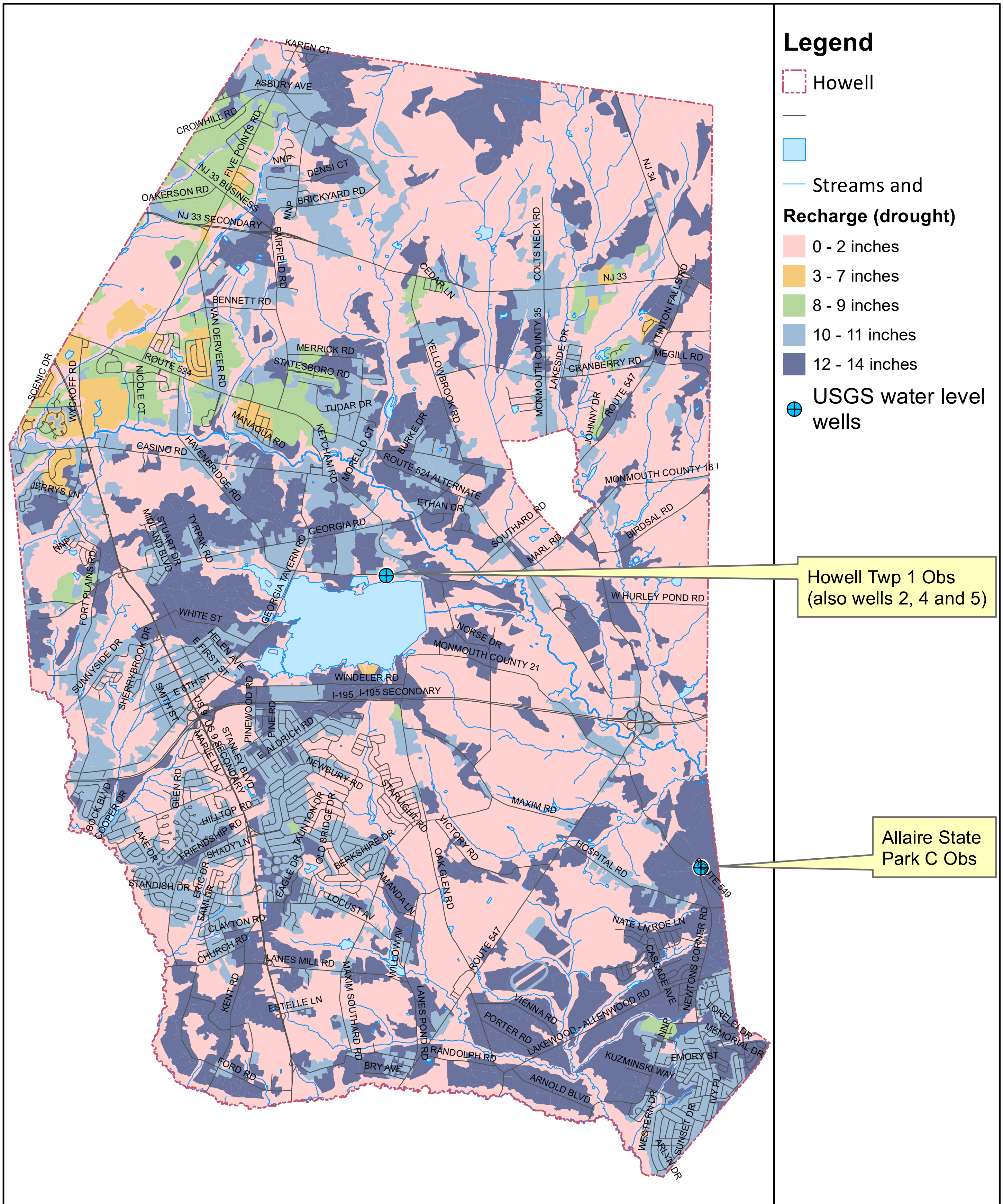
In view of the importance of not exceeding the aquifers' safe yield, the New Jersey Geological Survey has completed studies quantifying recharge, as discussed in the following sections.

6.4.1 New Jersey Geological Survey Recharge Method GSR-32

N.J.S.A. 58:11A, 12-16 required the NJDEP to publish a methodology to map and rank aquifer-recharge areas. In addition, the legislation required the development of ground water protection practices designed to encourage ecologically sound development in aquifer-recharge areas (Charles et. al., 1993). To fulfill the requirements of this legislation, the NJ Geological Survey developed GSR-32, which estimates ground water recharge (but not aquifer recharge), and is useful for evaluating the relative effect of present and future land uses on recharge areas (Charles et. al., 1993). For this method, recharge was calculated based on data for precipitation, soil, land-use/land-cover10, surface runoff, and evapotranspiration. This method was then applied by NJGS to create a GIS coverage. There were a number of assumptions made for the calculations and model inputs that limit the accuracy of the method: 1) the calculated ground water recharge includes any water entering the ground (in actuality, lesser amounts actually enter the aquifer); 2) assumes that all water that migrates below the root zone recharges the aquifer (which does not happen); 3) addresses only natural ground water recharge, and does not include artificial recharge, withdrawals or natural discharge; 4) wetlands and water bodies were eliminated from analysis, because the direction of flow between ground water and surface water is site-specific and also varies seasonally, and this level of detail was beyond the scope of the study (these areas were assumed to provide no recharge or discharge); 5) stream baseflows used may not be representative of local streams (Charles et. al., 1993) and 6) does not consider topography, depth to bedrock, presence of impervious surfaces, and/or type of bedrock underlying soils. An additional limitation of the data is that they estimate long-term average annual recharge, which does not represent the reduced recharge during critical summertime conditions.

Applying the GSR-32 method to Howell Township, the estimated average annual subsurface recharge rates range from 0 to 17 inches per year (excluding surface water, wetlands, and hydric soils) and 0 to 14 inches per year during drought (shown on **Figure 6.4**). Applying the 20% consumptive use limit to these figures results in usable recharge from 0 to 3 inches per year (NJGS, May 1, 2006).

[10] Land use/land cover data from 1995-1997 were used for this study. Changes in land use/land cover and impervious surfaces affect recharge, but are not reflected on **Figure 6.4**, because this involves complex calculations, and NJGS has not updated this GIS data layer.



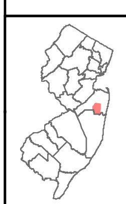


Figure 6.4. Howell Township, Recharge

0 0.5 1 2 Miles

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Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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6.5 Ground Water Level Monitoring

The *ground water level* is the distance from the land surface to the water in a well. Ground water level monitoring is critical for determining the current state of the ground water, identifying trends, and predicting ground water drought. In addition to drought, over-withdrawal of ground water can occur in areas where more ground water is being pumped out of the aquifer than is replenished through recharge. This could lead to a drop in the ground water level, affecting well performance, and sometimes causing wells to go dry; in addition to causing a decrease in the baseflows of adjacent streams and contributing to saltwater intrusion.

The USGS maintains a nation-wide network of wells to monitor the effects of droughts and other climate variability on ground water levels. There are five USGS monitoring wells within Howell Township, four of which are located adjacent to the Manasquan Reservoir but drilled to different depths, thereby monitoring different aquifers. The deepest, Howell Twp 1 Obs, is completed in the undifferentiated Potomac-Raritan-Magothy Aquifer System; followed in order of depth by Howell Twp 5 Obs in the upper aquifer of the Potomac-Raritan-Magothy Aquifer; Howell Twp 4 Obs in the Englishtown Formation (one of the confining unit members); and Howell Twp 2 Obs in the Vincentown Formation (another of the confining unit members). The fifth well in Howell is located in Allaire State Park in the Englishtown Formation. These well levels are among the factors that NJDEP uses to determine drought status (see **Internet Resources**). A description of these sites and graphs of ground water levels are shown in **Table 6.2**. Locations are shown in **Figure 6.4**. On average, the lowest ground water levels occur during June-October, while highest levels occur between March-May.

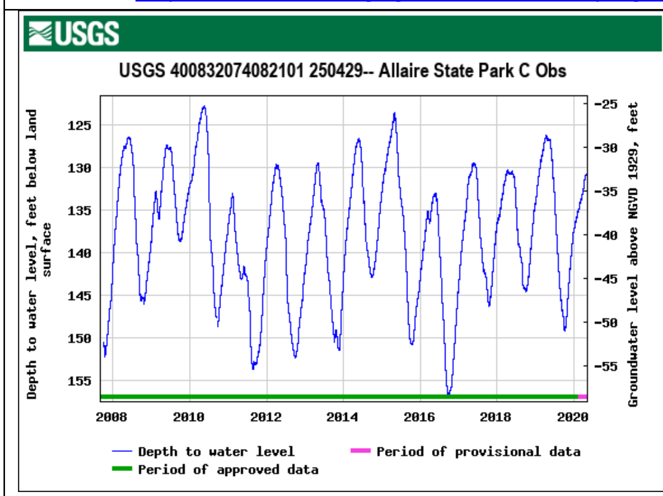
Table 6.2: USGS Real-Time Ground Water Level Network – Wells in Howell Township

USGS 400832074082101 250429-- Allaire State Park C Obs

Location: Latitude 40°08'34", Longitude 74°08'34" NAD27
Monmouth County, New Jersey, Hydrologic Unit 02040301
about 1.3 mi southeast of Lower Squankum off County Rt. 21, Allaire State Park.

Aquifer: Well completed in "Northern Atlantic Coastal Plain aquifer system" (S100NATLCP) national aquifer, "Englishtown Formation" (211EGLS) local aquifer

Website: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=400832074082101



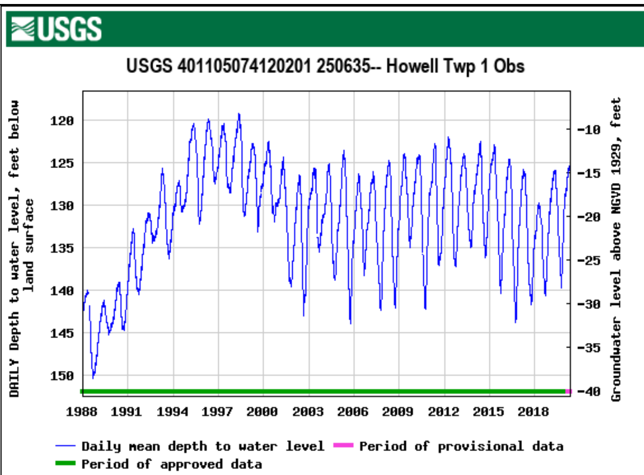
Well depth:	633 feet Drilled artesian well
Hole depth:	715 feet
Land surface altitude:	97.93 feet above NGVD29
Period of Record:	February 1964 to current year (October 2007 to present continuous available)
Extremes for Period of Record (feet below land surface datum):	
Highest Water Level:	122.69 feet, May 19, 2010
Lowest Water Level:	249.89 feet, between Jun 24 and Sep 28, 1988

USGS 401105074120201 250635-- Howell Twp 1 Obs

Location: Latitude 40°11'05", Longitude 74°12'02" NAD27
Monmouth County, New Jersey, Hydrologic Unit 02040301
about 5,000 ft east of the intersection of Georgia Tavern Rd. and Peskin Rd

Aquifer: Well completed in "Northern Atlantic Coastal Plain aquifer system" (S100NATLCP) national aquifer, "Magothy-Raritan-Potomac Aquifer System, Undifferentiated" (211MRPA) local aquifer

Website: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=401105074120201



Well depth:	1360.5 feet Drilled artesian well
Hole depth:	1670 feet
Land surface altitude:	111.3 feet above NGVD29
PERIOD OF RECORD:	December 1987 to current year
EXTREMES FOR PERIOD OF RECORD	
Highest Water Level:	119.12 ft below land surface datum, May 11, 1998
Lowest Water Level:	lowest, 150.32 ft below land surface datum, Sep 2, 1988

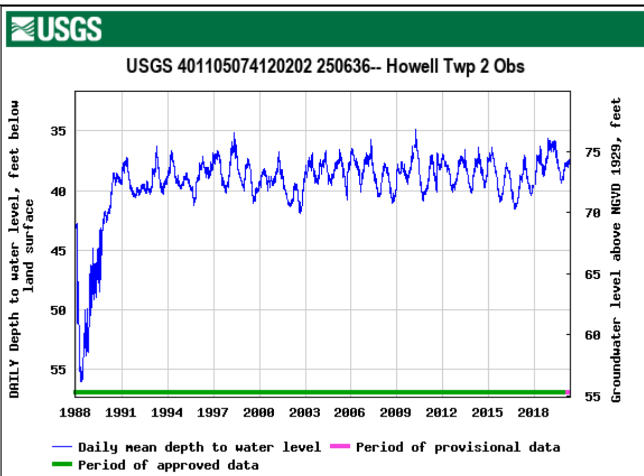
USGS 401105074120202 250636-- Howell Twp 2 Obs

Location: Latitude 40°11'05", Longitude 74°12'02" NAD27
Monmouth County, New Jersey, Hydrologic Unit 02040301
about 5,000 ft east of the intersection of Georgia Tavern Rd. and Peskin Rd.

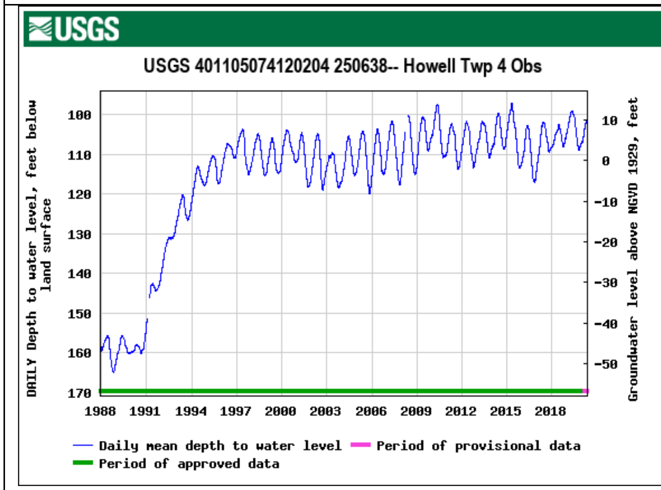
REMARKS: Water level is affected by the stage of the Manasquan Reservoir and by nearby pumping

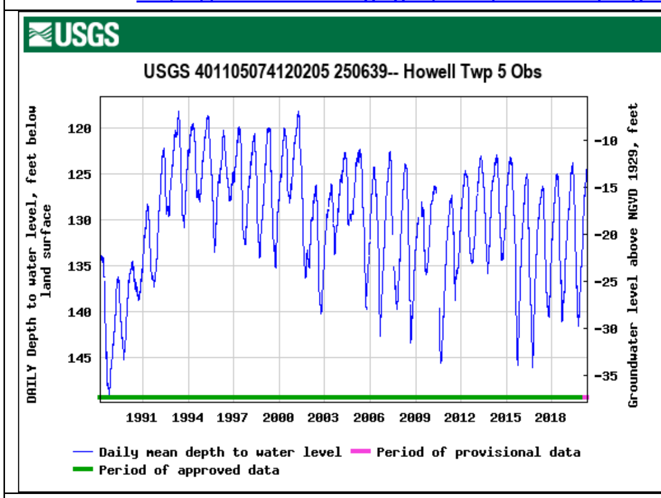
Aquifer: Well completed in "Northern Atlantic Coastal Plain aquifer system" (S100NATLCP) national aquifer, "Vincentown Formation" (125VNCN) local aquifer

Website: https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=401105074120202



Well depth:	100.2 feet
Hole depth:	102 feet
Land surface altitude:	111.9 feet above NGVD29
PERIOD OF RECORD:	December 1987 to current year
EXTREMES FOR PERIOD OF RECORD	
Highest Water Level:	34.83 feet below land surface datum, Mar 31, 2010
Lowest Water Level:	56.09 feet below land surface datum, Apr 29, 1988

USGS 401105074120204 250638-- Howell Twp 4 Obs		
Location: Latitude 40°11'05", Longitude 74°12'02" NAD27 Monmouth County, New Jersey, Hydrologic Unit 02040301 about 5,000 ft east of the intersection of Georgia Tavern Rd. and Peskin Rd. **Aquifer:** Well completed in "Northern Atlantic Coastal Plain aquifer system" (S100NATLCP) national aquifer, "Englishtown Formation" (211EGLS) local aquifer **Website:** https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=401105074120204		
	**Well depth:**	499.0 feet Drilled artesian well
	Hole depth:	512 feet
	Land surface altitude:	112.1 feet above NGVD29
	PERIOD OF RECORD:	December 1987 to current year
	EXTREMES FOR PERIOD OF RECORD	
	Highest Water Level:	97.02 feet below land surface datum, Apr 29, 30, May 2, 2015
	Lowest Water Level:	165.02 feet below land surface datum, Oct 21, 1988

USGS 401105074120205 250639-- Howell Twp 5 Obs		
Location: Latitude 40°11'05", Longitude 74°12'02" NAD27 Monmouth County, New Jersey, Hydrologic Unit 02040301 about 5,000 ft east of the intersection of Georgia Tavern Rd. and Peskin Rd. **Aquifer:** Well completed in "Northern Atlantic Coastal Plain aquifer system" (S100NATLCP) national aquifer, "Magothy-Raritan-Potomac Aquifer System, Upper Aquifer" (211MRPAU) local aquifer **Website:** https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=401105074120205		
	**Well depth:**	907.2 feet Drilled artesian well
	Hole depth:	913 feet
	Land surface altitude:	111.7 feet above NGVD29
	PERIOD OF RECORD:	March 1988 to current year
	EXTREMES FOR PERIOD OF RECORD	
	Highest Water Level:	118.12 feet below land surface datum, Mar 30, 2001
	Lowest Water Level:	149.23 feet below land surface datum, Oct 6-7, 1988
Note: These sites are maintained by USGS New Jersey Water Science Center. Sources: USGS New Jersey Water Science Center. Accessed May 11, 2020		

6.6 Ground Water Quality Standards

The New Jersey Ground Water Quality Standards (GWQS) (N.J.A.C. 7:9C) (last amended June 1, 2020) specify the quality criteria and designated uses for ground water, and serve as the basis for setting ground water discharge standards under the New Jersey Pollutant Discharge Elimination System program (see **Section 11.3**), as well as for establishing standards for ground water cleanups and other relevant laws. The criteria are numerical values assigned to each constituent (pollutant). The GWQS also contain technical and general policies to ensure that the designated uses can be adequately protected.

Ground water within watersheds of FW1 surface waters, state-owned Natural Areas, and the major aquifers of the Pinelands Area are designated *Class I*. The designated use for Class I ground water is the maintenance of special ecological resources, with secondary uses being potable, agricultural, and industrial water. There are no Class I ground waters in Howell Township.

Class II-A waters are "all ground water of the State, except for ground water designated in Classes I, II-B or III. The primary designated use for Class II-A ground water shall be potable water and conversion (through conventional water supply treatment, mixing or other similar technique) to potable water. Class II-A secondary designated uses include agricultural water and industrial water." (N.J.A.C. 7:9C, June 1, 2020). Class II criteria specify the levels of constituents above which the water would pose an unacceptable risk for drinking water. All of Howell Township's ground waters are designated Class II-A (to provide potable water with conventional treatment).

Class III ground waters can be used for anything other than for potable water (N.J.A.C. 7:9C, June 1, 2020). There are no Class III ground waters in Howell Township.

It should not be assumed that ground water quality everywhere meets the criteria for each classification area in view of natural variability and the possibility of localized pollution.

6.7 Water Supply

Howell Township obtains its water from both public and private wells drilled in six aquifer systems (Englishtown, Kirkwood-Cohansey, Mount Laurel-Wenonah, Potomac-Raritan-Magothy, upper Potomac-Raritan-Magothy and Vincentown). Public water purveyors may be government agencies, private companies, or quasi-government groups. Water purveyors are regulated by the NJDEP Bureau of Safe Drinking Water, under the Safe Drinking Water Act (N.J.S.A. 58:12A-1 et seq) and rules (N.J.A.C. 7:10). Drinking water quality issues are addressed in **Section 11.1**. There are seven public water systems serving portions of Howell Township, listed in **Table 6.3,** and shown in **Figure 6.5.** The characteristics of the 24 public community wells are listed in **Table 6.4** and locations are shown in **Figure 6.5**.

Table 6.3. Public Water Systems in Howell Township

PWSID	Water System Name	Water System Type	Max Population Served
Howell Township			
1319003	ANGLE INN MOBILE HOME PARK	Community	354
1319008	WINDING BROOK MHP SYS 1	Community	80
1319009	WINDING BROOK MHP SYSTEM 2	Community	184
1319010	GREEN ACRES NJ MHC LLC	Community	260
1345001	NJ AMERICAN WATER – COASTAL NORTH	Community	24,500
1506001	Brick Township MUA	Community	(unknown number in Ramtown)
Farmingdale Borough			
1314001	FARMINGDALE WATER DEPT	Community	1,500
Source: NJDEP, 2020; Personal Communication, Joan Osborne, October, 2020			

The majority of Howell Township obtains water from New Jersey American Water's Coastal North System (PWS ID: NJ1345001). The system serving Howell Township obtains water from a blend of sources that may include ground water from wells in the Potomac-Raritan-Magothy Aquifer (PRM) and surface water from Glendola Reservoir, Manasquan River/Reservoir, Shark River, and Swimming River/Reservoir (NJ American Water, no date). **Figure 6.5 (inset)** illustrates the general location of these sources. A description of the aquifers that the wells draw from is found in **Section 6.2**.

Table 6.4. Public Community Water Supply Wells

Well ID	Well Permit	Owner	Depth (feet)	Aquifer	Confined?	Pump Rate
NJGS0000 000343		Angle Inn Motor Court	150	Vincentown aquifer	Confined	45.0
NJGS0000 000344			150	Vincentown aquifer	Confined	29.8
WSWL000 0066287	29000 06063	Green Acres Manor	255	Mount Laurel-Wenonah aquifer	Confined	60.0
WSWL000 0070404	49000 47863		150	Kirkwood-Cohansey water-table aquifer system	Unconfined	40.0
WSWL000 0066165	29000 01995	NJ American Water Co (Lakewood / Ortley / Howell system)	370	Mount Laurel-Wenonah aquifer	Confined	300.0
WSWL000 0066257	29000 05346		550	Englishtown aquifer system	Confined	1200.0
WSWL000 0066375	29000 10756		177	Vincentown aquifer	Confined	800.0
WSWL000 0066225	29000 55769		396	Potomac-Raritan-Magothy aquifer system	Confined	450.0
WSWL000 0066298	29000 06276		195	Vincentown aquifer	Confined	900.0
WSWL000 0066192	29000 53516		440	Mount Laurel-Wenonah aquifer	Confined	420.0
WSWL000 0066462	29000 16821		255	Mount Laurel-Wenonah aquifer	Confined	200.0
WSWL000 0066328	29000 07784		877	upper Potomac-Raritan-Magothy aquifer	Confined	1000.0
WSWL000 0066315	29000 06947		773	upper Potomac-Raritan-Magothy aquifer	Confined	300.0
WSWL000 0066273	29000 05851		765	upper Potomac-Raritan-Magothy aquifer	Confined	300.0
WSWL000 0066459	29000 16728	Brick Township Municipal Utilities Authority[11]	649	Englishtown aquifer system	Confined	250.0
WSWL000 0066402	29000 12324		69	Kirkwood-Cohansey water-table aquifer system	Unconfined	150.0
WSWL000 0066397	29000 49789		66	Kirkwood-Cohansey water-table aquifer system	Unconfined	180.0
WSWL000 0066451	29000 15870		61	Kirkwood-Cohansey water-table aquifer system	Unconfined	120.0
WSWL000 0066417	29000 13461		73	Kirkwood-Cohansey water-table aquifer system	Unconfined	80.0
WSWL000 0066448	29000 15287		56	Kirkwood-Cohansey water-table aquifer system	Unconfined	150.0
WSWL000 0188590	29000 49634		75	Kirkwood-Cohansey water-table aquifer system	Unconfined	160.0
WSWL000	29000		75	Kirkwood-Cohansey water-table	Unconfined	150.0

[11] Formerly owned by Parkway Water Co.(Personal Communication, Joan Osborne, October, 2020)

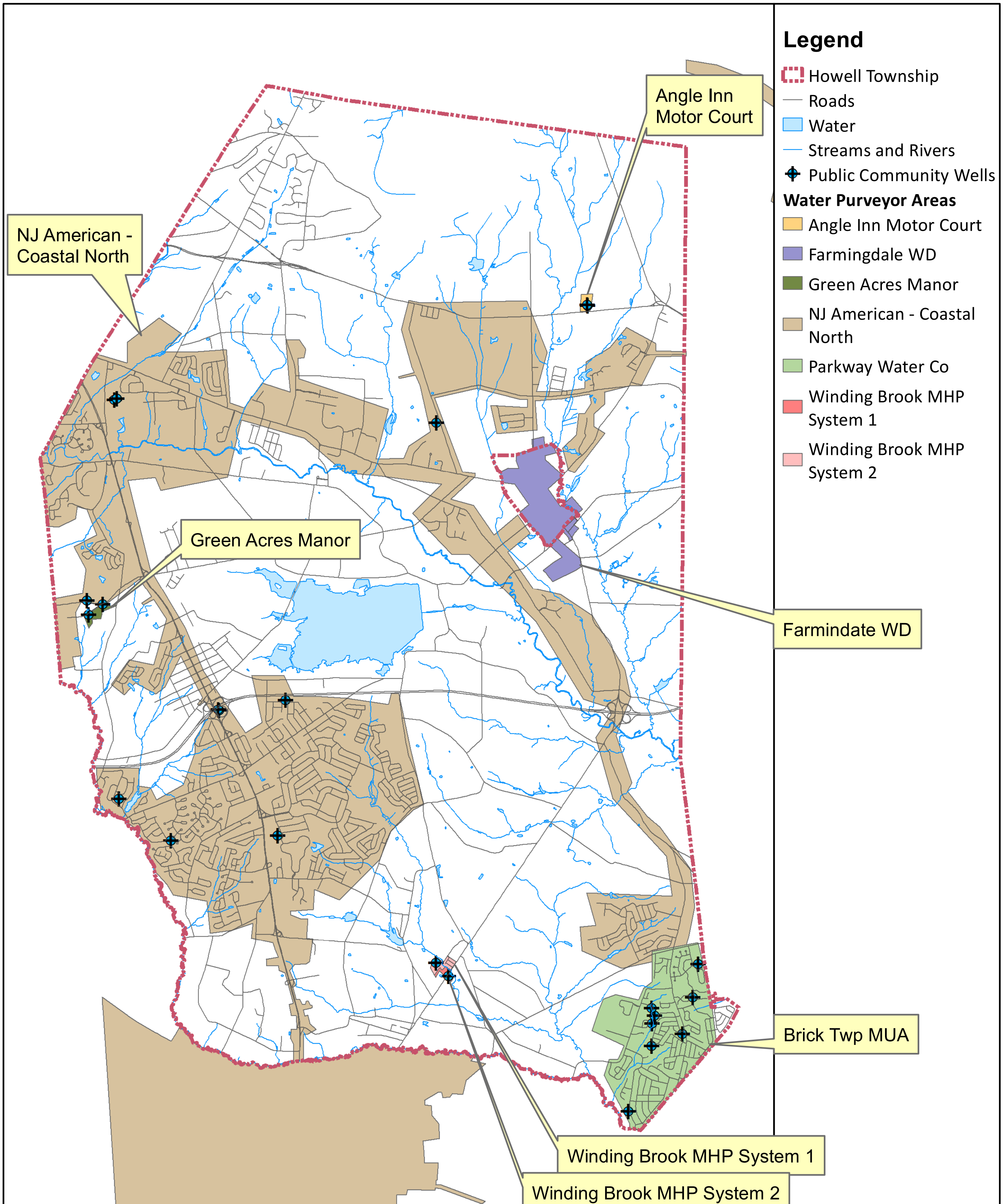
Well ID	Well Permit	Owner	Depth (feet)	Aquifer	Confined?	Pump Rate
0066741	30899			aquifer system		
WSWL000 0191647	49000 32713	Winding Brook Mobile Home Park System 1	410	Mount Laurel-Wenonah aquifer	Confined	50.0
NJGS0000 000348		Winding Brook Mobile Home Park System 2	550	Englishtown aquifer system	Confined	35.0
Source: NJDEP, February 18, 2010						

6.8 Future Water Supply

The New Jersey Water Supply Plan 2017-2022 (October 5, 2017) included an analysis of water purveyors' future water availability based on projected population growth. This evaluation can help identify areas where there is currently available approved supply and those areas that are currently, or are projected to, require additional sources of supply. The sustainable natural ground water capacities should also be considered. The results for the water purveyors in Howell Township are presented in **Table 6.5**, which project that there could be deficits in water supply for Angle Inn Motor Court, Winding Brook NHP System 2 and NJ American Water – Coastal North within the next 15 years.

Table 6.5. Deficit/surplus and the Future Water Availability for Each Water Purveyor

Public Water Supply ID	Public Water Supply ID NAME	2015 Deficit/ Surplus	Future Water Availability (mgd)			
			2015-2020	2015-2025	2015-2030	2015-2035
NJ1314001	Farmingdale Water Dept	0.05	0.04	0.04	0.04	0.04
NJ1319003	Angle Inn Motor Court	0.00	-0.01	-0.02	-0.02	-0.03
NJ1319007	Parkway Water Company (now Brick Twp MUA)	0.62	0.52	0.42	0.32	0.22
NJ1319008	Winding Brook MHP Sys 1	0.07	0.07	0.07	0.06	0.06
NJ1319009	Winding Brook MHP System 2	-0.02	-0.02	-0.02	-0.03	-0.03
NJ1319010	Green Acres NJ MHC LLC	0.07	0.06	0.06	0.05	0.05
NJ1345001	NJ American Water - Coastal North	4.78	3.46	2.14	0.82	-0.49
Source: NJDEP, October 5, 2017 (from Table D.4 of Appendix E)						



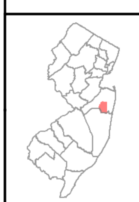


Figure 6.5. Howell Township, Public Community Water Supply Wells and Water Purveyor Areas

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI
2020

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http://www.nj.gov/dep/watershedrestoration/info.html

The Clean Water Book: Choices for Watershed Protection:
http://www.nj.gov/dep/watershedrestoration/waterbook_tble.html

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NJDEP Current and Proposed Rules https://www.nj.gov/dep/rules/

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- Annual Drinking Water Report: http://amwater.com/njaw/water-quality/water-quality-reports/coastal-north

NJDEP
- Drinking Water Watch: https://www9.state.nj.us/DEP_WaterWatch_public/JSP/WSDetail.jsp?tinwsys=384
- Your Utility and Its Water Quality (violations by year): http://www.nj.gov/dep/watersupply/dwc_systems.html
- Source Water Assessment: https://www.nj.gov/cgi-bin/dep/swap/swapdata2.pl?psid=1345001
- Private Well Testing Act: http://www.nj.gov/dep/watersupply/pw_pwta.html

Story Map: NJ Private Well Testing Act Data Summary (Sep. 2002 to Apr. 2014)
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- NJDEP Laws & Rules: http://www.nj.gov/dep/landuse/lawsregs.html
- NJDEP Rules & Regulations (current & proposed): http://www.nj.gov/dep/rules/

USGS - New Jersey District - Ground Water Information (USGS): https://waterdata.usgs.gov/nj/nwis/gw

7. SURFACE WATER

7.1 WATERSHEDS AND SURFACE WATERWAYS

Surface water is water that is visible above the ground surface, including creeks, rivers, ponds, lakes, and wetlands. Surface water is generally hydraulically connected to ground water, although the interactions are difficult to observe and are affected by variations in weather and human activities. Streams connect with ground water in in three basic ways: Streams can gain water from ground water through the streambed, lose water to ground water through the streambed, or have both gaining and losing reaches (Winter et. al., 1998).

Manasquan River Watershed sign. Photo credit: J. Dodds

7.1.1 Watersheds and Subwatersheds

A *watershed* (or basin) is the land area within the confines of a drainage divide in which all surface runoff will drain into a river, river system, or body of water. Watersheds can be divided in smaller watersheds and subwatersheds. The state of New Jersey uses two different naming systems, USGS hydrologic unit codes and watershed management areas, which are explained below and illustrated in **Figure 7.1** and **Figure 7.2**.

7.1.2 Watershed Management Areas

A ***watershed*** (or basin) is the land area within the confines of a drainage divide in which all surface runoff will drain into a river, river system, or body of water.

NJDEP divides the watersheds of the state differently from USGS system. *Watershed management* is the process of managing and protecting all of the water resources within the area of a watershed, rather than on a site-specific basis. The NJDEP recognizes that watersheds are "nature's boundaries" (NJDEP, January 1997). A watershed management approach is based on three key components: 1) a geographic focus; 2) continuous improvement based on sound science; and 3) partnerships/stakeholder involvement. NJDEP has divided the state's watersheds into 20 *Watershed Management Areas (WMAs)*. Howell Township falls within two watershed management areas: *Monmouth* (WMA 12) and Barnegat Bay (WMA 13) (see insets in **Figures 7.1a through 7.1d**). The land area in WMA 12, which includes the majority of Monmouth County and parts of Middlesex and Ocean Counties, drains to the Atlantic Ocean. WMA 13 drains to the Barnegat Bay and the Atlantic Ocean, and includes most of Ocean County, a small portion of Monmouth County, and a sliver of Burlington.

7.1.3 Hydrologic Unit Codes (HUC)

The U.S. Geological Survey created a hierarchical numbering system of *Hydrologic Unit Codes* which divides the United States into successively smaller nested watersheds. The first 2 digits of the code refer to the USGS Water Resources Region and a HUC beginning with "02" is in the Mid-Atlantic Region, and all of the land area of Howell Township drains towards the Atlantic Ocean.

The first 4 digits (also known as a HUC4) refer to the major drainage basin, or sub-region, and Howell Township straddles two sub-regions. Land in areas with a HUC4 of "0203" is the Lower Hudson-Long Island sub-region, which includes the Navesink and Manasquan Rivers. The area with a HUC4 of "0204" encompasses the coastal drainage from (but not including) the Manasquan River to (and including) the Delaware River Basin. In areas with a HUC8 of "02030104" the water flows towards Sandy Hook, NJ and Staten Island, NY while the area in "02040301" is labeled Mullica to Toms River (and includes Metedeconk River) (USGS, 2016).

Haystack Brook. Photo credit: J. Dodds

In this labeling system, the fourteen digit HUC (HUC14) is the smallest division. The land area of Howell Township drains 16 separate HUC14 subwatersheds. HUC14 sub-watersheds encompassing the Township of Howell are shown in **Figure 7.2** and listed in **Table 7.1** (NJDEP March 8, 2016).

Table 7.1. Hydrologic Unit Codes for Howell Township's Subwatersheds

Watershed Name	HUC14*	Subwatershed Name**	Acres in Howell Twp.
WMA 12: Monmouth			
Navesink River / Lower Shrewsbury River	02030104070040	Yellow Brook (above Bucks Mill)	309
	02030104070050	Mine Brook (Monmouth Co)	1,007
Whale Pond Bk / Shark R / Wreck Pond Bk	02030104090040	Shark River (above Remsen Mill gage)	226
Manasquan River	02030104100020	Manasquan R (Rt 9 to 74d17m50s road)	2,100
	02030104100030	Manasquan R (West Farms Rd to Rt 9)	7,064
	02030104100040	Marsh Bog Brook	2,989
	02030104100050	Manasquan R (gage to West Farms Rd)	3,516
	02030104100060	Mingamahone Brook (above Asbury Rd)	3,109
	02030104100070	Mingamahone Brook (below Asbury Rd)	2,268
	02030104100080	Manasquan R (74d07m30s to Squankum gage)	3,255
	02030104100090	Manasquan R (Rt 70 br to 74d07m30s)	206
WMA 13: Barnegat Bay			
Metedeconk River NB	02040301020010	Metedeconk R NB(above I-195)	977
	02040301020020	Metedeconk R NB(Rt 9 to I-195)	4,101
	02040301020030	Haystack Brook	3,914
	02040301020040	Muddy Ford Brook	2,900
	02040301020050	Metedeconk R NB (confluence to Rt 9)	1,186
		Total:	39,128
* 14-Digit Hydrologic Unit Code ** Names reflect the exact names in use by NJDEP and are generally named to reflect stream segments between, above (upstream of), or below (downstream of) roads, bridges, or coordinates (e.g. 74d17m50s).			
Source: NJDEP March 8, 2016			

7.1.4 Surface Water Resources

All of the land in Howell Township drains generally eastward to the Atlantic Ocean.

WMA12: Navesink River Watershed

The streams in the northwestern corner of the township flow northward to the Swimming River and then to the Navesink River (**Figure 7.1a**). The portions of the township in the Yellow Brook and Mine Brook watersheds drain about 3.4% of Howell Township. The watershed covers parts of 14 municipalities including Howell, and flows about 24 miles to enter the Atlantic Ocean between Middletown and Rumson.

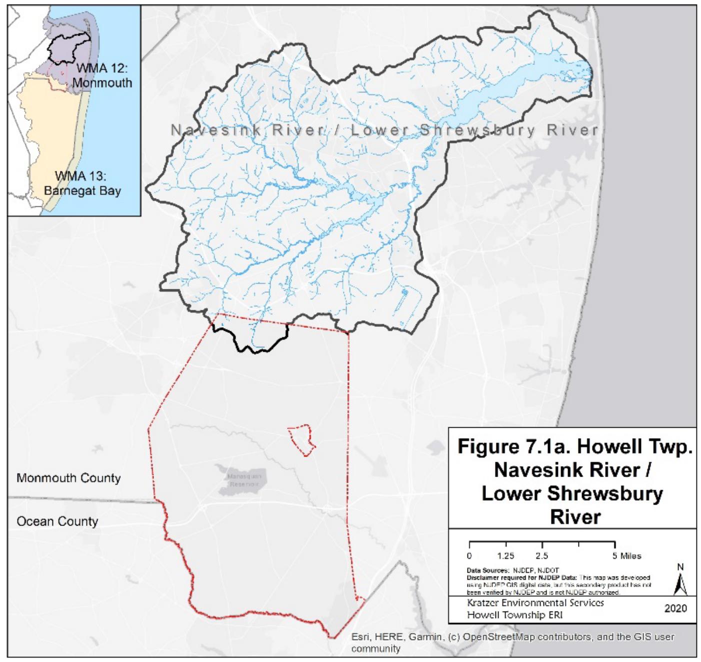


Figure 7.1a. Howell Twp. Navesink River / Lower Shrewsbury River

WMA12: Manasquan River Watershed

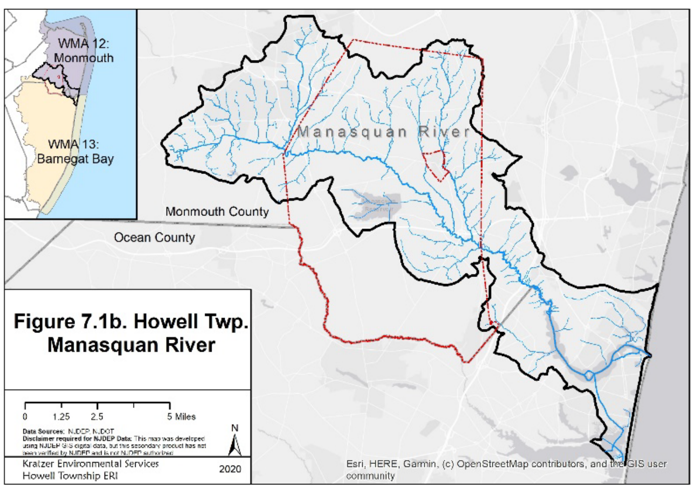


Figure 7.1b. Howell Twp. Manasquan River

The majority (63.2%) of Howell's land drains to the Manasquan River, including the Manasquan Reservoir (**Figure 7.1b**). The Manasquan River begins in Freehold Borough, Freehold Township and Colts Neck Township, flows through Howell and Farmingdale Borough, and then through Wall, Brick, and the coastal towns of Sea Girt, Manasquan, Brielle, Point Pleasant Beach, Point Pleasant, Bay Head and Mantoloking. The area of the Manasquan watershed covers about 54,700 acres and flows for a length of about 31 miles from its source in Freehold to the Atlantic Ocean at Manasquan Inlet (NJWSA, 2017).

"In addition to providing valuable habitat and contributing to local quality of life, the Manasquan River is a significant source of drinking water for Monmouth and Ocean counties. Within the watershed lies the 4.7 billion gallon Manasquan Reservoir, completed in 1990 by damming the Timber Swamp Brook. The reservoir is owned and operated by the New Jersey Water Supply Authority, which sells bulk water to a number of municipalities and private water purveyors, the largest of which is New Jersey American Water. It is estimated that at least 500,000 people in the area rely on the Manasquan Reservoir for at least part of their water needs. The Manasquan Reservoir is capable of yielding 30 million gallons per day, even during drought conditions, although typically 2 million gallons are withdrawn per day. Additionally, an estimated 10.8 million gallons of ground water are pumped per day by area residents (MWMA, 2000).

"The Manasquan Estuary is the body of water that the Manasquan River flows into before entering the Atlantic Ocean through the Manasquan Inlet. The Manasquan Estuary includes more than 1,500 acres of shellfish growing waters, which constitutes a major economic resource for the state. The Manasquan Inlet marks the northern boundary of the 116-mile long New Jersey Intracoastal Waterway, a passage that roughly parallels the Atlantic Coast from the Manasquan River south to Florida. The New Jersey portion of the Intracoastal Waterway extends 118 miles through bays, lagoons, thoroughfares, and land cuts from Manasquan Inlet to the Delaware Bay, 2 miles north of Cape May Lighthouse. The New Jersey Intracoastal Waterway is mainly used by pleasure craft and commercial and sport fishing vessels (NOAA, 1994).” (DVRPC, November 2008).

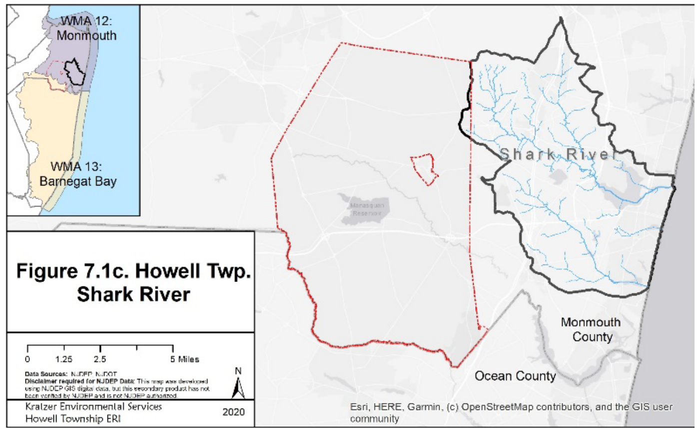


Figure 7.1c. Howell Twp. Shark River

WMA12: Shark River Watershed

Less than 1% of Howell Township drains to the Shark River watershed via (**Figure 7.1c**). The mainstem of the Shark River flows about 17 miles to the Atlantic Ocean at the inlet between Avon-by-the-Sea and Belmar.

WMA 13: Barnegat Bay: Metedeconk River

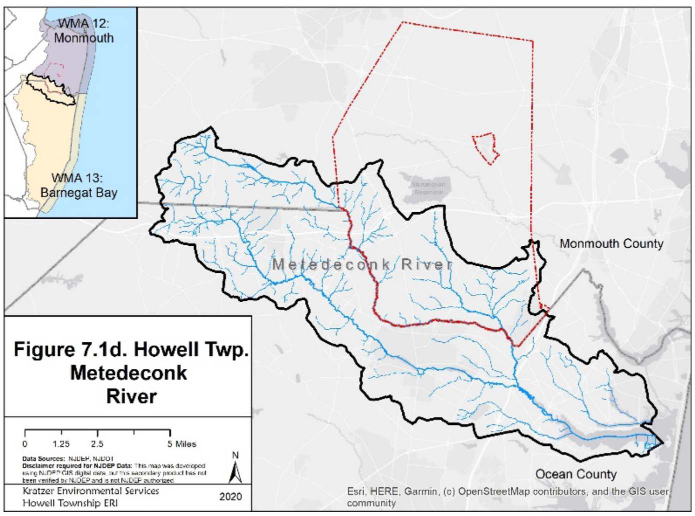


Figure 7.1d. Howell Twp. Metedeconk River

“The southern third (13,118 acres) of Howell Township drains to the Metedeconk River North Branch (NB) Watershed. Like the Manasquan, the name Metedeconk derives from the Lenape Indian language. This watershed is divided into five subwatersheds in Howell Township. One subwatershed drains to the Muddy Ford Brook, another drains to the Haystack Brook, and the other three subwatersheds drain to the Metedeconk River. The entire Metedeconk River Watershed (both North and South branches) covers nearly 90 square miles and portions of seven municipalities from its headwaters to the Barnegat Bay, and its water resources serve over 200,000 people. Jackson and Howell alone cover 60% of the entire watershed (Barten et al., 2003). The Metedeconk River Watershed is a subwatershed of the Barnegat Bay Watershed, which was designated by the EPA in 1995 as a National Estuary Program (NEP) site [Brick Township Municipal Utilities Authority (BTMUA), 2003b]. Where the two branches of the Metedeconk River converge at Forge Pond, the river widens and then flows into Barnegat Bay, which then empties into the Atlantic Ocean. The Metedeconk River Watershed is characterized by low, slightly rolling land, from sea level to only 320 feet above sea level. Most of the river’s base flow comes from the shallow, unconfined Kirkwood-Cohansey aquifer system, which provides high conductivity and high yields of water owing to its fine sands (BTMUA, 2003a). The average streamflow of the Metedeconk River North Branch in 2006 was 78 cubic feet per second (cfs), less than the Manasquan River’s average streamflow of 96 cfs (USGS Streamflow Measurements for the Nation).

“Although the Metedeconk River Watershed underlies an area with very high rates of growth and development, its water quality and quantity is protected by a number of factors. The Turkey Swamp Wildlife Management Area, located in Freehold Township, protects the headwaters of both North and South branches of the Metedeconk River (Barten et al., 2003). Covering nearly 4,000 acres of preserved land, the Turkey Swamp Wildlife Management Area is publicly owned land that was acquired mostly through Green Acres funding (NJDEP, Wildlife Management Areas, 2008). There are no direct discharges of pollution from either industry or wastewater treatment plants into the Metedeconk River, which also maintains the river’s quality (BTMUA, 2000). In addition, a large portion of the watershed is wetlands; riparian forests are relatively intact; there are few slopes exceeding 5%; and soils are sandy, deep, and well drained. These physical characteristics allow rainfall and stormwater runoff to infiltrate easily to recharge the groundwater and maintain water quantity in the Metedeconk River.

"In spite of these factors, the Metedeconk River watershed is threatened by increasing development pressures. The two main threats to the water quantity of the Metedeconk River watershed are (1) excessive withdrawals from the shallow Kirkwood-Cohansey aquifer and (2) decreasing amounts of rainfall recharging the groundwater due to increasing impervious coverage. Water quality is threatened by the rapid flows of groundwater in the Metedeconk River, which can quickly carry pollutants deeper from septic systems, parking lots, underground storage tanks, urban runoff, and spills (BTMUA, 2003a).

"Completed in 1926, the two-mile Point Pleasant Canal connected the Barnegat Bay (of which the Metedeconk watershed is a part) with the Manasquan River to the north. Before the canal was completed, the Metedeconk River and the upper portion of the Barnegat Bay flowed into freshwater bodies. However, the Manasquan River empties directly into the Atlantic Ocean and is therefore saltwater. The completion of the Point Pleasant Canal inadvertently led to saltwater intrusion from the Manasquan River into the Barnegat Bay and changed the nature of the Metedeconk River from freshwater to saltwater. This had a number of environmental repercussions, including a loss in bass, pike, and perch populations as well as the loss of cranberry bogs on the Metedeconk (Woolley and Heim, n.d.)." (DVRPC, November 2008).

7.2 SURFACE WATER QUALITY

7.2.1 Surface Water Quality Standards

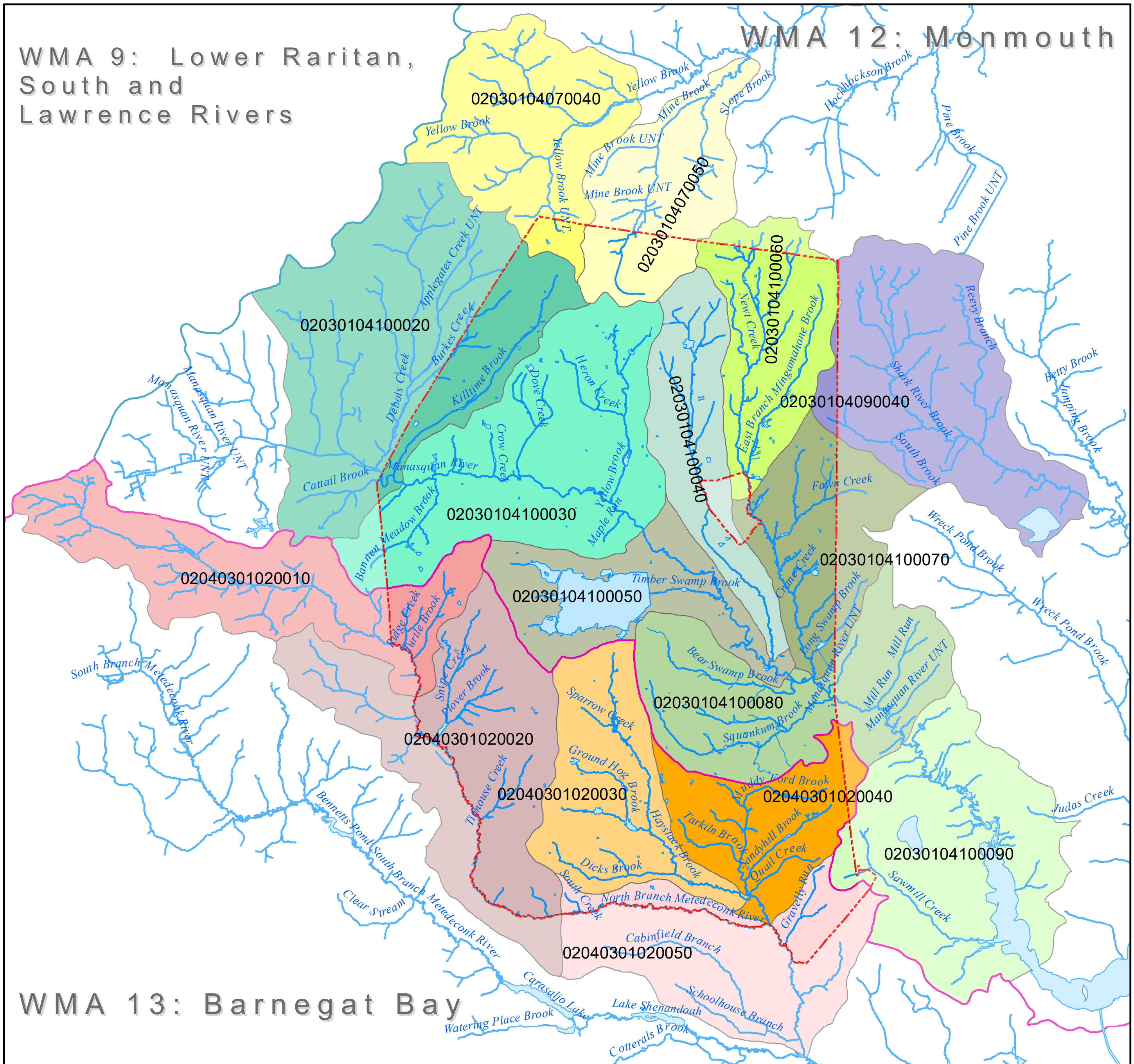
Surface Water Quality Standards (SWQS) are the rules in chapter N.J.A.C. 7:9B that set forth designated uses, use classifications, and water quality criteria for the State's waters based upon the uses, and the NJDEP's policies concerning these uses, classifications and criteria, which are necessary to protect the State's waters.

According to the Surface Water Quality Standards N.J.A.C. 7:9B,

> "Water is vital to life and comprises an invaluable natural resource which is not to be abused by any segment of the State's population or economy. It is the policy of the State to restore, maintain and enhance the chemical, physical and biological integrity of its waters, to protect the public health, to safeguard the aquatic biota, protect scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial, agricultural and other reasonable uses of the State's waters.
>
> "The restoration, maintenance and preservation of the quality of the waters of the State for the protection and preservation of public water supplies is a paramount interest of the citizens of New Jersey.... Toxic substances in waters of the State shall not be at levels that are toxic to humans or the aquatic biota, or that bioaccumulate in the aquatic biota so as to render them unfit for human consumption.... Human health-based ambient criteria have been established in freshwaters due to consumption of fish and water, and in saline water due to consumption of fish. For carcinogens, the criteria have been established at levels which would result in no greater than a one-in-one-million lifetime excess cancer risk. For non-carcinogens, the criteria have been established which would result in no appreciable risk of deleterious effect." (NJDEP, May 6, 2019).

"Water is vital to life and comprises an invaluable natural resource which is not to be abused by any segment of the State's population or economy"

(NJAC 7:9B, May 6, 2019).



Legend

- Howell
- Streams and Rivers
- WMA 12:
- WMA 13: Barnegat

HUC14

- 02030104070040 Yellow Brook (above Bucks Mill)
- 02030104070050 Mine Brook (Monmouth Co)
- 02030104090040 Shark River (above Remsen Mill gage)
- 02030104100020 Manasquan R (Rt 9 to 74d17m50s road)
- 02030104100030 Manasquan R (West Farms Rd to Rt 9)
- 02030104100040 Marsh Bog Brook
- 02030104100050 Manasquan R (gage to West Farms Rd)
- 02030104100060 Mingamahone Brook (above Asbury Rd)
- 02030104100070 Mingamahone Brook (below Asbury Rd)
- 02030104100080 Manasquan R (74d07m30s to Squankum gage)
- 02030104100090 Manasquan R (Rt 70 br to 74d07m30s)
- 02040301020010 Metedeconk R NB(above I-195)
- 02040301020020 Metedeconk R NB(Rt 9 to I-195)
- 02040301020030 Haystack Brook
- 02040301020040 Muddy Ford Brook
- 02040301020050 Metedeconk R NB (confluence to Rt 9)

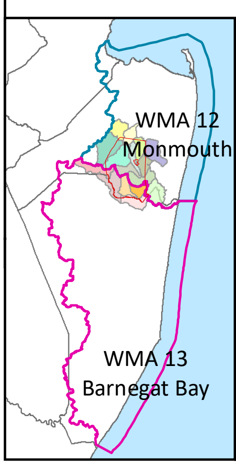


Figure 7.2. Howell Township, Subwatersheds

0 1 2 4 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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According to the designated uses under the SWQS, NJDEP assigns *surface water classifications* to each stream in order to group waters and assign water quality criteria. Designated uses include potable water, propagation of fish and wildlife, recreation, fishing, shellfish harvesting and agricultural and industrial supplies. The *criteria* are numerical targets for constituent concentrations (such as toxic pollutants) or narratives that describe in-stream conditions to be attained, maintained, or avoided, so that the specified uses are protected for the different use classifications.

The SWQS are used by several NJDEP programs, including the New Jersey Pollutant Discharge Elimination System program, Site Remediation program, Stream Encroachment, Land Use Regulation Program and Total Maximum Daily Loads (TMDLs, see **Section 7.2.5**).

Mingamahone Brook. Photo credit: J. Dodds

Table 7.2 describes the definitions of the surface water classifications. In **Figure 7.3**, "category" is shown, which is a compendium of all surface water classification designations for a given water body. Category describes a stream's surface water classification in terms of its general surface water class (e.g. FW2), its trout water status (e.g. TP) and its antidegradation status (e.g. C1).

Manasquan Reservoir. Photo credit: J. Dodds

The most protective antidegradation tier is ONRW, although no streams in Howell Township are in this designation.

The *Category One (C1)* antidegradation designation provides streams with additional protections that help prevent water quality degradation and discourage development where it would impair or destroy natural resources and water quality. Waterways can be designated C1 because of exceptional ecological significance, exceptional water supply significance, exceptional recreational significance, exceptional shellfish resource, or exceptional fisheries resource Surface Water Quality Standards & riparian buffer ((NJDEP Division of Water Monitoring and Standards, July 2017).

The antidegradation provisions of the SWQS are triggered when an applicant proposes an activity that has the potential to lower water quality. Previously approved wastewater discharges authorized through the NJPDES program as well as existing developments are not subject to the antidegradation policies unless a new or expanded activity is proposed. Under the Stormwater Management rules (N.J.A.C. 7:8) and the Flood Hazard Area Control Act rules (N.J.A.C. 7:13), for certain activities proposed adjacent to waters designated as C1, 300 foot buffers must be maintained in a natural state adjacent to all C1 waters and upstream tributaries of C1 waters (including named and unnamed tributaries), unless the disturbance is less than one acre and new impervious surface is less than 0.25 acres. However, where the buffer is already disturbed, the width may be reduced in the disturbed area, but will not be permitted to extend less than 150 feet from either bank. The buffer will not affect existing development. The buffer requirement can also be adjusted to reflect local conditions through the approval of a stream corridor protection plan as part of a regional stormwater management plan (NJDEP Division of Water Monitoring and Standards, July 2017).

Table 7.2. Surface Water Quality Standards Classification

Category	Definition
Freshwater General Surface Water Class	
FW1	**FW1** means those fresh waters, as designated in N.J.A.C. 7:9B-1.15(j), that are to be maintained in their natural state of quality (set aside for posterity) and not subjected to any man-made wastewater discharges or increases in runoff from anthropogenic activities. These waters are set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s).
FW2	**FW2** means the general surface water classification applied to those fresh waters that are not designated as FW1 or Pinelands Waters. In all FW2 waters the designated uses are: 1. Maintenance, migration, and propagation of the natural and established biota; 2. Primary contact recreation; 3. Industrial and agricultural water supply; 4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation, and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and 5. Any other reasonable uses.
Saline Waters	
SE	**SE** means the general surface water classification applied to saline waters of estuaries. When combined with a freshwater (FW) category, it means a waterway in which there may be a salt water/fresh water interface. The exact point of demarcation between the fresh and saline waters must be determined by salinity measurements (saline is > 3.5 parts per thousand at mean high tide).
Trout Water Status - this is for information only and does not affect the water quality criteria for those waters.	
TP	***Trout production*** means waters designated at N.J.A.C. 7:9B-1.15I through (i) for use by trout for spawning or nursery purposes during their first summer.
TM	***Trout maintenance*** means waters designated at N.J.A.C. 7:9B-1.15I through (i) for the support of trout throughout the year.
NT	***Nontrout waters*** means fresh waters that have not been designated in N.J.A.C. 7:9B-1.15I through (h) as trout production or trout maintenance. These waters are generally not suitable for trout because of their physical, chemical, or biological characteristics, but are suitable for a wide variety of other fish species.
Antidegradation	
ONRW	***Outstanding National Resource Waters*** means high quality waters that constitute an outstanding national resource (for example, waters of National/State Parks and Wildlife Refuges and waters of exceptional recreational or ecological significance). Waters classified as FW1 waters and Pinelands waters are Outstanding National Resource Waters.
FW1/Non-degrad-ation	***Nondegradation waters*** means those waters set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, or exceptional water supply significance. These waters include all waters designated as FW1.
C1	***Category one waters*** means those waters designated in the tables in N.J.A.C. 7:9B-1.15(c) through (i), for purposes of implementing the antidegradation policies set forth at N.J.A.C. 7:9B-1.5(d), for protection from measurable changes in water quality based on exceptional ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s) to protect their aesthetic value (color, clarity, scenic setting) and ecological integrity (habitat, water quality and biological functions).
C2	***Category two waters*** means those waters not designated as Outstanding National Resource Waters or Category One at N.J.A.C. 7:9B-1.15 for purposes of implementing the antidegradation policies set forth at N.J.A.C. 7:9B-1.5(d).
Source: NJDEP, May 6, 2019	

> “Previous investigations have concluded that anthropogenic sources of pollutants negatively affect the quality of water in reservoirs…. It is essential that initiatives be put into place to protect the drinking water supplies serving the State’s residents” (NJDEP, Proposed November 3, 2003).

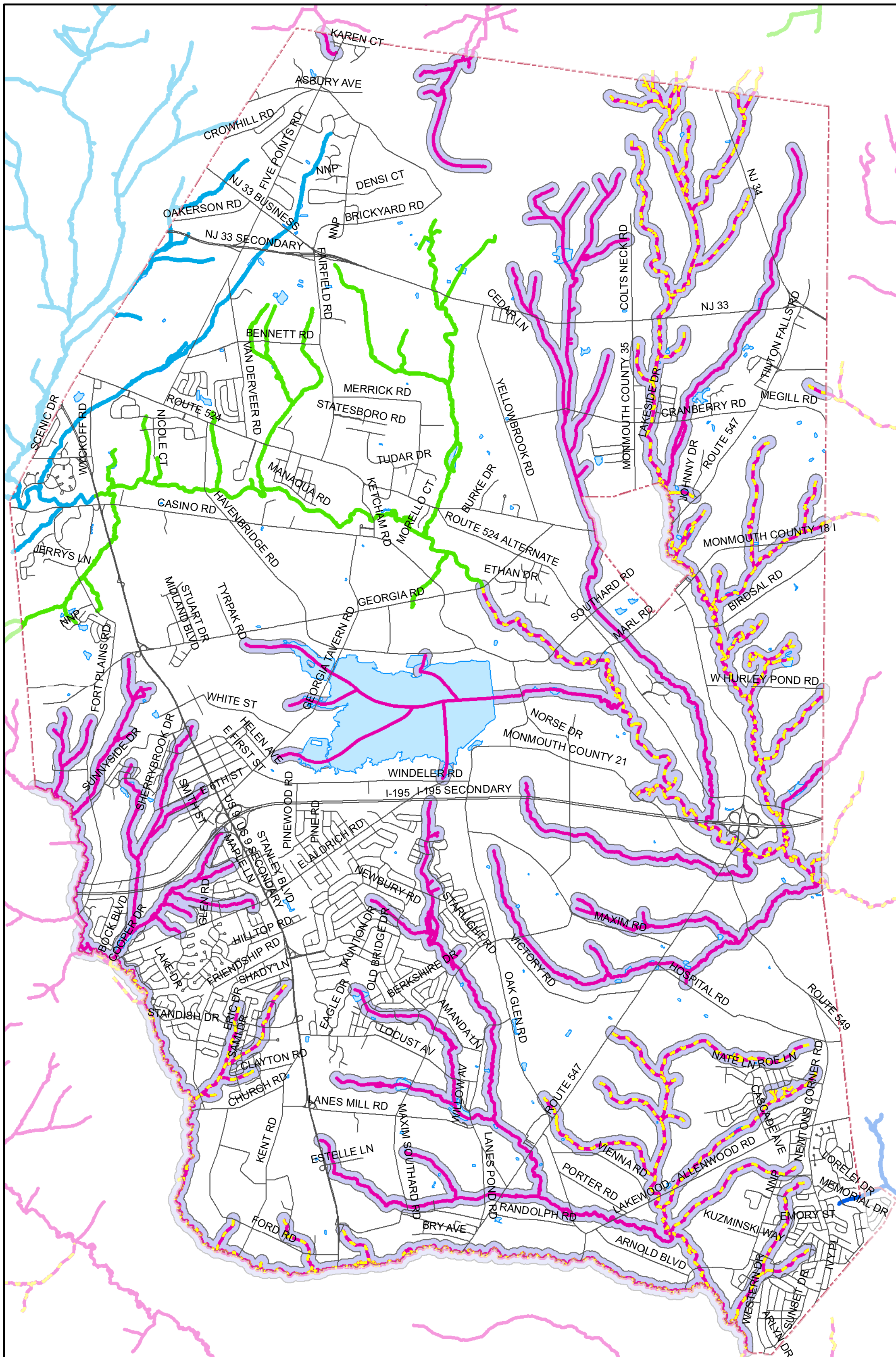
In 2003, NJDEP upgraded the Manasquan Reservoir to C1 based on exceptional water supply significance to protect the water supply from further degradation (NJDEP, proposed November 18, 2002; adopted April 22, 2003). Soon after, the department acknowledged that protecting reservoirs is not adequate if the feeder streams are allowed to degrade. The Manasquan Reservoir, operated by New Jersey Water Supply Authority, provided potable water for 150,000 residents and Brick Township Municipal Utilities Authority was constructing a new reservoir in the Metedeconk River watershed to provide potable water for 80,000 residents. NJDEP emphasized the need for a preventative focus to preserve and manage the drinking water supplies serving the residents of New Jersey. Therefore, based on exceptional water supply significance, the named and unnamed tributaries of the Manasquan (including Bear Swamp Brook, Long Swamp Brook, Marsh Bog Brook, Mingamahone Brook, Squankum Brook and Timber Swamp Brook) and Metedeconk (including Dicks Brook, Haystack Brook and Titmouse Creek) were upgraded to C1 (NJDEP, proposed November 3, 2003; adopted July 10, 2004). Similarly, the Shark River watershed, including a small area of Howell Township, was upgraded to C1 in 2005 to protect the water supply serving 245,000 New Jersey American Water Company customers (NJDEP, proposed December 20, 2014; adopted May 12, 2005). Proposed in 2007 and adopted in 2008, the tributaries of the Swimming River (in Howell these include Mine Brook and Yellow Brook) were upgraded to C1 based on exceptional water supply significance to protect the Swimming River Reservoir, operated by New Jersey American Water Company and serving a population of 302,000 (NJDEP, proposed May 21, 2007; adopted June 16, 2008).

The SWQS classification of surface waters within Howell Township are listed in **Table 7.3** and shown in **Figure 7.3.** Some streams are listed more than once if different sections are in different classifications.

Table 7.3. Surface Water Quality Standards Classification

Category*	Streams in Howell**
FW2/NT Stream Miles in Howell: 8.71	Killtime Brook Manasquan River
FW2-NT/SE1 Stream Miles in Howell: 0.34	Sawmill Creek UNT
FW2-NTC1 Stream Miles in Howell: 61.93	Aldrich Lake Bass Run Bear Swamp Brook Dace Creek Dicks Brook and North Branch Dicks Brook East Branch Mingamahone Brook East Fork Turtle Brook and East Fork Turtle Brook UNT Echo Lake Frog Creek Ground Hog Brook Haystack Brook and Haystack Brook UNT Lake Louise Long Swamp Brook Manasquan Reservoir and Manasquan Reservoir UNT Marsh Bog Brook, Marsh Bog Brook UNT and West Fork Marsh Bog Brook Mine Brook and Mine Brook UNT North Branch Metedeconk River North Branch Squankum Brook and North Branch Squankum Brook UNT Plover Brook and Plover Brook UNT

Category*	Streams in Howell**
	Polypod Brook Ridge Creek and Ridge Creek UNT Snipe Creek Sparrow Creek Squankum Brook and Squankum Brook UNT Tadpole Creek Timber Swamp Brook Toad Creek Turtle Brook, Turtle Brook UNT and West Fork Turtle Brook Weasel Creek Yellow Brook UNT
FW2-TM Stream Miles in Howell: 19.34	Ardena Brook Bannen Meadow Brook and Bannen Meadow Brook UNT Birch Creek Bittern Brook Crow Creek Dove Creek East Fork Yellow Brook Fox Creek Heron Creek Manasquan River and Manasquan River UNT (in part) Maple Run Small Branch West Fork Yellow Brook Yellow Brook
FW2-TMC1 Stream Miles in Howell: 58.28	Crane Creek and Crane Creek UNT Fawn Creek Gravelly Run Grouse Brook Hawk Creek Kingfisher Creek Manasquan River and Manasquan River UNT Marlpit Brook Mingamahone Brook and Mingamahone Brook UNT Mink Run Muddy Ford Brook and Muddy Ford Brook UNT Newt Creek North Branch Metedeconk River and North Branch Metedeconk River UNT Pine Creek Sandyhill Brook Snake Creek South Brook UNT (Shark River) South Creek Sweetgum Brook Tarkiln Brook Titmouse Creek Tree Swamp Brook and Tree Swamp Brook UNT Willow Run Woodcock Brook
Total stream miles in Howell Township: 148.60	
*See Table 7.2 for definitions. **Some streams or rivers have different sections in different categories.	
Source: NJDEP, December 2010	



Legend

- Howell Township
- Roads
- Lakes and Ponds

SWQS CATEGORY

- FW2-NT
- FW2-NT/SE1
- FW2-NTC1
- FW2-TM
- FW2-TMC1
- C1 300' buffer (approximate)*

* NOTE:
The Flood Hazard Area Control Act Rules (N.J.A.C. 7:13) limit disturbance in C1 streams' 300' buffer as measured from top of bank. This map displays an approximation of the 300' buffer measured from the mapped stream centerline.

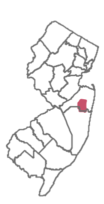


Figure 7.3. Howell Township, Surface Water Quality Standards (SWQS)

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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7.2.2 Surface Water Quality Monitoring

Water quality monitoring is the measurement of the physical, chemical, biological, and microbiological characteristics of water. The collection and analysis of water quality data is a fundamental tool in the management of water resources.

> "Monitoring water quality provides empirical evidence to support decision making on health and environmental issues." (Myers, no date).

"Our nation's waters are monitored by state, federal, and local agencies, universities, dischargers, and volunteers. Water quality data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills." (US EPA, December 3, 2013)

A search of the National Water Quality Monitoring Council's Water Quality Portal found a total of 259 surface water monitoring sites within Howell Township (NWQMC, 2020). This online database contains water quality data from EPA's STORET, USGS' NWIS, NJDEP and others. These sites represent data collected by a variety of entities for diverse purposes and time periods. The routine NJDEP and USGS surface water quality monitoring efforts within Howell Township are summarized here, and the sites in these networks are listed in **Table 7.4** and shown in **Figure 7.4**.

The Ambient Surface Water Quality Monitoring Network (ASWQMN) is a cooperative effort between NJDEP and USGS. The network was established in 1976 to assess the status and trends of surface waters in New Jersey. The network's objectives are: continued tracking of status and trends in ambient water quality, establish background water quality by physiographic province, provide data from a set of randomly selected sites to assess water quality state wide (1998 – 2011), provide data from set of selected sites in priority regions, basins, and/or watersheds (2011 – present), obtain water quality data that can be correlated with specific land uses (urban, mixed, agricultural and undeveloped), and coordinate the collection of water chemistry and biological data at common locations. Quarterly water monitoring measures discharge (flow), field parameters (such as pH, dissolved oxygen, and specific conductance), total and filtered nutrients and filtered ions. Selected sites are monitored, at a reduced frequency, for supplemental parameters including diurnal dissolved oxygen, pesticides, total recoverable metals, volatile organic compounds (VOCs) (1998 – 2003), sediment nutrients, sediment metals and sediment PAH's. There are eight ASWQMN sites in Howell Township (see **Table 7.4 and Figure 7.4)**.

The NJDEP Ambient Biomonitoring Network (AMNET) consists of 866 sites throughout New Jersey. Sites in each of the state's five Water Regions are evaluated for benthic macroinvertebrate and habitat health on a rotating schedule (once every five years). More information describing the AMNET program and results are in **Section 7.2.3**. There are 15 AMNET sites within Howell Township. An additional site just outside of Howell in Freehold Township is included in the table due to its proximity (see **Table 7.4** and **Figure 7.4)**.

USGS maintains a network of stations that collects and disseminates water quality and flow data in real-time on the internet. The USGS site located on the Manasquan River at Squankum collects data on water temperature, specific conductance, discharge, gage height and turbidity. Two other sites in this network are included due to their proximity (see **Table 7.4, Figure 7.4,** and **Internet Resources**).

In 2017, the NJDEP Division of Water Monitoring and Standards Continuous Data Monitoring Program installed a continuous water quality station in the Manasquan Reservoir. During the warm weather months, temperature, specific conductance, salinity, dissolved oxygen (concentration and percent), pH, turbidity and phycocyanin are measured. The issue of cyanobacteria harmful algal blooms (HABs) in Manasquan Reservoir is discussed in **Section 12.1.6**.

Table 7.4. Water Quality Monitoring Stations

HUC14	HUC14 Name	Monitoring Program	STATION	NAME	Munici-pality
WMA 12: Monmouth					
02030104 100020	Manasquan R (Rt 9 to 74d17m50s road)	ASWQMN	01407868	Long Brook at Wyckoff Mills	Howell
		AMNET	AN0487	Debois Creek at Strickland Rd	Freehold
		AMNET	AN0488	Killtime Brook at Strickland Rd	Howell
02030104 100030	Manasquan R (West Farms Rd to Rt 9)	AMNET	AN0489	Manasquan River at Route 9	Howell
02030104 100040	Marsh Bog Brook	ASWQMN	01407988	Marsh Bog Brook near Shacks Corner	Howell
		ASWQMN	01407997	Marsh Bog Brook at Squankum	Howell
		AMNET	AN0491 & MB-2	Marsh Bog Brook at Cranberry Bog Road	Howell
		AMNET	AN0492	Marsh Bog Brook at Yellow Brook Road	Howell
02030104 100050	Manasquan R (gage to West Farms Rd)	NJDEP Continuous	BFBM000258	Manasquan Reservoir	Howell
		AMNET & ASWQMN	AN0490 & 01407900	Manasquan River at West Farms Road	Howell
		STORET	01407970	Timber Swamp Brook at Manassa Road	Howell
		ASWQMN & USGS	01408000*	Manasquan River at Squankum	Howell
		AMNET	AN0493	Manasquan River at Rt 547	Howell
02030104 100060	Mingamahone Brook (above Asbury Rd)	ASWQMN	01408009	Mingamahone Bk near Earle	Howell
		STORET	01408020	Mingamahone Bk at Rt 524	Howell
		AMNET	AN0494	Mingamahone Brook at Cranberry Bog Rd	Howell
02030104 100070	Mingamahone Brook (below Asbury Rd)	AMNET	AN0495	Mingamahone Brook at Route 524	Howell
02030104 100080	Manasquan R (74d07m30s to Squankum gage)	USGS	01408029*	Manasquan River near Allenwood NJ	Wall
		AMNET	AN0496	Stan Brook at Easy Street	Howell
		AMNET	AN0497	Squankum Brook at Route 549	Howell
02040301 020030	Haystack Brook	ASWQMN	01408110	Haystack Brook near Southard	Howell
02040301 020050	Metedeconk R NB (confluence to Rt 9)	ASWQMN & USGS	01408100*	Metedeconk River North Branch at Lakewood	Lakewood /Howell
WMA 13: Barnegat Bay					
02040301 020020	Metedeconk R NB(Rt 9 to I-195)	AMNET	AN0501	Metedeconk River North Branch at Aldrich Road	Jackson/ Howell
		AMNET	AN0502	Metedeconk River North Branch at Route 9	Howell
02040301 020030	Haystack Brook	AMNET	AN0503	Haystack Bk at Southard Rd	Howell
		AMNET	AN0504	Haystack Brook at Route 547	Howell
02040301 020040	Muddy Ford Brook	AMNET	AN0505	Haystack Brook (Muddy Ford Bk) at Greenville Rd	Howell
*USGS Real-time Sites (flow and water quality)					
Sources: NJDEP, June 6, 2017; NJDEP, September 30, 2019; NWQMC, 2020; USGS, 2020.					

Manasquan Reservoir. Photos credit: L. Doud

7.2.3 Biomonitoring

Macroinvertebrates are larger-than-microscopic fauna, which are found in freshwater and estuarine environments, and are an essential part of the aquatic food web. These include insects (primarily immature forms), worms, mollusks (snails, clams) and crustaceans (scuds, shrimp, crayfish, etc.), most of which are bottom-dwelling (benthic). They are more easily collected and quantified than other biological indicators (fish or periphyton communities). Assessments of benthic macroinvertebrates provide a good indication of localized conditions of water quality. Due to the creatures' limited mobility, they are suitable for the evaluation of site-specific pollution impacts. Different species differ in their sensitivity to pollutants and environmental impacts from both point and non-point sources of pollution. Combined with relevant chemical/physical parameters, benthic macroinvertebrate communities can be used to identify sources of impairment (NJDEP, June 5, 2017).

The Ambient Biomonitoring Network (AMNET) is the NJDEP's ongoing macroinvertebrate monitoring program. From 1992 to 2004, the *New Jersey Impairment Score (NJIS)* was used to assign a rating of non-impaired, moderately impaired, or severely impaired. Beginning in 2004, an improved index has been used, which takes into account the different ecoregions in the state. The streams in Howell Township are assessed using the *Coastal Plain Macroinvertebrate Index (CPMI)* which uses genus-level instead of family level identification, which provide four assessment rating levels: excellent, good, fair, and poor. NJDEP uses this information in assessing progress toward the goals of the Clean Water Act through the Integrated Water Quality Monitoring and Assessment Report (see **Section 7.2.4**) (NJDEP, June 5, 2017). Locations of monitoring sites are shown on **Figure 7.4,** and results are shown in **Table 7.5**.

Table 7.5. Macroinvertebrate and Habitat Scores

SITE	Round	CPMI (Coastal Plain Macroinvertebrate Index)		Habitat Analysis		Most Recent
		Score	Rating	Score	Rating	
WMA12						
AN0488 Unnamed Tributary to Manasquan River (Killtime Bk) at Strickland Rd	1	12 (NJIS)	Moderate			Good
	2	2	Poor	128	Suboptimal	
	3	8	Fair	146	Suboptimal	
	4	12	Good	129	Suboptimal	
	5	na				
AN0489 Manasquan River at Rt 9	1	12 (NJIS)	Moderate			Poor
	2	6	Fair	126	Suboptimal	
	3	16	Good	95	Marginal	
	4	10	Fair	117	Suboptimal	
	5	20.95	Poor	128	Suboptimal	
AN0490 Manasquan River at W Farms Rd	1	18 (NJIS)	Moderate			Poor
	2	14	Good	139	Suboptimal	
	3	8	Fair	139	Suboptimal	
	4	10	Fair	142	Suboptimal	
	5	2.91	Poor	135	Suboptimal	
AN0491 Marsh Bog Brook at Cranberry Bog Rd	1	12 (NJIS)	Moderate			Fair
	2	2	Poor	169	Optimal	
	3	4	Poor	151	Suboptimal	
	4	6	Fair	164	Optimal	
	5	na				
AN0492 Marsh Bog Brook at Yellow Brook Rd	1	21 (NJIS)	Moderate			Good
	2	20	Good	118	Suboptimal	
	3	8	Fair	158	Suboptimal	
	4	10	Fair	130	Suboptimal	
	5	67.23	Good	158	Suboptimal	
AN0493 Manasquan River at Rt 547	1	18 (NJIS)	Moderate			Fair
	2	10	Fair	162	Optimal	
	3	10	Fair	145	Suboptimal	
	4	10	Fair	120	Suboptimal	
	5	31.84	Fair	158	Suboptimal	
AN0494 Mingamahone Brook at Cranberry Bog Rd	1	15 (NJIS)	Moderate			Fair
	2	8	Fair	150	Suboptimal	
	3	10	Fair	160	Optimal	
	4	4	Poor	154	Suboptimal	
	5	24.36	Fair	174	Optimal	
AN0495 Mingamahone Brook at Rt 524	1	24 (NJIS)	Non-impaired			Excellent
	2	16	Good	166	Optimal	
	3	26	Excellent	176	Optimal	
	4	20	Good	150	Suboptimal	
	5	80.27	Excellent	154	Suboptimal	
AN0496 Stan Brook at Easy St	1	27 (NJIS)	Non-impaired			Poor
	2	10	Fair	137	Suboptimal	
	3	18	Good	152	Suboptimal	
	4	4	Poor	132	Suboptimal	
	5	na				
AN0497 Squankum Brook at Spur 549	1	24 (NJIS)	Non-impaired			Good
	2	20	Good	146	Suboptimal	
	3	28	Excellent	153	Suboptimal	
	4	16	Good	149	Suboptimal	

SITE	Round	CPMI (Coastal Plain Macroinvertebrate Index)		Habitat Analysis		Most Recent
		Score	Rating	Score	Rating	
	5	62.3	Good	163	Optimal	
WMA13						
AN0502 Metedeconk River North Branch at Rt 9	1	18 (NJIS)	Moderate			Good
	2	14	Good	148	Suboptimal	
	3	18	Good	133	Suboptimal	
	4	8	Fair	99	Marginal	
	5	56.72	Good	129	Suboptimal	
AN0503 Haystack Brook at Southard Rd	1	9 (NJIS)	Moderate			Good
	2	4	Poor	156	Suboptimal	
	3	6	Fair	120	Suboptimal	
	4	12	Good	156	Suboptimal	
	5	na				
AN0504 Haystack Brook at Rt 547	1	27 (NJIS)	Non-impaired			Good
	2	6	Fair	141	Suboptimal	
	3	24	Excellent	147	Suboptimal	
	4	12	Good	154	Suboptimal	
	5	63.3	Good	151	Suboptimal	
AN0505 Haystack Brook (Muddy Ford Bk) at Greenville Rd	1	24 (NJIS)	Non-impaired			Excellent
	2	24	Excellent	168	Optimal	
	3	24	Excellent	167	Optimal	
	4	26	Excellent	152	Suboptimal	
	5	81.26	Excellent	164	Optimal	
AN0501 Metedeconk River North Branch at Aldrich Rd (Jackson/Howell boundary)	1	21 (NJIS)	Moderate			Good
	2	10	Fair	162	Optimal	
	3	24	Excellent	154	Suboptimal	
	4	18	Good	159	Suboptimal	
	5	na				

MA 12 Just Outside of Howell						
AN0487 Debois Creek at Strickland Rd (Freehold)	1	6 (NJIS)	Severe			Poor
	2	2	Poor	137	Suboptimal	
	3	8	Fair	132	Suboptimal	
	4	10	Fair	125	Suboptimal	
	5	17.22	Poor	136	Suboptimal	

* Parameter:

CPMI (Coastal Plain Macroinvertebrate Index): **Excellent** 22 - 30 Full Attainment; **Good** 20-12 Full Attainment; **Fair** 10-6 Non-Attainment; **Poor** < 6 Non-Attainment

NJIS (New Jersey Impairment Score): A composite of 5 scores based on family level taxonomy. **N=Non-impaired**: score of 24 to 30. **M=Moderately Impaired**: score of 9 to 21; **S= Severely Impaired**: score of 0 to 9.

HABITAT SCORES: **OPTIMAL**= 160 – 200; **SUB-OPTIMAL**=110 – 159; **MARGINAL**= 60 – 109; **POOR**= < 60. Parameters evaluated included in-stream substrate, channel morphology, bank structural features, and riparian vegetation for the sample site and its immediate surroundings (usually 100-200 foot radius).

Sources: NJDEP, June 5, 2017; NJDEP BFBM, August 19, 2019

7.2.4 Water Quality Impairments

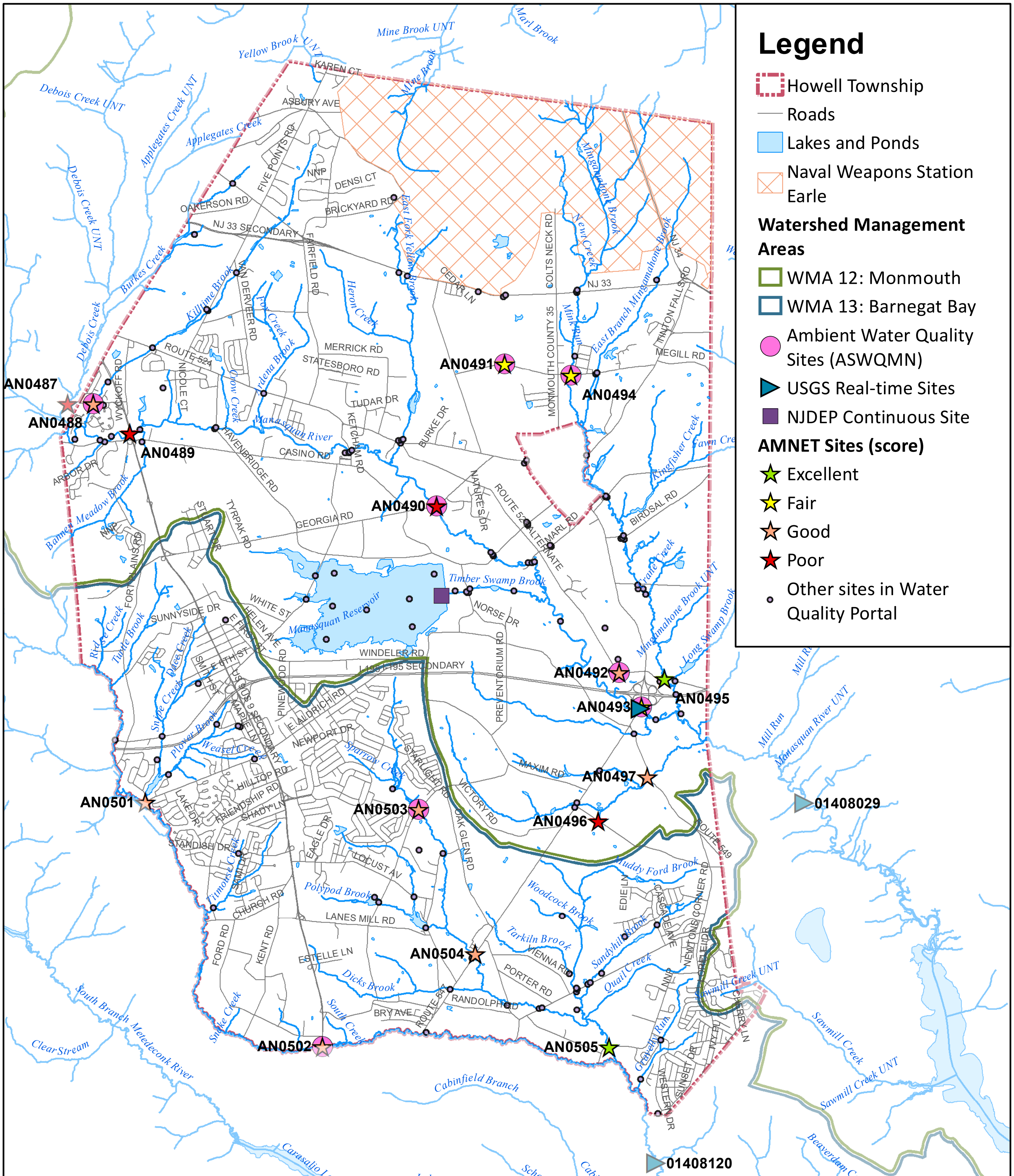
States are required by the Federal Clean Water Act (US Federal Water Pollution Control Act, November 27, 2002) to develop a biennial Water Quality Inventory Report (required under Section 305(b) of the act) and a List of Water Quality Limited Segments (required under Section 303(d)). Since 2001, the USEPA has recommended that states integrate these two, producing the *Integrated List.* The goal is to provide an effective tool for maintaining high quality waters where designated uses (designated by the SWQS, discussed above in **Section 7.2.1**) are attained, and improving the quality of surface waters that do not attain their designated uses (NJDEP, December 2019).

The Integrated List is subject to regulatory requirements, which include public participation and submission to the USEPA for approval and adoption. The Integrated List identifies the status of all applicable designated uses for every assessment unit (usually by HUC14[12] sub-watershed) by labeling the results of each designated use assessment as *Attaining, Non Attaining*, or *Insufficient Data* (see **Figure 7.5** and **Table 7.6**).

The NJDEP is required to use all existing and readily available data to assess water quality for the Integrated List. A methods document summarizes each step in the assessment process; to evaluate stations and data quality, combine stations to evaluate an assessment unit, assess designated uses, rank and prioritize assessment units that do not attain designated uses, develop a monitoring and assessment plan and provide for public participation (NJDEP, June 2017).

The 2016 Integrated List summarizes whether or not the surface water quality of Howell Township's 16 subwatersheds meets the SWQS (see **Table 7.6**). Where there is sufficient data for assessment, the water quality in Howell Township generally does not support designated uses. Six of the 16 subwatersheds meet the water quality standards for public water supply, while Haystack and Muddy Ford Brooks were the only streams to support aquatic life (general) and Muddy Ford Brook also supports aquatic life (trout). Compared to the 2014 Integrated List, there was only one change: the Metedeconk R NB (Rt 9 to I-195) subwatershed had supported the public water supply use in 2014, but did not meet standards in the 2016 list. **Table 7.7** displays more information about the impaired waters within Howell Township.

[12] HUC14 = 14-digit Hydrologic Unit Code (see **Section 7.1.2** for definition)



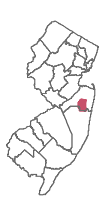


Figure 7.4. Howell Township, Surface Water Quality and Flow Monitoring Locations

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.
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Table 7.6. 2016 305(b) Water Quality Inventory

HUC14	Assessment Unit Name	Designated Use*					
		Aquatic Life General	Aquatic Life Trout	Fish Consumption	Public Water Supply	Recreation	Shellfish
02030104 070040	Yellow Brook (above Bucks Mill)	Non Attaining	NA	Insufficient Data	Attaining	Non Attaining	NA
02030104 070050	Mine Brook (Monmouth Co)	Non Attaining	NA	Insufficient Data	Non Attaining	Non Attaining	NA
02030104 090040	Shark River (above Remsen Mill gage)	Non Attaining	Non Attaining	Non Attaining	Non Attaining	Non Attaining	NA
02030104 100020	Manasquan R (Rt 9 to 74d17m50s road)	Non Attaining	NA	Insufficient Data	Non Attaining	Non Attaining	NA
02030104 100030	Manasquan R (West Farms Rd to Rt 9)	Non Attaining	Non Attaining	Insufficient Data	Attaining	Non Attaining	NA
02030104 100040	Marsh Bog Brook	Non Attaining	NA	Insufficient Data	Non Attaining	Non Attaining	NA
02030104 100050	Manasquan R (gage to West Farms Rd)	Non Attaining	Non Attaining	Non Attaining	Attaining	Non Attaining	NA
02030104 100060	Mingamahone Brook (above Asbury Rd)	Non Attaining	Non Attaining	Insufficient Data	Attaining	Non Attaining	NA
02030104 100070	Mingamahone Brook (below Asbury Rd)	Non Attaining	Non Attaining	Insufficient Data	Attaining	Non Attaining	NA
02030104 100080	Manasquan R (74d07 m30s to Squankum gage)	Non Attaining	Non Attaining	Insufficient Data	Non Attaining	Non Attaining	NA
02030104 100090	Manasquan R (Rt 70 br to 74d07m30s)	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Non Attaining	Non Attaining
02040301 020010	Metedeconk R NB (above I-195)	Non Attaining	NA	Non Attaining	Non Attaining	Non Attaining	NA
02040301 020020	Metedeconk R NB (Rt 9 to I-195)	Non Attaining	Non Attaining	Insufficient Data	Non Attaining	Non Attaining	NA
02040301 020030	Haystack Brook	Attaining	NA	Insufficient Data	Non Attaining	Non Attaining	NA
02040301 020040	Muddy Ford Brook	Attaining	Attaining	Insufficient Data	Attaining	Non Attaining	NA
02040301 020050	Metedeconk R NB (confluence to Rt 9)	Non Attaining	Non Attaining	Insufficient Data	Non Attaining	Non Attaining	NA

***Minimum suite of parameters needed to determine if water quality is fully attaining a use:**

General Aquatic Life - Biological data
Aquatic Life - Trout Biological data and Temperature and DO
Recreation - Pathogenic Indicator Bacteria
Shellfish Harvest for Consumption - Fecal Coliform
Public Water Supply - Nitrate
Fish Consumption - Fish tissue data

For a full list of parameters for each designated use, see Appendix A of the 2016 methods document (NJDEP, June 2017)

Sources: NJDEP, May 2017; NJDEP, June 2017; NJDEP, December 2019 (Appendix A Designated Uses)

Figure 7.5. Howell Township, Integrated List

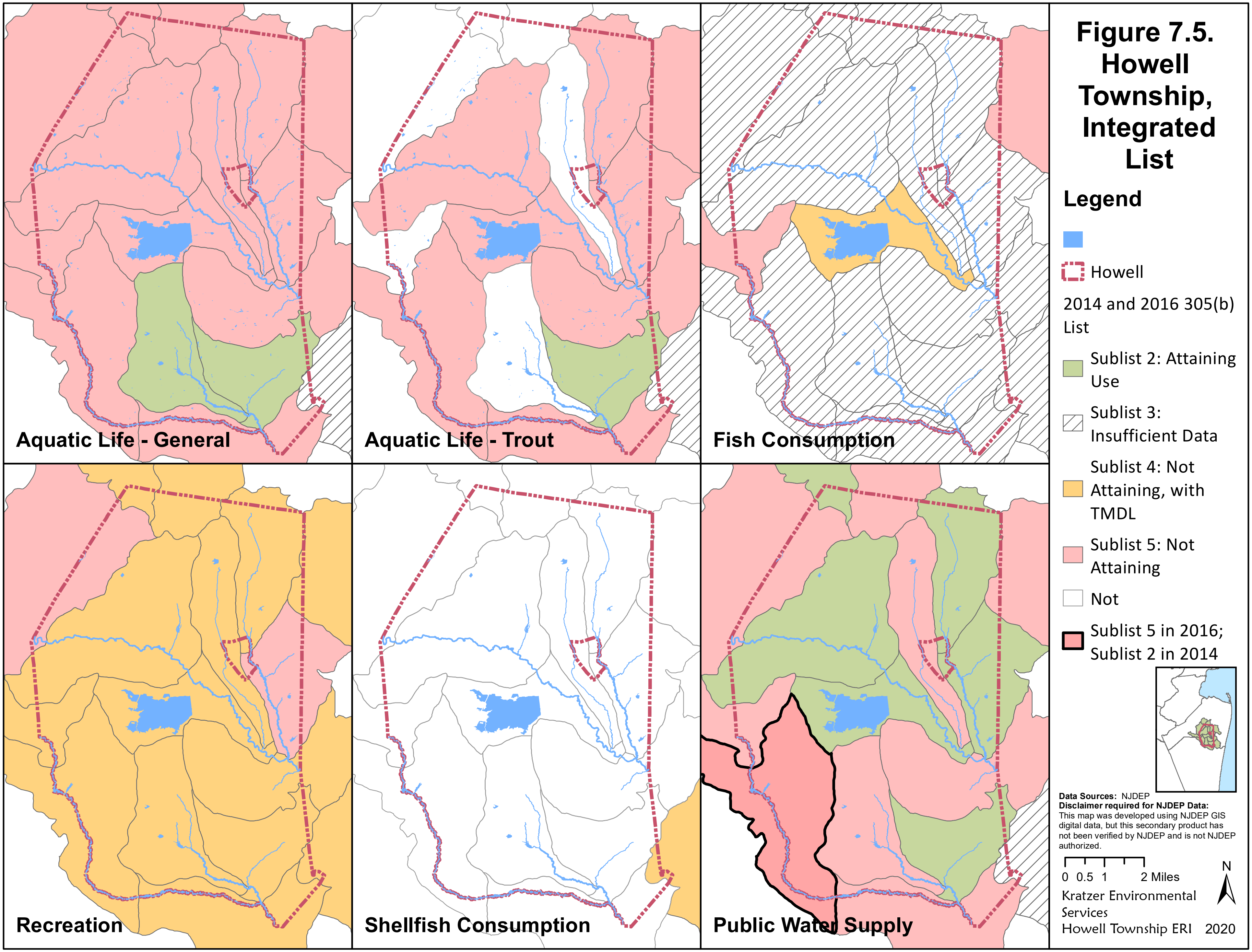

Table 7.7 2016 303(d) Impaired Waters Parameters and Sources (Sublist 5)

HUC14 Number HUC14 Name	Parameter	Station Number	Designated Use	Sublist 5 Subpart (A, R, L)*	TMDL Priority Ranking**
WMA 12: Monmouth					
02030104070 040 Yellow Brook (above Bucks Mill)	BIOLOGICAL-CAUSE UNKNOWN	AN0471	Aquatic Life General		Low
02030104070 050 Mine Brook (Monmouth Co)	ARSENIC	01407450	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0473	Aquatic Life General		Low
	PHOSPHORUS, TOTAL	01407450, MCHD-58	Aquatic Life General		Medium
02030104090 040 Shark River (above Remsen Mill gage)	ARSENIC	01407670	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0481, AN0482	Aquatic Life General, Aquatic Life Trout		Low
	CHLORDANE IN FISH TISSUE	Shark River at Belmar	Fish Consumption	L	Low
	DDT IN FISH TISSUE	Shark River at Belmar	Fish Consumption	L	Low
	PCBS IN FISH TISSUE	Shark River at Belmar	Fish Consumption	L	Low
02030104100 020 Manasquan R (Rt 9 to 74d17m50s road)	ARSENIC	01407846, 01407862	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0486, AN0487	Aquatic Life General		Low
	TOTAL SUSPENDED SOLIDS (TSS)	01407862, 01407868	Aquatic Life General		Medium
	TURBIDITY	01407862	Aquatic Life General		Medium
02030104100 030 Manasquan R (West Farms Rd to Rt 9)	BIOLOGICAL-CAUSE UNKNOWN	AN0489, AN0490	Aquatic Life General, Aquatic Life Trout		Low
	TURBIDITY	01408000	Aquatic Life General		Medium
02030104100 040 Marsh Bog Brook	ARSENIC	01407988	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0491, AN0492	Aquatic Life General		Low
02030104100 050 Manasquan R (gage to West Farms Rd)	BIOLOGICAL-CAUSE UNKNOWN	AN0490, AN0493	Aquatic Life General, Aquatic Life Trout		Low
	PCBS IN FISH TISSUE	Manasquan Reservoir	Fish Consumption	L	Low
	TURBIDITY	01408000	Aquatic Life General		Medium
02030104100 060 Mingamahone Brook (above Asbury Rd)	BIOLOGICAL-CAUSE UNKNOWN	AN0494	Aquatic Life General, Aquatic Life Trout		Low
	TOTAL SUSPENDED SOLIDS (TSS)	01408009	Aquatic Life General		Medium
	TURBIDITY	01408009	Aquatic Life General		Medium
02030104100 070 Mingamahon	PHOSPHORUS, TOTAL	01408020	Aquatic Life General		Medium

HUC14 Number HUC14 Name	Parameter	Station Number	Designated Use	Sublist 5 Subpart (A, R, L)*	TMDL Priority Ranking**
e Brook (below Asbury Rd)					
02030104100080 Manasquan R (74d07m30s to Squankum gage)	ARSENIC	0140802850	Public Water Supply	A	Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0496	Aquatic Life General		Low
	PHOSPHORUS, TOTAL	MCHD-16	Aquatic Life General		Medium
	TEMPERATURE	01408029	Aquatic Life Trout		Medium
	TURBIDITY	01408029	Aquatic Life General		Medium
WMA 13: Barnegat Bay					
02040301020010 Metedeconk R NB (above I-195)	ARSENIC	NK, NM, NO, NP	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0499	Aquatic Life General		Medium
	CHLORDANE IN FISH TISSUE	Metedeconk River North Branch	Fish Consumption	L	Low
	DDT IN FISH TISSUE	Metedeconk River North Branch	Fish Consumption	L	Low
	DISSOLVED OXYGEN	NO	Aquatic Life General		Low
	LEAD	NO, NP	Public Water Supply		Low
	MERCURY IN FISH TISSUE	Metedeconk River North Branch	Fish Consumption		Low
	PCBS IN FISH TISSUE	Metedeconk River North Branch	Fish Consumption	L	Low
	TURBIDITY	NK, NM, NN, NO, NP	Aquatic Life General	R	Medium
02040301020020 Metedeconk R NB (Rt 9 to I-195)	ARSENIC	01408100, NG	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0502	Aquatic Life General		Low
	TEMPERATURE	01408100	Aquatic Life Trout		Medium
02040301020030 Haystack Brook	ARSENIC	HS-1	Public Water Supply		Low
02040301020050 Metedeconk R NB (confluence to Rt 9)	ARSENIC	01408100, BT01, CB, CB-1, ND	Public Water Supply		Low
	BIOLOGICAL-CAUSE UNKNOWN	AN0502, AN0506	Aquatic Life General, Aquatic Life Trout		Low
	LEAD	CB-1, CB	Public Water Supply		Low
	TEMPERATURE	01408100	Aquatic Life Trout		Medium

*Explanation of Sublist 5 Subparts:

Sublist 5A - Arsenic does not attain standards, but concentrations are below those demonstrated to be from naturally occurring conditions.

Sublist 5L - Designated use impairment is caused by a "legacy" pollutant that is no longer actively discharged by a point source.

HUC14 Number HUC14 Name	Parameter	Station Number	Designated Use	Sublist 5 Subpart (A, R, L)*	TMDL Priority Ranking**
Sublist 5R - Water quality impairment is not effectively addressed by a TMDL, such as nonpoint source pollution that will be controlled under an approved watershed restoration plan or 319(h) Watershed Based Plan. **Explanation of Priority Ranking for TMDL Completion: **Medium** priority = NJDEP expects to complete TMDL in the near future, but not within the next two years. **Low** priority = NJDEP does not expect to complete TMDL in the immediate or near future.					
Source: NJDEP, December 2019					

7.2.5 Total Maximum Daily Loads (TMDLs)

When surface waters do not meet the SWQS, *Total Maximum Daily Loads* (TMDLs) must be developed, as specified under Section 303(d) of the Federal Clean Water Act (US Federal Water Pollution Control Act, November 27, 2002). A TMDL identifies all the contributors to surface water quality impacts and sets goals for load[13] reductions for specific pollutants in order to meet the SWQS. Regulations concerning TMDLs are contained in EPA's Water Quality Planning and Management Regulations (USEPA, 2020).

TMDLs represent the assimilative capacity of surface water for a given parameter of concern. The development of TMDLs includes balancing the impacts from point sources, nonpoint sources, and natural background levels of a specific pollutant. The TMDL then quantifies the amount of a pollutant a water body can assimilate without violating a state's water quality standards and allocates that load capacity to known point and nonpoint sources in the form of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, plus a margin of safety (MOS). Load allocations (for nonpoint source pollution) consist of identifying categories of nonpoint sources that contribute to the parameters of concern, followed by recommendations for implementation measures for specific load reductions. Examples include best management practices (BMPs), including structural (stormwater runoff controls) and non-structural (local ordinances for stormwater management and nonpoint source pollution control) mechanisms for addressing the water quality parameter(s) of concern (NJDEP Division of Watershed Management, February 12, 2020).

Waters requiring TMDLs are identified and prioritized in the Integrated Water Quality Assessment. After the Integrated List is approved, the NJDEP writes a TMDL report, which is a proposed Water Quality Management Plan Amendment. When this is published in the NJ Register for public review and comment, the TMDL is considered *proposed*. NJDEP then considers comments received during public comment and finalizes the TMDL report, and the TMDL is considered *established* when it is formally submitted to the US EPA Region 2 for thirty-day review. The TMDL is considered *approved* when the US EPA Region 2 approves it. Next, the TMDL is referred to as *adopted* when the EPA-approved TMDL is adopted by NJDEP as a Water Quality Management Plan amendment and the adoption notice is published in the NJ Register (NJDEP BEARS, February 12, 2020).

Table 7.8 lists adopted TMDLs for waters in Howell Township, with the percent load reduction required in order to meet surface water quality standards. The TMDL documents, which include details about how these reductions were calculated, as well as implementation, are also listed and linked in the table. Implementation usually includes discharge limits for point sources, and restoration plans and projects to reduce nonpoint source pollution, such as green infrastructure, stormwater basins and agricultural best management practices. Reduction of mercury from air deposition is implemented on a statewide and inter-state basis. No additional TMDL are on NJDEP's high priority for completion in the immediate future NJDEP, December 2019).

[13] Load is the total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight per unit time (USEPA, 2020).

Table 7.8 TMDLs for Waters in Howell Township (Sublist 4a*)

HUC14 Number HUC14 Name	Parameter	Station	TMDL Number	TMDL Date	Year Listed**	Designated Use	TMDL Document ★	% Reduction
WMA 12: Monmouth								
02030104070040 Yellow Brook (above Bucks Mill)	ESCHERICHIA COLI (E. COLI)	01407360	10996	2003	2006	Recreation	A	92%
02030104070050 Mine Brook (Monmouth Co)	ESCHERICHIA COLI (E. COLI)	01407450, MCHD-58	31392	2006	2012	Recreation/ shellfish harvest	B	92%
02030104090040 Shark River (above Remsen Mill gage)	ESCHERICHIA COLI (E. COLI)	01407670, MCHD-70	11096	2004	2006	Recreation	C	88%
	MERCURY IN FISH TISSUE	Shark River at Belmar	40821	2020	2006	Fish Consumption	D	84.3%
	PHOSPHORUS, TOTAL	01407670, MCHD-70	12330	2005	2008	Aquatic Life General	E	25.06%
02030104100020 Manasquan R (Rt 9 to 74d17m50s road)	ESCHERICHIA COLI (E. COLI)	01407868	10998	2003	2006	Recreation	A	92%
	PHOSPHORUS, TOTAL	01407846, 01407862, 01407868, MCHD-25	12326	2005	2006	Aquatic Life General	F	53.3%
02030104100030 Manasquan R (West Farms Rd to Rt 9)	ESCHERICHIA COLI (E. COLI)	01407892, 01407900, 01408000, MCHD-73	9959	2003	2006	Recreation	A	92%
	PHOSPHORUS, TOTAL	01407892, 01408000, MCHD-73	12327	2005	2006	Aquatic Life General	F	52.3%
02030104100040 Marsh Bog Brook	ESCHERICHIA COLI (E. COLI)	01407997	9964	2003	2006	Recreation	A	92%
02030104100050 Manasquan R (gage to West Farms Rd)	ESCHERICHIA COLI (E. COLI)	01407900, 01408000	9959	2003	2006	Recreation	A	92%
	PHOSPHORUS, TOTAL	01408000	12327	2005	2006	Aquatic Life General	F	52.3%
02030104100060 Mingamahone Brook (above Asbury Rd)	ESCHERICHIA COLI (E. COLI)	01408009	10999	2003	2006	Recreation	A	79%
02030104100070 Mingamahone Brook (below Asbury Rd)	ESCHERICHIA COLI (E. COLI)	BFBM000164	10999	2003	2016	Recreation	A	79%
02030104100080 Manasquan R (74d07m30s to Squankum gage)	ESCHERICHIA COLI (E. COLI)	MCHD-16	11012	2003	2006	Recreation	A	92%★
02030104100090 Manasquan R (Rt 70 br to 74d07m30s)	TOTAL COLIFORM	Shellfish Network (Manasquan River Estuary)	31391	2006	2006	Shellfish Harvest	B	77%
WMA 13: Barnegat Bay								
02040301020010 Metedeconk R NB (above I-195)	ESCHERICHIA COLI (E. COLI)	MCHD-6, NK, NM	10531	2003	2006	Recreation	A	90%
	PHOSPHORUS, TOTAL	MCHD-6, NK, NM, NP	12334	2005	2006	Aquatic Life General	E	49.81%
	ESCHERICHIA COLI (E. COLI)	01408100, MCHD-19, NF, NG, NI	10531	2003	2006	Recreation	A	90%
02040301020030 Haystack Brook	ESCHERICHIA COLI (E. COLI)	01408110, HS-1	10529	2003	2006	Recreation	A	90%

HUC14 Number HUC14 Name	Parameter	Station	TMDL Number	TMDL Date	Year Listed**	Designated Use	TMDL Document ★	% Reduction
02040301020040 Muddy Ford Brook	ESCHERICHIA COLI (E. COLI)	MCHD-17, MF-1	10548	2003	2006	Recreation	A	90%
02040301020050 Metedeconk R NB (confluence to Rt 9)	ESCHERICHIA COLI (E. COLI)	01408100, BTNA, MCHD-23, NA, NB, ND, NF	10531	2003	2006	Recreation	A	90%

*The following are the TMDL documents referenced by letters A-F above.

Letter	Parameter and TMDL Year	TMDL Document Title	Link to TMDL Document
A	Fecal Coliform - 2003	Total Maximum Daily Loads for Fecal Coliform to Address 31 Streams in the Atlantic Water Region	View the TMDL Document
B	Total coliform - 2006	Five Total Maximum Daily Loads for Total Coliform to Address Shellfish-Impaired Waters in Watershed Management Area 12	View the TMDL Document
C	Fecal Coliform - 2004	Total Maximum Daily Loads for Fecal Coliform to Address 3 Streams in the Atlantic Water Region	View the TMDL Document
D	Mercury - 2010 (and 2011 addendum)	Total Maximum Daily Load for Mercury Impairments Based on Concentration in Fish Tissue Caused Mainly by Air Deposition to Address 122 HUC 14s Statewide	View the TMDL Document and NJ Register, July 20, 2020
E	Total Phosphorus - 2005	Total Maximum Daily Loads for Phosphorus to Address 3 Stream Segments in the Atlantic Coastal Water Region	View the TMDL Document
F	Total Phosphorus - 2005	Total Maximum Daily Loads for Total Phosphorus to Address Two Streams Segments in the Manasquan River Watershed, Monmouth County Atlantic Coastal Water Region	View the TMDL Document

*__Sublist 4a__ means a TMDL has been completed for the parameter causing designated use nonsupport.
** **Year listed** indicates the first year the impairment was identified.
★ In the 2003 Atlantic Coastal fecal coliform TMDL, Squankum Creek was listed separately and assigned a reduction of 94%.

Source: NJDEP, March 27, 2019; NJDEP, December 2019 (Appendix B Sublist 4); NJ Register, July 20, 2020

Prior to 2006, NJDEP used fecal coliform as an indicator of pathogens for determining recreation use. This was changed in 2006 upon EPA's recommendation to use E. coli and Enterococcus for freshwater and Enterococcus for saltwater (NJDEP, December 2006). Eight subwatersheds within WMA 12 and five within WMA13 require reductions in loads of pathogens to restore recreational use:

WMA 12: Monmouth

- 02030104070040 Yellow Brook (above Bucks Mill) requires a 92% reduction
- 02030104090040 Shark River (above Remsen Mill gage) requires an 88% reduction
- 02030104100020 Manasquan R (Rt 9 to 74d17m50s road) requires a 92% reduction
- 02030104100030 Manasquan R (West Farms Rd to Rt 9) requires a 92% reduction
- 02030104100040 Marsh Bog Brook requires a 92% reduction
- 02030104100050 Manasquan R (gage to West Farms Rd) requires a 92% reduction
- 02030104100060 Mingamahone Brook (above Asbury Rd) requires a 79% reduction
- 02030104100070 Mingamahone Brook (below Asbury Rd) requires a 79% reduction
- 02030104100080 Manasquan R (74d07m30s to Squankum gage) requires a 92% reduction

WMA 13: Barnegat Bay

- 02040301020010 Metedeconk R NB (above I-195) requires a 90% reduction
- 02040301020010 Metedeconk R NB (above I-195) requires a 90% reduction
- 02040301020030 Haystack Brook requires a 90% reduction
- 02040301020040 Muddy Ford Brook requires a 90% reduction
- 02040301020050 Metedeconk R NB (confluence to Rt 9) requires a 90% reduction

Two subwatersheds within WMA 12 require reductions in loads of pathogens to restore shellfish harvest use:

WMA 12: Monmouth

- 02030104070050 Mine Brook (Monmouth Co) (Navesink River Estuary) requires a 92% reduction
- 02030104100090 Manasquan R (Rt 70 br to 74d07m30s) (Manasquan River Estuary) requires a 77% reduction

In 2010, NJDEP established a TMDL for mercury in fish tissue for fish consumption where the source of mercury is primarily air deposition. The TMDL target is when the level of mercury in fish tissue would be considered safe for the general population to consume without limits and for the high-risk population to consume one meal per week (see **Section 3.2.5** for information about mercury in air deposition and **Section 11.2** for fish consumption advisories). A 2020 addendum added one subwatershed within Howell Township to the mercury TMDL. According to the TMDL adoption notice, "The Department's *Air Deposition Reduction Strategy* is expected to be updated with new information and technology when it is available" (NJ Register, July 20, 2020).

WMA 12: Monmouth

- 02030104090040 Shark River (above Remsen Mill gage) requires an 84.3% reduction

Four subwatersheds within WMA 12 and one in WMA 13 require reductions in loads of phosphorus to support aquatic life:

WMA 12: Monmouth

- 02030104090040 Shark River (above Remsen Mill gage) requires a 25.06% reduction
- 02030104100020 Manasquan R (Rt 9 to 74d17m50s road) requires a 53.3% reduction
- 02030104100030 Manasquan R (West Farms Rd to Rt 9) requires a 52.3% reduction
- 02030104100050 Manasquan R (gage to West Farms Rd) requires a 52.3% reduction

WMA 13: Barnegat Bay

- 02040301020010 Metedeconk R NB (above I-195) requires a 49.81% reduction

7.3 FLOOD ZONES

7.3.1 Flood Risk

A *floodplain* is the land along a river or stream that is subject to periodic flooding when the river or stream overflows its banks. As required by the Flood Disaster Protection Act of 1973, the Federal Emergency Management Administration (FEMA) is responsible for delineating floodplains.

According to FEMA, "Everyone lives in some type of flood zone." (FEMA, June 21, 2007). FEMA defines these geographic areas based on studies of flood risk.

FEMA provides flood hazard and risk data to states and communities to guide mitigation actions. The National Flood Insurance Program is the basis of the National Flood Insurance Program regulations and flood insurance requirements. Flood hazard mapping is an important part of the National Flood Insurance Program. FEMA uses the best available technical data, such as statistical information on river flows, to create the *Flood Insurance Rate Maps* that show the flood zone boundaries (FEMA, February 14, 2020).

The flood zone boundaries shown in **Figure 7.6** are produced using FEMA's National Flood Hazard Layer (FEMA, September 25, 2009). Special Flood Hazard Areas are defined as areas subject to inundation by a flood having, on average, about 1 in 100 chance in any given year, also referred to as the 1% annual chance flood, while in a "500-year flood zone," the probability goes down to 0.2% in any one year[14] (FEMA, March 18, 2019). Because FEMA maps are based on historical data, some scientists warn that rapid urbanization and changing climate conditions (for example, warmer air holds more moisture and sea levels are rising) will increase the likelihood and severity of future floods (Popovich and O'Neill, August 28, 2017) (climate is addressed in **Section 3**).

The term "100-year flood" does not mean a flood that happens once every 100 years. It is a statistical designation that there is a 1% chance that a flood of a given size will be equaled or exceeded during any one year.

Below are brief definitions of the FEMA flood zones that occur within Howell Township.

Zones with a high-risk of flooding, or Special Flood Hazard Areas, include *Zone A* and *Zone AE*. *Zone A* corresponds to the 1% annual chance floodplains that are determined by approximate methods of analysis (i.e., not with Base Flood Elevations).

Zone AE corresponds to the 1% annual chance floodplains that are determined by detailed methods of analysis, which includes detailed hydraulic analyses to determine Base Flood Elevations. In communities such as Howell Township that participate in the National Flood Insurance Program, all homeowners in Zones A and AE are required to get flood insurance in order to get a loan from a federally regulated lender (FEMA, March 18, 2019; FEMA, July 25, 2017).

7.3.2 Flood Zones

Flood zones in Howell Township are shown in **Figure 7.6**, based on FEMA determinations (FEMA, September 25, 2009). Approximately 8% of the township is within the 1% annual chance of flooding. Less than 1% of Howell Township is mapped as having a 0.2% annual chance of flooding (typically referred to as the 500 year flood). These areas are not considered high risk, and include areas of little hazard, such as those with average depths of less than 1 foot and minimal hazard, such as ponding and local drainage problems. Insurance purchase is not required in this zone

Areas in *Zone X*, which includes approximately 91% of Howell Township, have low to moderate risk of flooding and are not in the Special Flood Hazard Areas. They correspond to areas outside the 1% annual chance

Flood Facts

- Floods and flash floods happen in all 50 states.
- Hurricanes, winter storms and snowmelt are common (but often overlooked) causes of flooding.
- New land development can increase flood risk, especially if the construction changes natural runoff paths.
- Federal disaster assistance is usually a loan that must be paid back with interest.
- If you live in a Special Flood Hazard Area or high-risk area and have a Federally backed mortgage, your mortgage lender requires you to have flood insurance
- 20 to 25% of all flood claims are filed in low to moderate flood risk areas.

(FEMA, July 25, 2017; FEMA, June 21, 2007)

[14] Flood designations are based on statistical averages, not the number of years between big floods. The term "100-year flood" does not mean a flood that happens once every 100 years. It is a statistical designation that there is a 1 in 100 chance that a flood of any given size will be equaled or exceeded during any year. Changes and variability in climate and land use over time can change flood frequency (Dinicola, 2005).

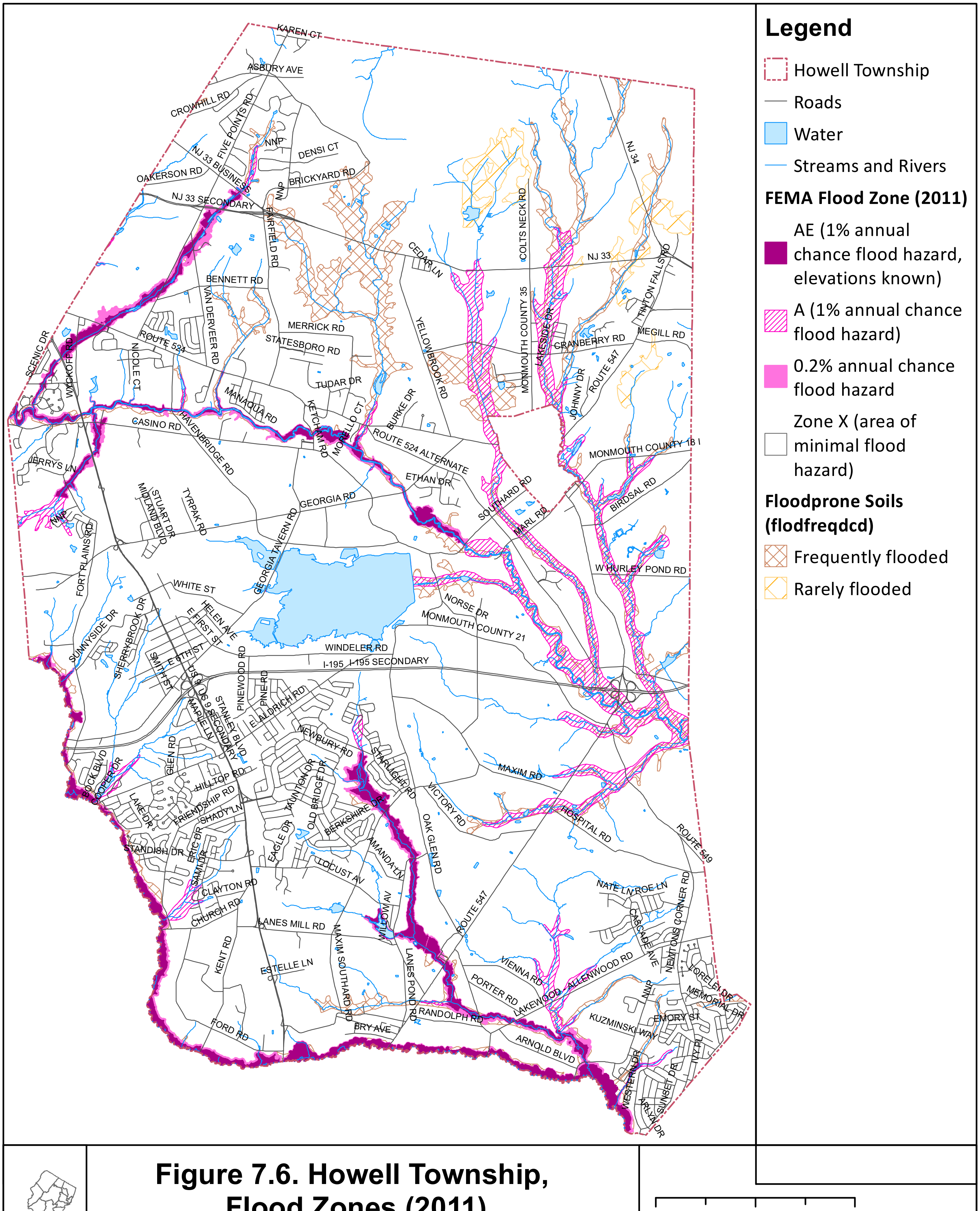

Figure 7.6. Howell Township, Flood Zones (2011)

According to FEMA flood zone maps, approximately 8.2% of Howell Township is within the 1% annual chance of flooding, while another 0.4% has a 0.2% annual chance of flooding. Approximately 91.4% of the township is in an area defined as minimal flood hazard.

Data Sources: NJDEP, NJDOT, FEMA
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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floodplain, outside of 1% annual chance sheet flow[15] flooding where average depths are less than 1 foot, outside of 1% annual chance stream flooding or where the contributing drainage area is less than 1 square mile. No Base Flood Elevations or depths are shown within this zone (FEMA, March 18, 2019).

Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. Community involvement is an important element in making flood insurance available to home and business owners. These measures may include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances. Riparian buffer and wetlands protection regulations and ordinances can also reduce flood damage by protecting those areas most susceptible to flooding and providing natural flood control. According to the FEMA Community Status Book Report, Howell Township participates in the National Flood Program (FEMA, no date).

7.4 WETLANDS

Wetland. Photo credit: J. Dodds

7.4.1 Wetland Classification

A *wetland* is a transitional area between aquatic and terrestrial ecosystems. Wetlands are those areas that are inundated (for example in a floodplain) or saturated by surface water or ground water (such as a perched water table) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation. To determine if an area is a wetland, the vegetation (plants that like wet conditions), soils (wetland, or hydric, soil types often show mottling) and hydrology (low spots or evidence of water) are evaluated according to the April 1, 1987 interim-final draft "Wetland Identification and Delineation Manual" developed by the United States Environmental Protection Agency. A *transition area*, or buffer, is an area of land adjacent to a freshwater wetland that minimizes adverse impacts on the wetland or serves as an integral component of the wetlands ecosystem (N.J.S.A. 13:9B-1 et seq in NJDEP Division of Land Use Management, 2016).

In the past, wetlands were often regarded as wastelands – only useful when drained and filled. In contrast, a 1978 Tufts University study showed that one acre of wetland provides at least $153,000 (1978 dollars) of public value, considering proven monetary benefits of flood protection, pollution reduction, water supply, recreation, and aesthetics (Fair, 2004). Some of the benefits of wetlands include:

- Wetlands protect drinking water by filtering out pollutants and sediments that would otherwise obstruct and contaminate our waters.
- Wetlands soak up runoff from heavy rains and snow melts, providing natural flood control.
- Wetlands release stored waters during droughts.
- Wetlands provide critical habitats for a major proportion of the state's fish and wildlife, including many endangered, commercial, and recreational species.

[15] Sheet flow, or overland flow, is flow that occurs overland in places where there are no defined channels, so the flood water spreads out over a large area at a uniform depth.

- Wetlands provide high quality open space for recreation and tourism (NJDEP Land Use Regulation, August 26, 2019).

The value of wetlands was not broadly accepted until at least the 1970s and 1980s. By then, more than half of the country's wetlands had been destroyed (NJDEP Land Use Regulation, August 26, 2019). Loss of wetlands has resulted in erosion, flooding, sedimentation, and decreased populations of many types of wildlife. Structures built in wetlands suffer from frost heaving and other structural problems.

7.4.2 Regulations Related to Wetlands

New Jersey protects wetlands under the 1987 New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B) and Rules (N.J.A.C. 7:7A) (NJDEP Division of Land Use Management, 2016 and July 15, 2019). Under these, NJDEP regulates virtually all activities proposed within wetlands and transition areas or buffers around freshwater wetlands, including cutting of vegetation, dredging, excavation or removal of soil, drainage or disturbance of the water level, and filling or discharge of any materials. Development that would impair the wetland's ability to provide the values listed above (filtration, flood control, etc.) is prohibited. There are limited exemptions for existing farming, ranching, or forestry operations.

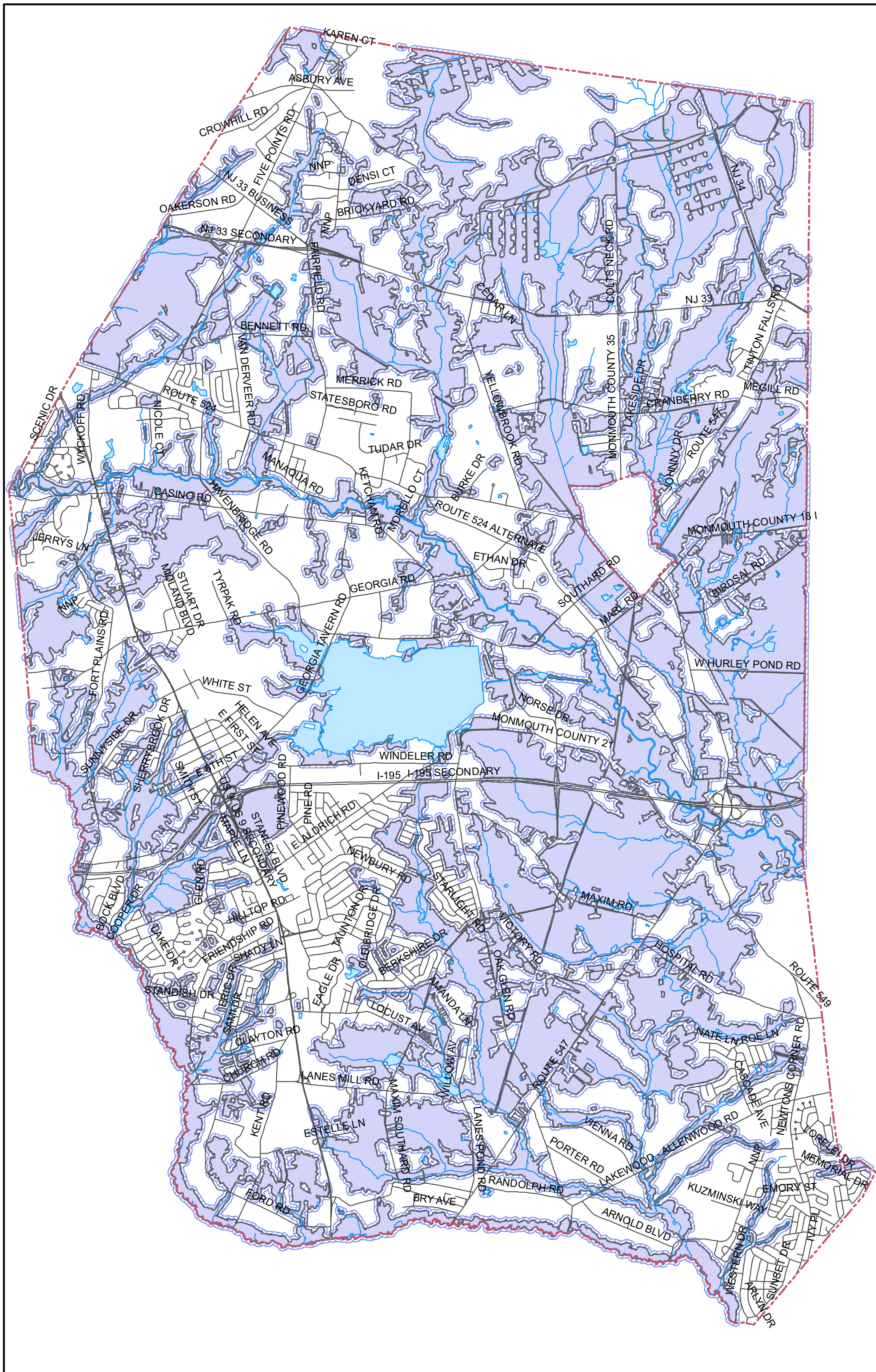
On-site inspection (direct testing and observation of soils, hydrology, and vegetation) by a qualified professional is needed prior to making any disturbance within a wetland or transition area. Only an official determination from NJDEP, called a *Letter of Interpretation* (LOI) can verify the presence, absence, or boundaries of freshwater wetlands and transition areas on a site. Copies of these maps are filed at the NJDEP and the township building, but unfortunately, NJDEP does not digitize these determinations into a GIS layer[16].

In addition to defining the boundary of the wetland, the LOI establishes the value of the wetland, which will determine the width of the regulated transition area. *Ordinary Value* wetlands, such as man-made drainage ditches and swales, have a 0 foot buffer. *Intermediate Value* wetlands have a 50 foot buffer, which includes those wetlands not included in the definitions of Ordinary or Exceptional value. *Exceptional Value* wetlands have a 150 foot buffer width. Exceptional Value wetlands include wetlands that provide habitat for endangered and threatened species. A determination of threatened and endangered species habitat is provided by using the Landscape Project data (see **Section 8.2**).

According to NJDEP's 2015 Land Use GIS data (derived from aerial photography), there are 13,474 acres of wetlands within Howell Township, covering 34% of the township (NJDEP, January 28, 2019). The wetlands shown in **Figure 7.7** were determined by selecting all wetlands land use types from the GIS layer, therefore provides guidance on where wetlands are found in Howell Township. This map is intended to serve as a resource for analysis rather than regulatory delineations because the wetlands are not derived from on-site surveys. A transition area (buffer) width of 150 feet is mapped in **Figure 7.7** because the GIS data does not determine the value of each wetland. The actual transition area width (0, 50 or 150') required by the NJDEP is determined in the LOI.

More than half of Howell Township's wetland acreage (19% of the township) consists of deciduous wooded wetlands, while about 8% of the township is mixed deciduous and coniferous wooded wetlands. There are several other types of natural freshwater wetlands in the township including coniferous wetlands, deciduous, coniferous, and mixed scrub/shrub wetlands, and herbaceous wetlands (see **Section 8.1** and **Table 8.1**). About 12% of the township's wetlands have classifications that indicate alterations by human activity, including modified agricultural wetlands (1,052 acres), wetland rights-of-way (262 acres) and disturbed wetlands (156 acres).

[16] Digitizing involves giving latitude and longitude coordinates to areas and lines to depict mapped features.



Legend

- Howell Township
- Roads
- Water
- Streams and Rivers
- Wetlands (2015 Land Use)
- 50 foot transition area (buffer) applies to some wetlands
- 150 foot transition area (buffer) applies to some wetlands

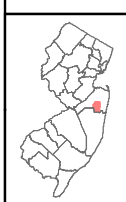


Figure 7.7. Howell Township, Wetlands (Land Use 2015)

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI

2020

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Basic Watershed Information (Watershed Restoration Section): http://www.nj.gov/dep/watershedrestoration/info.html

The Clean Water Book: Choices for Watershed Protection: http://www.nj.gov/dep/watershedrestoration/waterbook_tble.html

Harmful Algal Blooms: https://www.state.nj.us/dep/hab/

Protecting Our Streams: https://anjec.org/wp-content/uploads/2019/07/RP_Streams.pdf

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Integrated List & TMDL
NJDEP Integrated WQ monitoring and Assessment Report: https://www.state.nj.us/dep/wms/bears/assessment.htm

NJDEP Total Maximum Daily Load (TMDL): http://www.nj.gov/dep/wms/bears/tmdls.html

USEPA Laws and Regulations: http://www2.epa.gov/laws-regulations

Surface Water Quality and Flow
Clean Shores: https://www.state.nj.us/dep/wms/bears/cleanshores.html

Cooperative Coastal Monitoring Program (Includes beach closings/advisories): https://www.njbeaches.org/

NJDEP DWM&S Continuous Data at BFBM000258: Manasquan Reservoir http://njdep.rutgers.edu/continuous/

NJ Geological and Water Survey: https://www.state.nj.us/dep/njgs/index.html

NJ Water Supply Authority Manasquan System: http://www.njwsa.org/manasquan.html

USGS Water Resources of NJ: https://nj.usgs.gov/
Continuous Real-Time Water Quality: https://waterwatch.usgs.gov/wqwatch/map?state=nj&pcode=00010
Real-time flow data index of NJ sites: http://waterdata.usgs.gov/nj/nwis/current/?type=flow
USGS 01408029 Manasquan River near Allenwood NJ: https://waterdata.usgs.gov/usa/nwis/uv?01408029
USGS 01408000 Manasquan River at Squankum NJ: https://waterdata.usgs.gov/nj/nwis/uv?site_no=01408000
USGS 01408120 North Branch Metedeconk River near Lakewood NJ: https://waterdata.usgs.gov/nj/nwis/uv?01408120

Water Quality Data Portal: https://www.waterqualitydata.us/

Floodplains & Floods
FEMA Flood Map Service Center: http://msc.fema.gov/portal

Flood Hazard Area Program (NJDEP Land Use Regulation): https://www.nj.gov/dep/landuse/fha_main.html

FloodSmart: The Official Site of the National Flood Insurance Program: http://www.floodsmart.gov

Wetlands
Freshwater Wetlands Program (NJDEP Land Use Regulation): http://www.nj.gov/dep/landuse/fww/fww_main.html

Freshwater Wetlands Program: Before You Buy – Before You Build: http://www.nj.gov/dep/landuse/bybob.html

NJDEP Regulations:
NJDEP Laws & Rules: http://www.nj.gov/dep/landuse/lawsregs.html

NJDEP Rules & Regulations, current and proposed: http://www.state.nj.us/dep/rules

Phone Contacts:
NJ Drought Hotline: 1-800-4-ITS DRY (1-800-448-7379) or https://www.njdrought.org/

NJ Environmental Incident Hotline (hazardous spill, fire, explosion, illegal dumping, wildlife problem):
1-877-WARNDEP / 1-877-927-6337 (toll-free, 24 hours) or https://www.nj.gov/dep/warndep.htm

NJDEP Bureau of Coastal & Land Use Compliance & Enforcement: 1-609-292-1240

NJDEP Division of Land Use Regulation (Wetlands, Streams/Rivers, Flood Hazard Areas):
Technical Support Center: (609) 777-0454 or https://www.nj.gov/dep/landuse/contact.html
Forms: https://www.nj.gov/dep/landuse/forms.html

8. BIOLOGICAL RESOURCES

8.1 VEGETATION

8.1.1 Native Vegetation Types/Species

What are current threats?

The New Jersey Comparative Risk Project (March 2003) listed habitat fragmentation and habitat loss as the highest ranking stressors of Statewide ecological quality. Certain species that require large expanses of intact habitat are becoming less common. Other factors that impact ecological health include invasive non-native species and diseases, overpopulations of deer and geese, and pollution.

Dominant Vegetation (Land Cover)

The 2015 Land Use/Land Cover (LU/LC) data layer was created by a consultant to NJDEP by comparing the 2012 LU/LC layer to 2015 color infrared imagery and delineating and coding areas of change with a 1-foot pixel resolution. The classification system used was a modified Anderson Classification System (USGS, 2010) that provided the parameters for proper and consistent coding of the LU/LC feature classes and subclasses.[17] The general land types were summarized in **Figure 2.4**

, but the categories are broken down into a greater level of detail in **Table 8.1**. More detailed information regarding forested land and wetlands is also provided in **Figure 8.1** and **Figure 8.2**.

Since Howell Township's 2008 ERI was written, an additional 2% (634 acres) of forests and 1% (555 acres) of wetlands have been lost to development. For more on land use change, see Chapter 2.4.

More than half of the undeveloped land in Howell consists of protected wetlands, with open waters and forest land compromising the rest. Most of the forested land in Howell Township (80.79%) is made up of deciduous, coniferous, or mixed woodlands with greater than 50% crown closure, and another 8.55% is comprised of woodlands with less than 50% crown closure. Shrub or brush cover accounts for 10.07% of the forested land, with the remaining acreage (0.59%) classified as plantation. Of the township's acres that are classified as wetlands, 83.65% are forested. Another 4.14% are natural communities with shrubby or herbaceous cover, and the remaining 12.22% of wetlands have been modified by human activity. Deciduous woodlands are the dominant type in both the forest and wetland categories.

Table 8.1. Land Use Classifications in Howell Township (2015)

Land Cover Code	Land Cover Name	Acres*	Percent of Howell Township
AGRICULTURE LAND USE TYPE			
2100	CROPLAND AND PASTURELAND	1,384.08	3.54
2200	ORCHARDS/VINEYARDS/NURSERIES/HORTICULTURAL AREAS	362.00	0.92
2300	CONFINED FEEDING OPERATIONS	21.82	0.06
2400	OTHER AGRICULTURE	1,070.35	2.73
	Total Acres of AGRICULTURE:	**2,838.25**	**7.25**

[17] It should be noted that 1) changes since 2015 are not shown, and 2) the method is not 100% accurate. In addition, since it is based on interpretation of aerial photographs, the data layer cannot provide information about the particular species found in an area.

Land Cover Code	Land Cover Name	Acres*	Percent of Howell Township
BARREN LAND USE TYPE			
7300	EXTRACTIVE MINING	21.46	0.05
7400	ALTERED LANDS	142.52	0.36
7500	TRANSITIONAL AREAS	265.88	0.68
7600	UNDIFFERENTIATED BARREN LANDS	1.15	0.003
	Total Acres of BARREN LAND:	**431.01**	**1.10**
FOREST LAND USE TYPE			
4110	DECIDUOUS FOREST (10-50% CROWN CLOSURE)	385.06	0.98
4120	DECIDUOUS FOREST (>50% CROWN CLOSURE)	3,764.88	9.62
4210	CONIFEROUS FOREST (10-50% CROWN CLOSURE)	77.29	0.20
4220	CONIFEROUS FOREST (>50% CROWN CLOSURE)	707.40	1.81
4230	PLANTATION	44.40	0.11
4311	MIXED FOREST (>50% CONIFEROUS WITH 10-50% CROWN CLOSURE)	54.92	0.14
4312	MIXED FOREST (>50% CONIFEROUS WITH >50% CROWN CLOSURE)	597.22	1.53
4321	MIXED FOREST (>50% DECIDUOUS WITH 10-50% CROWN CLOSURE)	125.43	0.32
4322	MIXED FOREST (>50% DECIDUOUS WITH >50% CROWN CLOSURE)	1,005.43	2.57
4410	OLD FIELD (< 25% BRUSH COVERED)	149.59	0.38
4420	DECIDUOUS BRUSH/SHRUBLAND	220.98	0.56
4430	CONIFEROUS BRUSH/SHRUBLAND	127.95	0.33
4440	MIXED DECIDUOUS/CONIFEROUS BRUSH/SHRUBLAND	258.54	0.66
	Total Acres of FOREST:	**7,519.10**	**19.21**
URBAN LAND USE TYPE			
1110	RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING	560.91	1.43
1120	RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	3,515.31	8.98
1130	RESIDENTIAL, SINGLE UNIT, LOW DENSITY	1,616.36	4.13
1140	RESIDENTIAL, RURAL, SINGLE UNIT	3,379.25	8.63
1200	COMMERCIAL/SERVICES	943.84	2.41
1211	MILITARY INSTALLATIONS	445.12	1.14
1300	INDUSTRIAL	546.02	1.39
1400	TRANSPORTATION/COMMUNICATION/UTILITIES	292.55	0.75
1410	MAJOR ROADWAY	275.83	0.70
1411	MIXED TRANSPORTATION CORRIDOR OVERLAP AREA	0.50	0.001
1420	RAILROADS	84.24	0.22
1440	AIRPORT FACILITIES	5.55	0.01
1463	UPLAND RIGHTS-OF-WAY UNDEVELOPED	112.04	0.29
1499	STORMWATER BASIN	311.87	0.80
1500	INDUSTRIAL AND COMMERCIAL COMPLEXES	15.88	0.04
1700	OTHER URBAN OR BUILT-UP LAND	958.21	2.45
1710	CEMETERY	25.24	0.06
1800	RECREATIONAL LAND	614.42	1.57
1804	ATHLETIC FIELDS (SCHOOLS)	164.83	0.42
1810	STADIUM, THEATERS, CULTURAL CENTERS AND ZOOS	1.86	0.005
	Total Acres of URBAN:	**13,869.83**	**35.43**
WATER LAND USE TYPE			
1419	BRIDGE OVER WATER	0.89	0.002

Land Cover Code	Land Cover Name	Acres*	Percent of Howell Township
5100	STREAMS AND CANALS	63.25	0.16
5200	NATURAL LAKES	4.14	0.01
5300	ARTIFICIAL LAKES	948.02	2.42
	Total Acres of WATER:	**1,016.31**	**2.60**
WETLANDS LAND USE TYPE			
1461	WETLAND RIGHTS-OF-WAY	262.24	0.67
1711	CEMETERY ON WETLAND	0.40	0.001
1750	MANAGED WETLAND IN MAINTAINED LAWN GREENSPACE	70.20	0.18
1850	MANAGED WETLAND IN BUILT-UP MAINTAINED REC AREA	82.26	0.21
2140	AGRICULTURAL WETLANDS (MODIFIED)	1,052.67	2.69
2150	FORMER AGRICULTURAL WETLAND (BECOMING SHRUBBY, NOT BUILT-UP)	21.84	0.06
6210	DECIDUOUS WOODED WETLANDS	7,449.03	19.03
6220	CONIFEROUS WOODED WETLANDS	546.92	1.40
6221	ATLANTIC WHITE CEDAR WETLANDS	4.29	0.01
6231	DECIDUOUS SCRUB/SHRUB WETLANDS	350.02	0.89
6232	CONIFEROUS SCRUB/SHRUB WETLANDS	32.93	0.08
6233	MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)	72.56	0.19
6234	MIXED SCRUB/SHRUB WETLANDS (CONIFEROUS DOM.)	24.30	0.06
6240	HERBACEOUS WETLANDS	77.98	0.20
6251	MIXED WOODED WETLANDS (DECIDUOUS DOM.)	1,224.13	3.13
6252	MIXED WOODED WETLANDS (CONIFEROUS DOM.)	2,046.34	5.23
7430	DISTURBED WETLANDS (MODIFIED)	156.34	0.40
	Total Acres of WETLANDS:	**13,474.46**	**34.42**
	Howell Township Total Acres:	**39,148.96**	**100.00**
* Acreage from the GIS data may vary from acreage calculated based on tax maps.			
Source: NJDEP, January 28, 2019; USGS, 2010.			

Significant Ecological Communities

Natural Heritage Priority Sites are ecological communities that have been identified by the New Jersey Office of Natural Lands Management (ONLM) as areas critically important for preservation of the state's biological diversity. The sites are considered some of the best and most viable occurrences of endangered and threatened plant species and natural communities, although other occurrences of endangered and threatened plant species may exist. Records from the New Jersey Natural Heritage Program show two Natural Heritage Priority Sites that are located fully or partially within Howell Township (NJDEP ONLM, 2019). Manasquan River Woods is located in the heart of the township, just east of the Manasquan Reservoir. The priority site protects a state-imperiled plant species in a forested wetland on a tract owned by the New Jersey Water Supply Authority. The Shark River Station site, encompassing a blend of pine barren wetland and upland habitats, protects multiple species of rare plants, including one critically imperiled species. The majority of Shark River Station falls within Wall Township, but a small portion of the priority site extends into the northeastern portion of Howell, where it is situated primarily on property owned by the United States Navy. The Priority Site locations are shown in **Figure 8.3**.

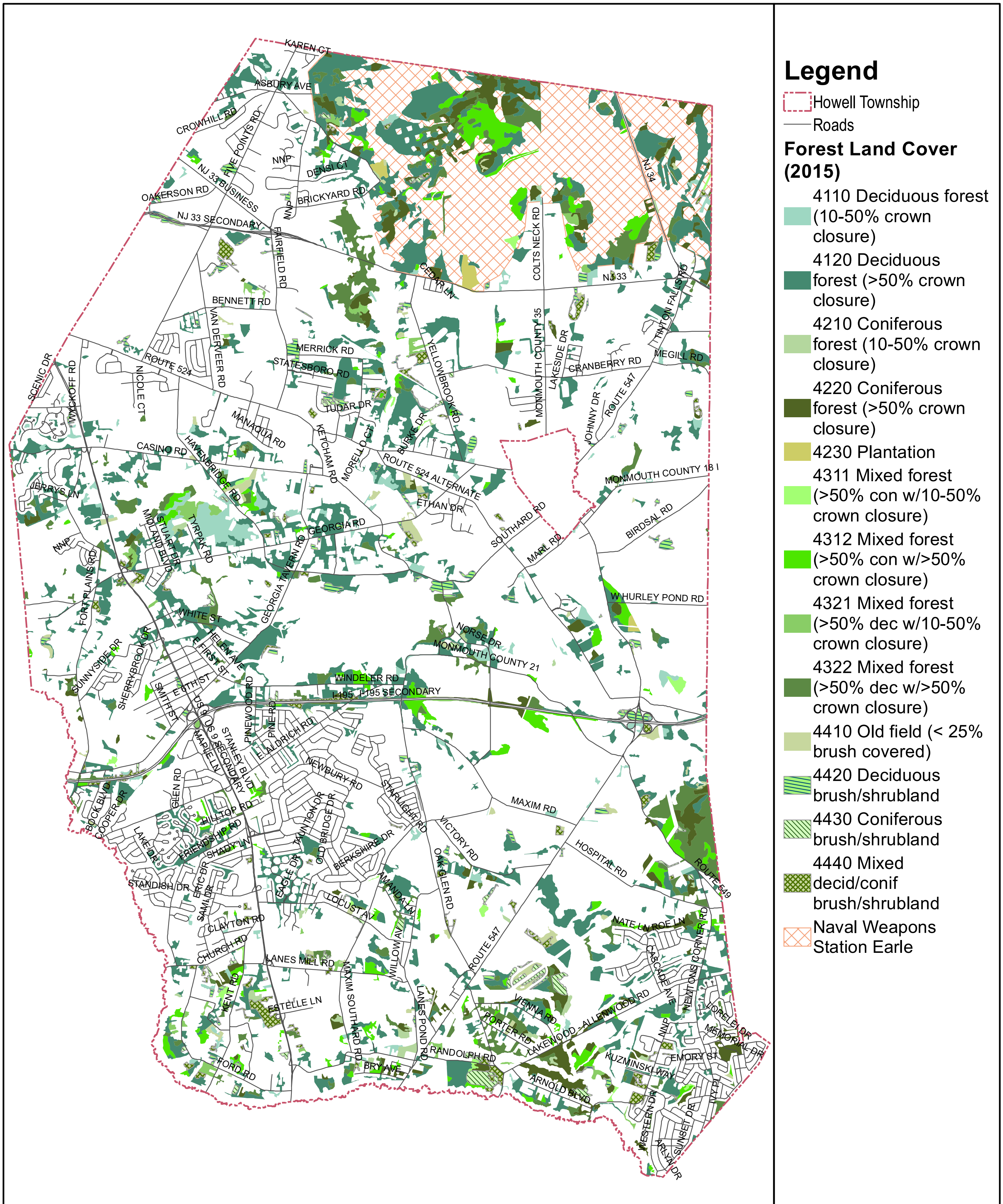

Figure 8.1. Howell Township, Vegetation Land Cover Forest Types

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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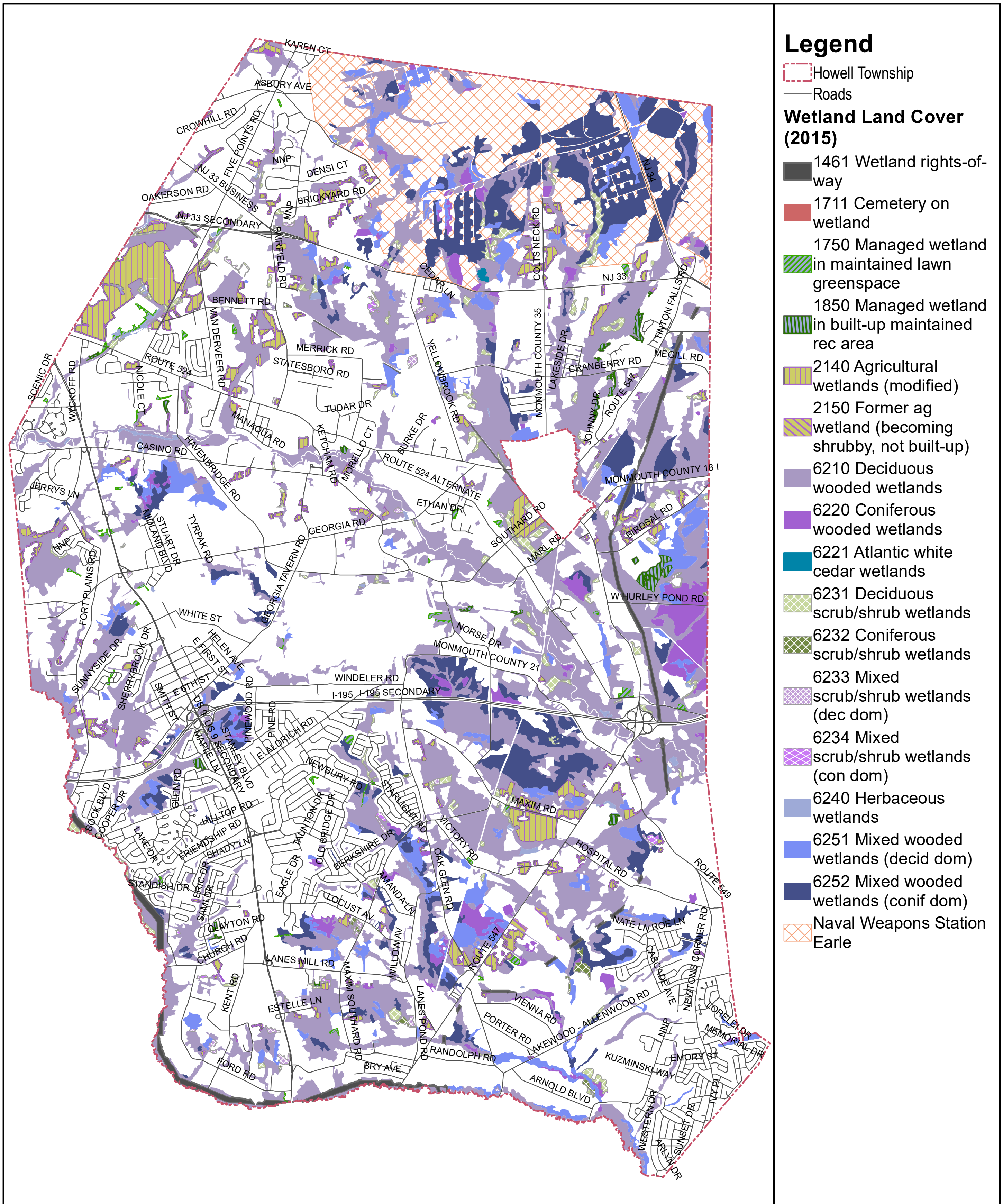

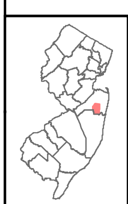

Figure 8.2. Howell Township, Vegetation Land Cover Wetland Types

0 0.5 1 2 Miles

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Howell Township has two Natural Heritage Priority Sites that are critically important for preservation of the state's biological diversity.

Howell Township also includes some communities that have been identified as ecologically significant sites within Monmouth County. An early inventory of the county's key natural features (Monmouth County Environmental Council, 1975) identified four noteworthy sites within the township, including Howell Park, an Atlantic White Cedar swamp, the Polypod Brook Watershed, and an orchid colony along a utility right-of-way in the southeastern part of town. Also on the list were Allaire State Park and the Manasquan River, both of which are only partially situated within Howell Township. The initial Natural Features Study was further refined and developed into the Monmouth County Unique Areas Study, which was designed to identify priority areas for conservation throughout the county (Monmouth County Environmental Council, 1978). The cedar swamp in Howell Township was one of five sites included in the category of 'Bogs, Marshes and Swamps'. The twelve waterways discussed in the document included both Polypod/Groundhog Brook and the Manasquan River, and Allaire State Park was one of eight sites to make the list in the category of 'Meadows, Parks and Forests'.

Wildfire Fuel Hazard

The New Jersey Forest Fire Service (NJFFS), a division of NJDEP, assessed *Wildfire Fuel Hazard* (WFH) throughout New Jersey (see **Figure 8.4**). The purpose was to provide information for state Forest Fire Service personnel, government agencies, and others interested in assessing the risk of wildfires throughout New Jersey. Modified Anderson Land Use/Land Cover Classifications from the 2002 Land Use/Land Cover dataset were assigned Wildfire Fuel Hazard Rankings (0 = Water, 1 = Low, 2 = Moderate, 3 = High, 4 = Very High, 5 = Extreme, 6 = Urban, 7 = Agriculture, 8 = Barren Land). Areas with 30% or greater slope and Wildfire Fuel Hazard 1 to 4 were increased by 1 (e.g. Low became Moderate, etc.) (NJDEP, April 17, 2009).

Fuel hazard risk is summarized according to the township's cover classifications in **Table 8.2.** Wildfire Fuel Hazard for the majority of the land in Howell Township (55.5%) is ranked as low (39.8%), moderate (13.3%) or water (2.5%). Nearly a third (30.9%) falls into unranked categories including Urban, Agriculture, and Barren Land. The remaining cover (13.6%) falls into the categories of greatest risk, including high (8.5%), very high (0.9%) or extreme (4.1%).

Table 8.2. Wildfire Fuel Hazard Levels for Howell Township

Rank	Description	Acres	Percentage
0	WATER	965.42	2.5%
1	LOW	15,559.36	39.8%
2	MODERATE	5,206.16	13.3%
3	HIGH	3,344.57	8.5%
4	VERY HIGH	364.93	0.9%
5	EXTREME	1,610.58	4.1%
6	URBAN	7,835.08	20.0%
7	AGRICULTURE	3,499.32	8.9%
8	BARREN LAND	745.17	1.9%
	TOTAL	**39,130.59**	**100.0%**
Source: NJDEP, April 17, 2009			

8.1.2 Rare Plant Species

What are current threats?

New Jersey has great floral diversity for a small, densely populated state and is home to more than 2,100 native plant species (NJDEP Division of Science and Research, 2006). However, at least a third of the state's native plants (794 vascular plants) are currently listed as extirpated, historical, endangered or species of concern (NJDEP ONLM, 2016). NJDEP's 2006 report on the status of rare plants identified 37 causes of extirpation, the most common of which were identified as development, urbanization, succession, transportation, dams, bulkheads or fill, mines, and agriculture.

The report also examined threats to extant populations of endangered plants. The most common anthropogenic threats were road construction and maintenance, habitat disturbance, development, pollution, and recreation. Additional human activities listed as threats included agriculture, dams, dredging, land clearing, mining, railroads, rights-of-way, and overcollection. Native plants are also threatened by herbivory, invasive species, competition, and succession (NJDEP, 2006).

Inventory

The Endangered Plant Species List Act (N.J.S.A. 13:1B-15.151) was enacted in 1989, defining endangered plants as "any native plant species whose survival in the State or the nation is in jeopardy... and any species having five or fewer extant populations within the State." The Division of Parks and Forestry has the responsibility of creating the list of NJ endangered plant species (N.J.A.C. 7:5C–1.1). While the rule does not provide any protection for officially listed species, several regulatory agencies within NJDEP responsible for protecting plant habitat have incorporated the Endangered Plant Species List into their criteria for review of permits (NJDEP Division of Parks and Forestry, January 4, 2007). The Department of Environmental Protection, through its Natural Heritage Database, is responsible for monitoring the status of many additional plant species that are not included on the official Endangered Plant Species List. The List of Endangered Plant Species and Plant Species of Concern includes all plant species that are considered to be of conservation concern in the state.

Table 8.3 presents the definitions used by NJDEP in describing the status of rare plants. In order to better document the status or change in status of species, the New Jersey Natural Heritage Program solicits information from the general public concerning sightings of rare plant species. People should use the appropriate reporting forms (see **Internet Resources** and **Appendix D.1)**.

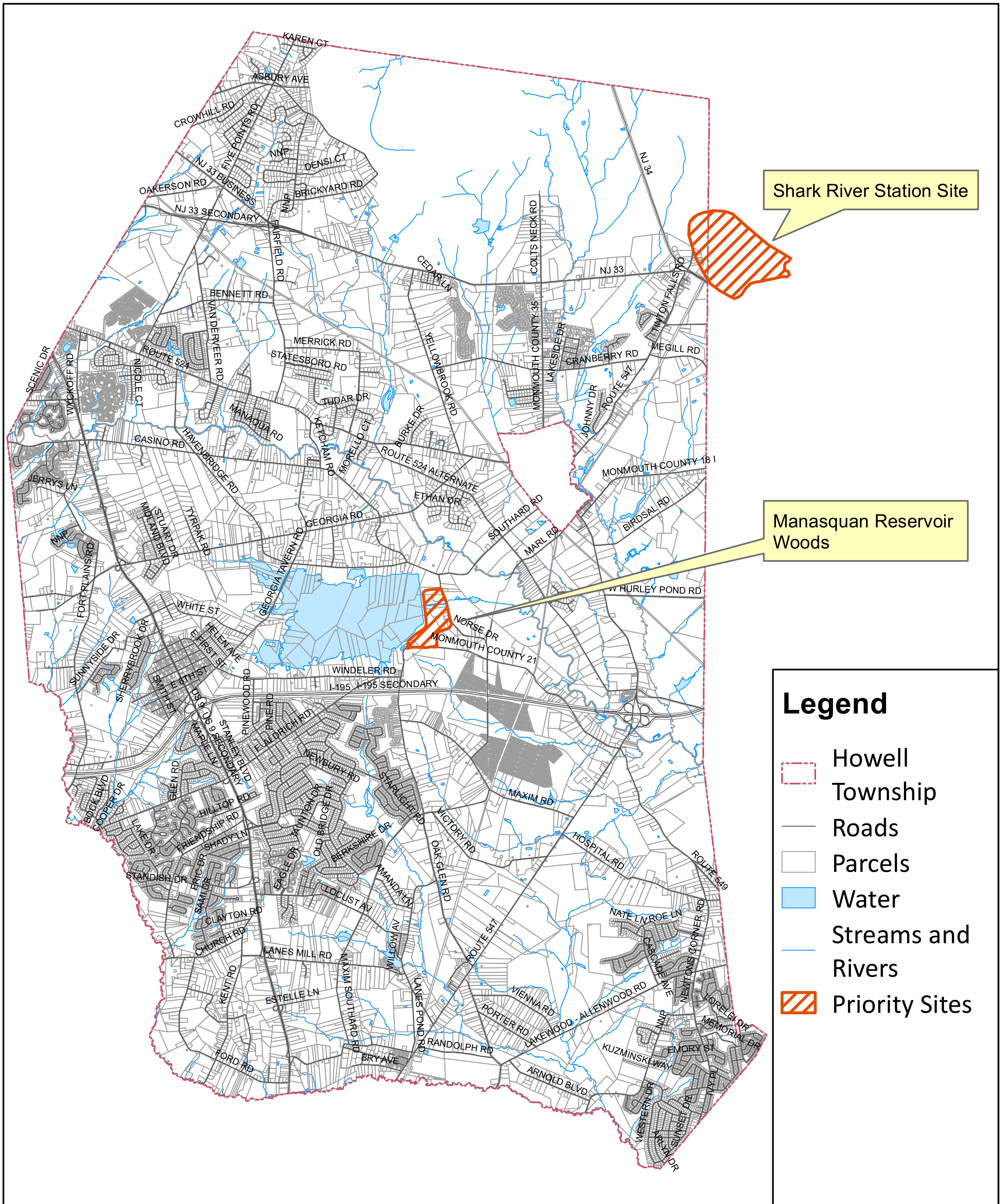

Figure 8.3. Howell Township, Natural Heritage Priority Site

Generalized Locations of Rare Plant Species and ecological communities.

0 0.5 1 2 Miles

Data Sources: NJDEP, NJDOT

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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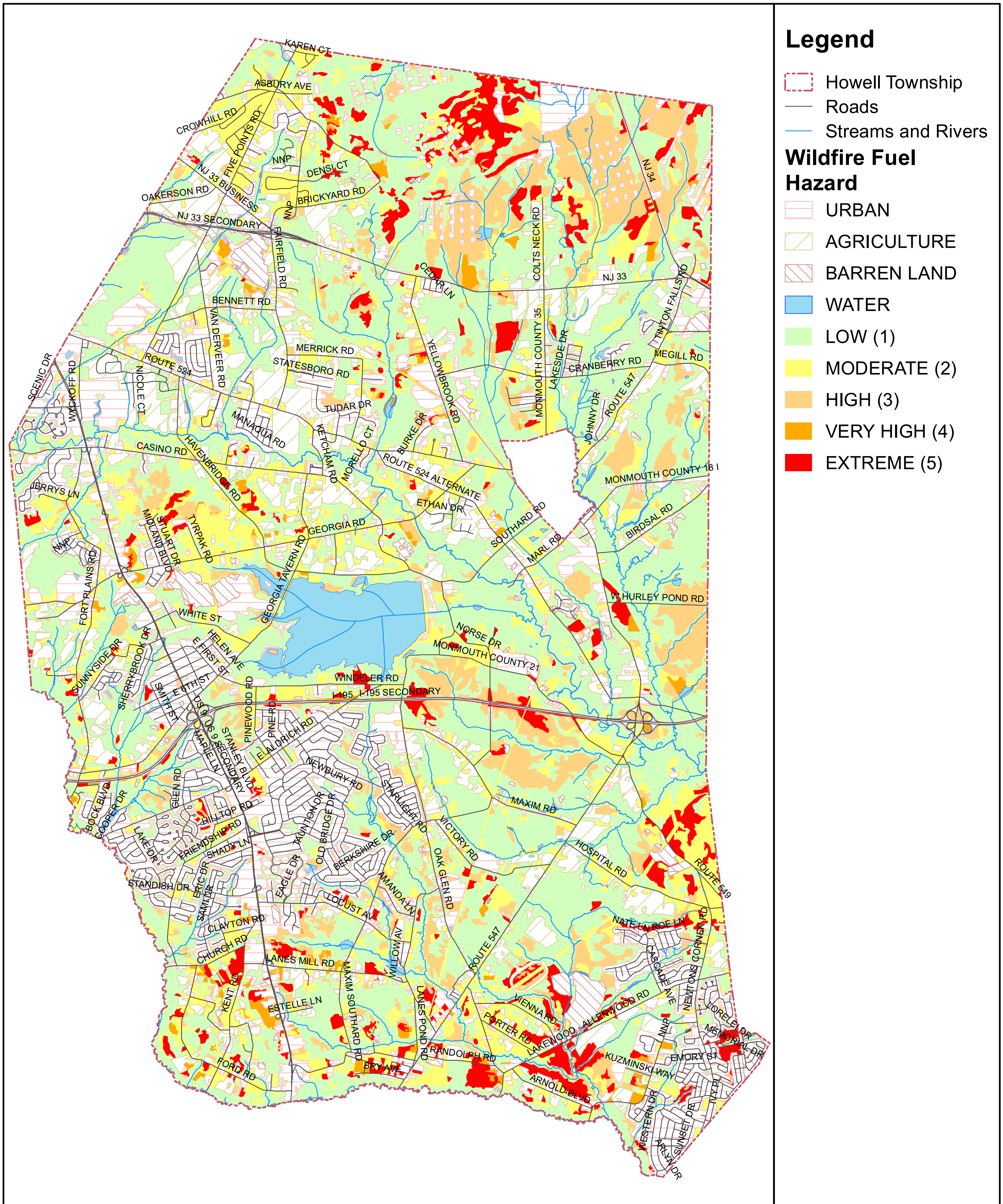

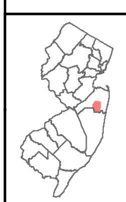

Figure 8.4. Howell Township, Wildfire Fuel Hazard

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Table 8.3. Definitions of Special Plant Species Status

STATE STATUS	STATE STATUS DEFINITION
E	Native New Jersey plant species whose survival in the State or nation is in jeopardy.
REGIONAL STATUS CODES FOR PLANTS AND ECOLOGICAL COMMUNITIES	
LP	Taxa listed by the Pinelands Commission as endangered or threatened within their legal jurisdiction. Not all species currently tracked by the Pinelands Commission are tracked by the Natural Heritage Program. A complete list of endangered and threatened Pineland species is included in the New Jersey Pinelands Comprehensive Management Plan.
HL	Taxa or ecological communities protected by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area.
ELEMENT RANKS	The Nature Conservancy developed a ranking system for use in identifying elements (rare species and ecological communities) of natural diversity most endangered with extinction. Each element is ranked according to its global, national, and state (or subnational in other countries) rarity. These ranks are used to prioritize conservation work so that the most endangered elements receive attention first. Definitions for element ranks are after The Nature Conservancy (1982: Chapter 4, 4.1-1 through 4.4.1.3-3).
GLOBAL RANK	GLOBAL ELEMENT RANK DEFINITION
G1	Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2	Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3	Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.
G4	Apparently secure globally; although it may be quite rare in parts of its range, especially at the periphery.
G5	Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery.
GH	Of historical occurrence throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.
G?	Species has not yet been ranked.
STATE RANK	STATE ELEMENT RANK DEFINITION
S1	Critically imperiled in New Jersey because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.
S2	Imperiled in New Jersey because of rarity (6 to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additional occurrences.

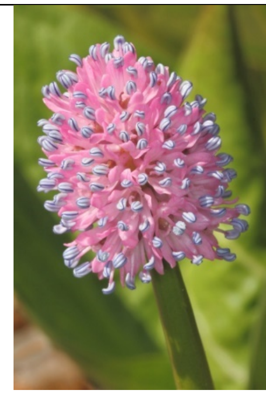
STATE STATUS	STATE STATUS DEFINITION
S3	Rare in state with 21 to 100 occurrences (plant species and ecological communities in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abundant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.
SH	Elements of historical occurrence in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed, and unsearched potential habitat remains, historically ranked taxa are considered possibly extant, and remain a conservation priority for continued field work with the expectation they may be rediscovered.
SX	Elements that have been determined or are presumed to be extirpated from New Jersey. All historical occurrences have been searched and a reasonable search of potential habitat has been completed. Extirpated taxa are not a current conservation priority.
SU	Elements believed to be in peril but the degree of rarity uncertain. Also included are rare taxa of uncertain taxonomical standing. More information is needed to resolve rank.
T	Element ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species. For example, Stachys palustris var. homotricha is ranked "G5T? SH" meaning the full species is globally secure but the global rarity of the var. homotricha has not been determined; in New Jersey the variety is ranked historic.
Q	Elements containing a "Q" in the global portion of its rank indicates that the taxon is of questionable, or uncertain taxonomical standing, e.g., some authors regard it as a full species, while others treat it at the subspecific level.
.1	Elements only ever documented from a single location.
Source: NJDEP Division of Parks and Forestry, March 22, 2010	

Information on the rare plants and natural communities throughout the state is tracked in the *New Jersey Natural Heritage Database* by the NJDEP Office of Natural Lands Management (ONLM). A search of the Natural Heritage Database in August 2019 revealed a number of records for special concern plants in Howell Township or its immediate vicinity (NJDEP ONLM, August 2019). Nine rare plants species were listed for the township (**Table 8.4**) and an additional eight species were listed for the immediate vicinity of the township (**Table 8.5**).

Table 8.4. Rare Plants Known from Howell Township

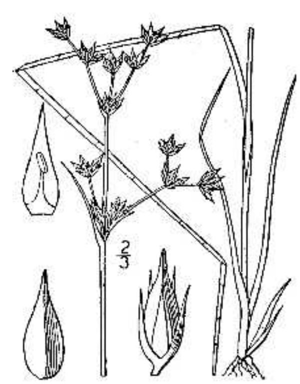
Scientific Name	Common Name	Federal Status	NJ Protection
Diodia virginiana var. virginiana	Larger Buttonweed	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5T5	S3	8/20/2013
Madder family (Rubiaceae)			
Description: plant 2-8 dm high, leaves opposite, entire and narrow, flowers white or pink with 4 petals and 2 sepals			
Habitat: moist, open, low ground of watersides and ditches			
Description from Gleason & Cronquist (1991). Image credit: of Mohlenbrock (1989) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
*Helonias bullata**	Swamp pink	LT	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G3	S3	5/4/2006
Lily family (Liliaceae)			
Description: leaves basal and entire, inflorescence on a tall stalk with six-parted pink flowers			
Habitat: swamps and bogs			
Description from Gleason & Cronquist (1991). Image credit: of Jill S. Dodds.			



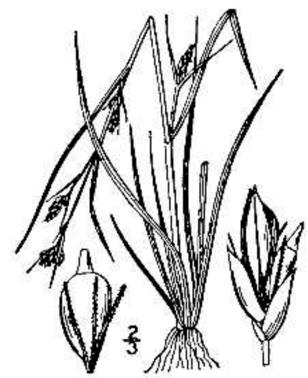
Scientific Name	Common Name	Federal Status	NJ Protection
Juncus articulatus	Jointed rush	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G5	S2	7/17/2013
Rush family (Juncaceae)			
Description: leaves hollow with solid nodes, branching inflorescence of small brown flowers, seeds tiny			
Habitat: bogs, wet meadows and shores			
Description from Gleason & Cronquist (1991). Image credit: of Mohlenbrock (1992) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
*Juncus caesariensis**	New Jersey rush	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G2G3	S2	7/20/1988
Rush family (Juncaceae)			
Description: leaves hollow with solid nodes, rough, branching inflorescence of small brown flowers, seeds narrow			
Habitat: sphagnum bogs in the pine barrens			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			

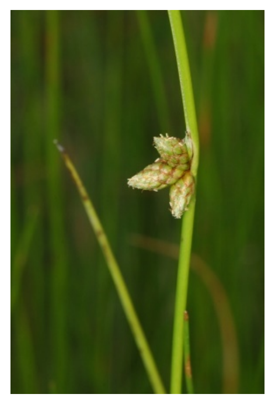


Scientific Name	Common Name	Federal Status	NJ Protection
Plantago pusilla	Dwarf plantain	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5	S1	5/28/2014
Plantain family (Plantaginaceae)			
Description: leaves basal and linear, flowers mall and greenish in a bracted spike			
Habitat: dry, sandy open ground of woods edges, fields, dunes			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			

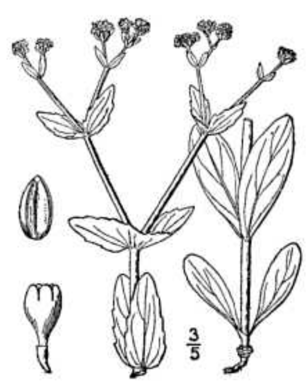
Scientific Name	Common Name	Federal Status	NJ Protection
Rhynchospora knierskernii	Knieskern's beaked-rush	LT	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G2	S2	9/25/1994
Sedge family (Cyperaceae)			
Description: leaves narrow and stems slender, spikelets along stem with leafy bracts beneath			
Habitat: ruderal habitats in pine barren bogs			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			



Scientific Name	Common Name	Federal Status	NJ Protection
Schoenoplectus smithii	Smith's club-rush	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G5?	S2	9/13/2013
Sedge family (Cyperaceae)			
Description: leaves +/- round in cross-section, small cluster of spikelets appears to be lateral on the stem			
Habitat: wet shores in intertidal zones and along inland lakes			
Description from Gleason & Cronquist (1991). Image credit: of Jill S. Dodds.			



Scientific Name	Common Name	Federal Status	NJ Protection
Valerianella radiata	Beaked cornsalad	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5	S1	4/1/2012
Valerian family (Valerianaceae)			
Description: Leaves opposite and toothed, tiny white flowers in dense clusters at ends of branches			
Habitat: moist streamsides, fields, meadows, woods and edges			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			



Scientific Name	Common Name	Federal Status	NJ Protection
*Viola brittoniana var. brittoniana**	Britton's coast violet	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G4G5T4T5	S3	6/24/2012
Violet family (Violaceae)			
Description: leaves basal and divided or deeply lobed, flowers rich violet with a conspicuous white throat			
Habitat: low, wet or moist, sandy or peaty ground in woods edges & meadows			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			
* Two records listed for species.			

Three of the rare plant species listed for Howell Township were documented at multiple sites, including *Helonias bullata*, *Juncus caesariensis* and *Viola brittoniana*. *Helonias bullata* was also repeated as a species known from the immediate vicinity of the township. While most of the plants described in **Table 8.4** have been observed within the past few decades, the majority of observations in **Table 8.5** are from roughly a century ago.

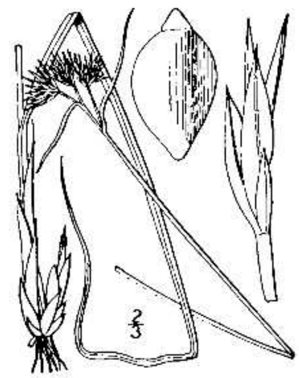
Table 8.5. Rare Plants Known from the Immediate Vicinity of Howell Township

Scientific Name	Common Name	Federal Status	NJ Protection
Carex polymorpha	Variable sedge	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G3	S1	5/21/1922
Sedge family (Cyperaceae)			
Description: densely colonial with stout stems and firm leaves, 1 or 2 pistillate spikes with a staminate terminal spike on a long peduncle			
Habitat: dry open woods, mostly in acid soils			
Description from Gleason & Cronquist (1991). Image credit: of Mohlenbrock (1995) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
Polygala mariana	Maryland milkwort	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5	S2	7/6/1910
Milkwort family (Polygalaceae)			
Description: leaves alternate and narrow, pink or rose flowers in dense spikes at tips of branches			
Habitat: dry, usually sandy ground but sometimes in clay or peat			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
Pyrola chlorantha	Greenish-flower wintergreen	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5	S1	7/6/1910
Wintergreen family (Pyrolaceae)			
Description: leaves basal and round with long petioles, flowers with five white petals veined with green			
Habitat: dry woods			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
Rhynchospora pallida	Pale beaked-rush	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G3	S3	7/6/1910
Sedge family (Cyperaceae)			
Description: leaves narrow and stems slender, spikelets terminal with two unequal bracts			
Habitat: acid bogs along the coast			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			

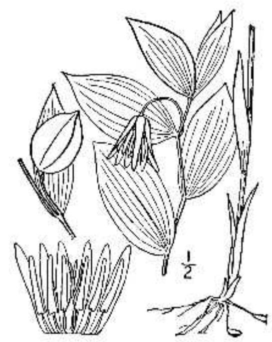


Scientific Name	Common Name	Federal Status	NJ Protection
Sphagnum fuscum	sphagnum	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G5	S2	Nov 1988
Sphagnum family (Sphagnaceae)			
Description: a greenish-brown sphagnum moss that forms large, compact dry hummocks in acid bogs			
Habitat: elevated bogs			
Description from McQueen (1990). Image credit: of Sten Porse (2006) via Creative Commons (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
Sphenopholis pensylvanica	Swamp oats	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G4	S2	May 1910
Grass family (Poaceae)			
Description: stems smooth but leaves a little rough, branches drooping, spikelets long with bent awns			
Habitat: swamps and wet woods			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
Stachys tenuifolia	Smooth hedge nettle	-	-
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G5	S3	7/4/1910
Mint family (Lamiaceae)			
Description: leaves opposite and toothed, flowers irregular and pale in whorls above the upper stem leaves			
Habitat: rich, moist ground of swamps, meadows, low woods			
Description from Gleason & Cronquist (1991). Image credit: of Mohlenbrock (1989) via USDA (2019).			

Scientific Name	Common Name	Federal Status	NJ Protection
Uvularia puberula var. nitida	Pine Barren bellwort	-	E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5T3	S2	5/15/1952
Lily family (Liliaceae)			
Description: leaves alternate, entire and somewhat shining; stem forked, flowers yellowish and bell-like			
Habitat: woods on the coastal plain			
Description from Gleason & Cronquist (1991). Image credit: of Britton and Brown (1913) via USDA (2019).			
Source of species presence: NJDEP ONLM, August 27, 2019			



Appendix D.2 provides a list of additional rare plant species known from Monmouth County. Rare plants that have been documented at other locations in the county could be present in Howell Township if suitable habitat is present within the township.

Mapping (Natural Heritage Grid and Priority Sites)

The NJDEP Office of Natural Lands Management (ONLM) has developed the Natural Heritage Grid Map (see **Figure 8.5**[18]), which provides a general representation of the locations of rare plant species and natural communities, including both historically and recently documented habitat. The purpose of the Grid Map is to document rare plant species and natural community habitats to inform decision-makers who need to address the conservation of natural resources. The map identifies potentially sensitive areas and indicates where custom database searches are needed for land use decision-making.

Forty-seven quadrangles on the grid map are located either fully or partially within Howell Township. Eight of those quadrangles mark the precisely known location of a rare plant species, and the remaining 39 indicate that a rare plant species has been documented within 1.5 miles of the site. Rare plant information provided in this manner is summarized in **Table 8.6**. The Grid Map does not include habitat for animal species, and not all areas have been surveyed (NJDEP ONLM, November 2009).

[18] The Natural Heritage Database search results (2019) differed from the most recent GIS data (2009) for the Natural Heritage Grid, therefore the search information is more recent).

Table 8.6. Rare Plants Identified on the Natural Heritage Grid Map

Name		# of Quads	Federal Status	NJ Listed	Regional Status	Global Rank	State Rank	Habitat*
Aster radula	Low Rough Aster	4		E	LP, HL	G5	S1	P
Cacalia atriplicifolia	Pale Indian Plantain	1		E	LP, HL	G4G5	S1	P/T
Data Sensitive Species or Ecological Community		2			LP, HL	G4	S2	P
Data Sensitive Species or Ecological Community		9		E	LP, HL	G5	S1	T
Data Sensitive Species or Ecological Community		3		E	LP, HL	G3	S1	T
Eriocaulon parkeri	Parker's Pipewort	2			HL	G3	S2	P
Helonias bullata[1]	Swamp-pink	13	LT	E	LP, HL	G3	S3	P
Juncus caesariensis[1]	New Jersey Rush	1		E	LP, HL	G2	S2	P
Juncus greenei	Greene's Rush	3			HL	G5	S2	T
Sisyrinchium fuscatum	Sand-plain Blue-eyed Grass	3			HL	G5?	S2	T
Sphenopholis pensylvanica[2]	Swamp Oats	4			HL	G4	S2	P
Uvularia puberula var. nitida[2]	Pine Barren Bellwort	2		E	LP, HL	G5T3?	S2	P

* P= Palustrine, T=Terrestrial

[1] Included in **Table 8.4** (known from township), and [2] Included in **Table 8.5** (known from vicinity)

8.1.3 Invasive and Non-native Vegetation

Invasive Plants in New Jersey

Non-native species (also called alien, exotic or introduced species) are those species that have been introduced outside their natural geographic range as a result of human actions, whether intentionally (e.g. as sources of food, for landscaping purposes or the release of unwanted pets) or unintentionally (e.g. in the ballast of a ship or in a load of lumber). Executive Order 13112 defines an *invasive species* as a species that is non-native to the ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (USDA, February 3, 1999). The most problematic of these displace native species, contribute to local elimination of species or even extinctions, alter the community structure, and may eventually disrupt ecosystem processes (Snyder and Kaufman, 2004). Preliminary research in NJ has documented over 1,200 species of nonindigenous plant species, or as much as 62% of the state's total vascular flora (Snyder and Kaufman, 2004).

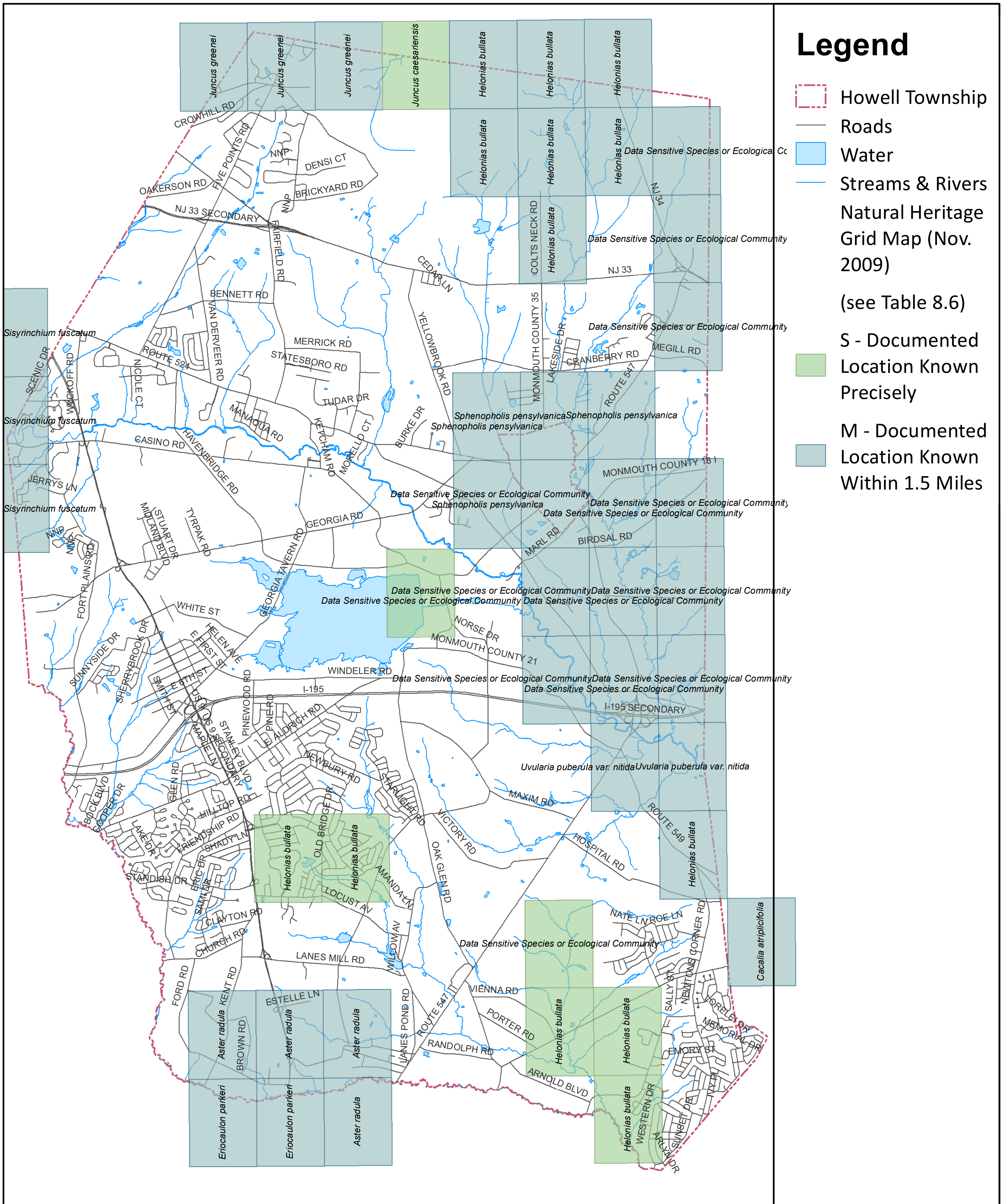


Figure 8.5. Howell Township, Natural Heritage Grid

Generalized Locations of Rare Plant Species and ecological communities.

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Native plants can be susceptible to introduced diseases, which they have not evolved resistance to. The chestnut blight fungus was an accidental introduction that destroyed all mature American chestnut (*Castanea dentata*) trees, once one of the dominant trees in the New Jersey landscape. Another introduced fungus, Dutch elm disease, destroyed the American elm (*Ulmus americana*). In addition, native plants may have little resistance to certain introduced insects, and/or these insects may have no natural enemies in their new surroundings, allowing them to rapidly reach pest proportions. Introduced insects which may be impacting Howell Township's trees include the southern pine beetle, the gypsy moth, and the emerald ash borer (NJ Forest Service, 2019). The pests weaken their host trees, which often succumb to successive years of infestation, to diseases carried by the insects, or other environmental stresses.

For these reasons, the Final Report of the New Jersey Comparative Risk Project, which evaluated the relative risks of environmental problems to the people and ecosystems of New Jersey identified invasive species (including plants, insects, and other organisms) as one of the state's top environmental problems (Steering Committee of the New Jersey Comparative Risk Project, 2003).

While there is no official invasive species list for New Jersey, An Overview of Nonindigenous Plant Species in New Jersey (Snyder and Kaufman, 2004) profiled 27 nonindigenous plant species that aggressively invade natural plant communities in New Jersey. Subsequently, a statewide management plan for invasive species was developed, ranking non-native plants according to their abundance and level of threat to natural communities (VanClef, 2009). The 29 species in the highest-ranking category are summarized in **Table 8.7**.

Common reed (*Phragmites australis ssp. australis*) at Echo Lake.
Photo credit: J. Dodds

Common reed (*Phragmites australis ssp. australis*) has sometimes been excluded from invasive species lists due to its strong resemblance to a native subspecies (*Phragmites australis ssp. americanus*). The two subspecies have recently been found to be morphologically distinguishable (Sarver et al., 2008). While the invasive subspecies is widely established throughout New Jersey, the native subspecies is only known from Atlantic County (Kartesz, 2013). Because the large grass forms large, monotypic stands that completely exclude other wetland vegetation it is considered highly threatening to native communities.

The Invasive Species Strike Team focuses on preventing the spread of newer invasive species throughout the state (FoHVOS, 2018). The strike team page offers links to fact sheets which provide information regarding identification, threat levels and control measures for each species tracked in their system. Although their focus is on eradicating newly introduced species before they can establish and spread, fact sheets are also available for many of the widespread invasives.

Table 8.7. New Jersey's Most Invasive Non-native Plants[19]

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Acer platanoides	Norway maple	Dispersed seeds easily sprout in shade, crowding out native plants. Canopy produces deep shade and roots produce a toxic substance preventing growth of wildflowers and other trees under its canopy.		Jan Samanek, State Phytosanitary Admin., Bugwood.org
Ailanthus altissima	tree of heaven	Aggressive in disturbed areas, crowding out native plants.		Jill S. Dodds
Alliaria petiolata	**garlic mustard**	**Aggressive in shady habitats, crowding out native plants.**		Deborah J. Kratzer
Ampelopsis glandulosa var. brevipedunculata	porcelain berry	Forms thick mats, blanketing the ground and trees and shrubs on forest edges		Michael Davenport
Berberis thunbergii	Japanese barberry	Can grow so thick in the understory of open forests that it shades out indigenous understory plants. Affects soil properties, particularly pH, which can affect plant establishment. Can form nearly impenetrable thorny thickets that impact the recreational value of natural lands.		Deborah J. Kratzer

[19] Species in bold in Table 8.7 are regulated under Township of Howell Ordinance §180-1 et seq.

Table 8.7. New Jersey's Most Invasive Non-native Plants[19]

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Carex kobomugi	Japanese sedge	Forms dense mats and crowds out native species on beaches and dunes		Leslie R. Mehrhoff, University of Connecticut, Bugwood.org
Celastrus orbiculatus	oriental bittersweet	The vine twines around surrounding plants, impeding sap flow. Also makes host plants too heavy, increasing wind, snow & ice damage.		Deborah J. Kratzer
Centaurea biebersteinii (C. stoebe, C. maculata)	spotted knapweed	Forms dense stands that replace native plants and alter community structure. Also produces leachate that inhibits the germination of grasses and conifer seeds.		Rob Routledge, Sault College, Bugwood.org
Cirsium arvense	**Canada thistle**	**Competes with crops and degrades pastures (inedible to livestock).**		Deborah J. Kratzer
Clematis terniflora	Japanese clematis	Spreads prolifically, invading forest edges, right-of-ways and urban green space		Richard Webb, Bugwood.org
Dipsacus fullonum	wild teasel	Highway mowing equipment and discarded dried teasel heads from flower arrangements can lead to the establishment of new colonies, often forming a monoculture that displaces native communities.		Steve Dewey, Utah State University, Bugwood.org

Table 8.7. New Jersey's Most Invasive Non-native Plants[19]

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Elaeagnus umbellata	**autumn olive**	**Sprouts vigorously in disturbed areas, produces shade, preventing sprouting of native trees.**		Deborah J. Kratzer
Eragrostis curvula	weeping lovegrass	Establishes in disturbed areas and then persists, replacing native species		Forest and Kim Starr, Starr Environmental, Bugwood.org
Euonymus alatus	burning bush	Grows well in many sites, especially upland forests and pastures, crowding out native plants.		James H. Miller, USDA Forest Service, Bugwood.org
Hedera helix	English ivy	Grows vigorously in deep shade, inhibiting growth of native woodland plants. Vines up tree trunks, adding to weight, and increasing likelihood of wind damage.		Deborah J. Kratzer
Lespedeza cuneata	sericea lespedeza	Forms dense stands in meadows, open woodlands and wetland borders, disrupting successional patterns and replacing native species		Chris Evans, University of Illinois, Bugwood.org
Lonicera japonica	Japanese honey-suckle	Spreads aggressively in disturbed habitats, crowding out native plants. Aggressive roots can decrease the growth of native trees and vines. Vines engulf small trees and shrubs, causing them to collapse. Leafs out very early in spring, which could inhibit flowering by spring ephemerals.		Deborah J. Kratzer

Table 8.7. New Jersey's Most Invasive Non-native Plants[19]

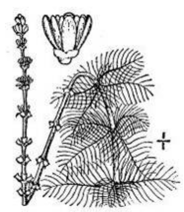
Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Lonicera morrowii	Morrow honeysuckle	Forms a dense shrub layer that deprives native understory plants of light, moisture and nutrients.		Stacy Leicht, University of Connecticut, Bugwood.org
Lythrum salicaria	**purple loosestrife**	**Spreads aggressively in wetlands, eliminating open water habitats and crowding out native plants. Contributes to the loss of wildlife that depend on native wetland plants.**		John D. Byrd, Mississippi State University, Bugwood.org
Microstegium vimenium	**Japanese stiltgrass**	**Spreads aggressively in disturbed, moist, shady areas, crowding out native plants. May raise pH and reduce organic soil horizon.**		Deborah J. Kratzer
***Myriophyllum spicatum* L.**	**Eurasian water-milfoil**	**An aquatic plant that begins growing earlier in spring than most indigenous aquatic plants, it quickly overtops, outshades, and outcompetes surrounding vegetation.**		Britton and Brown, 1913, Vol. 2: 614.
Polygonum cuspidatum (Fallopia japonica)	**Japanese knotweed**	**Spreads aggressively in disturbed, sunny areas, especially river banks and wetlands, crowding out native plants.**		Tom Heutte, USDA Forest Service, Bugwood.org
Polygonum perfoliatum	**mile-a-minute vine**	**Grows very rapidly, blanketing the landscape and overtaking native vegetation, smothering seedlings and outcompeting mature plants.**		Jill S. Dodds

Table 8.7. New Jersey's Most Invasive Non-native Plants[19]

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Potamogeton crispus L.	curly leaf pondweed	An aquatic plant that begins growing earlier in spring than most indigenous aquatic plants, it quickly overtops, outshades, and outcompetes surrounding vegetation. Can form dense mats that disrupt boating, swimming, and fishing.		Mohlenbrock, 1995
Ranunculus ficaria (Ficaria verna)	lesser celandine	Forms extensive monocultures in floodplains and other moist areas early in the season, threatening native spring ephemerals.		Jill S. Dodds
Robinia pseudoacacia	black locust	Forms dense stands in open habitats, altering sucessional processes and replacing native species. May also alter natural soil chemistry.		Jan Samanek, Phytosanitary Admin., Bugwood.org
Rosa multiflora	multiflora rose	Spreads everywhere, except standing water, crowding out native plants and degrading pastures.		James H. Miller, USDA Forest Service, Bugwood.org
Rubus phoenicolasius	wineberry	Forms an extensive, nearly impenetrable understory layer in favorable locations such as moist soils in forests over dolomite, marble, shale, diabase, and traprock, crowding out native plants.		Jil M. Swearingen, USDI National Park Service, Bugwood.org

Table 8.7. New Jersey's Most Invasive Non-native Plants[19]

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Wisteria floribunda	Japanese wisteria	Aggressive climbing vines that girdle tree trunks and branches. Dense canopies weigh down branches and shade underlying areas.		Ted Bodner at USDA-NRCS PLANTS Database

Sources: Van Clef, 2009; Snyder & Kaufman, 2004; Center for Invasive Species and Ecosystem Health (Invasive.org), 2020; Courtney, 1997; Britton & Brown, 1913; Mohlenbrock, 1995; Bodner at USDA-NRCS PLANTS Database

Photo sources: Ted Bodner at USDA-NRCS PLANTS Database; Britton and Brown, 1913, Vol. 2: 614; John D. Byrd, Mississippi State University, Bugwood.org; Steve Dewey, Utah State University, Bugwood.org; Jill S. Dodds; Chris Evans, University of Illinois, Bugwood.org; Deborah J. Kratzer; Michael Davenport; Tom Heutte, USDA Forest Service, Bugwood.org; Stacy Leicht, University of Connecticut, Bugwood.org; Leslie R. Mehrhoff, University of Connecticut, Bugwood.org; James H. Miller, USDA Forest Service, Bugwood.org; Mohlenbrock , 1995; Rob Routledge, Sault College, Bugwood.org; Jan Samanek, Phytosanitary Admin., Bugwood.org; Forest and Kim Starr, Starr Environmental, Bugwood.org; Jil M. Swearingen, USDI National Park Service, Bugwood.org; Richard Webb, Bugwood.org.

Linden viburnum does not appear in **Table 8.7** because it was not ranked in the top category on the 2009 list of New Jersey's invasive plants. The shrub forms dense thickets that shade out native herbs and woody seedlings, and young plants may blanket the forest floor (Center for Invasive Species and Ecosystem Health, 2020).

Invasive Plants in Howell

Six of the invasive plant species on the Strike Team's Monmouth county list were specifically mapped in Howell Township (FoHVOS, 2018). Japanese stiltgrass (*Microstegium vimineum*), purple loosestrife (*Lythrum salicaria*), and mile-a-minute-vine (*Persicaria perfoliata*) are included on the state list of established invasives in **Table 8.7**. The stiltgrass was documented at Allaire State Park, the loosestrife was found in a Queen Anne Boulevard runoff pond and the mile-a-minute-vine was reported from Bear Swamp; although these species are undoubtedly found in other locations, as well. The other three species are more recent invaders (see **Table 8.8**). Two aquatic species, Carolina fanwort (*Cabomba caroliniana*) and hydrilla (*Hydrilla verticillata*) were noted in the Manasquan Reservoir. Kudzu (*Pueraria montana var. lobata*) was reported at Manasquan Reservoir County Park. All six species are considered highly threatening to native communities.

Another non-native plant that is a known problem in Howell Township is bamboo. Many kinds of bamboo are planted as ornamentals, including various species of *Bambusa*, *Phyllostachys*, *Pseudosasa* and *Sasa*. Once established, bamboo forms a dense, monospecific stand that replaces native plant species and may expand or escape into other habitats. Examples may be seen along sections of the Manasquan River as it traverses the township.

Municipal regulations regarding invasive plants

Howell Township recently expanded Chapter 180 §180-1 et seq. of the Howell Township Municipal Code regarding invasive plant species. This ordinance requires an owner to remove invasive plant species at their cost if they encroach onto a neighboring property. Property owners are "strongly discouraged from planting any invasive plants whatsoever," and are "required to confine, at their cost, such species to prevent the encroachment, spread, invasion or intrusion of same onto any other private or public property or public right-of-way. Failure to control the spread of an invasive plant beyond the boundaries of the property is a violation of this chapter." (Township of Howell, 2020). The 2014 ordinance had applied only to bamboo, but has been expanded to cover the following species:

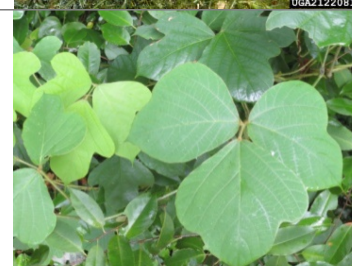
Canadian thistle (*Cirsium arvense*)
Eurasian watermilfoil (*Lonicera japonica*)
garlic mustard (*Alliaria petiolata*)
Japanese knotweed (*Polygonum caspidatum*)
Japanese stiltgrass (*Microstegium vimineum*)
mile-a-minute (*Polygonum perfoliatum*)
purple loosestrife (*Lythrum salicaria*)
Russian olive (*Elaeagnus angustifolia*)
water chestnut (*Trapa natans*)

bamboo (both "running" or "clumping" types), including:
- *Arundinaria*
- *Bambusa*
- *Chimonobambusa*
- *Dendrocalamus*
- *Fargesia*
- *Phyllosta*
- *Pleioblastus*
- *Pseudosasa*
- *Sasa*
- *Sasaella*
- *Semiarundinaria*

Linden viburnum is among the most frequently reported invasive species in Monmouth County Photo credit: Doug Manning, Invasive.org.

Invasive plants along the Manasquan River Greenway include Japanese knotweed and bamboo. Photo credit: J. Dodds. September 9, 2019.

Table 8.8. Additional Recent Invasives Reported in Howell Township

Scientific Name	Common Name	Problems caused	Illustration	Source
Cabomba carolinana	Carolina fanwort	forms extremely dense stands which can clog drainage systems and interfere with recreational activities		Jill S. Dodds (photo from Echo Lake)
Hydrilla verticillata	Hydrilla	forms dense mats at the surface of the water that restrict native vegetation, recreation, and water flow		Chris Evans, University of Illinois, Bugwood.org
Pueraria montana var. lobata	Kudzu	often grows over, shades out and kills all other vegetation, including trees		Jill S. Dodds
Trapa natans	**water chestnut**	Dense mats of floating plants displace native species and limit boating, fishing, and swimming		Jill S. Dodds
Source: Center for Invasive Species and Ecosystem Health (Invasive.org), 2020.				

8.1.4 Trees and Canopy Closure

Over half of the township (53.62%) is classified as either wetland (34.42%) or forest (19.21%), and both land use types are dominated by trees (see **Section 8.1.1**). **Figure 8.6** illustrates the various forest types located within portions of the township that have been mapped as forest. In recognition of the many values of trees, the Township of Howell has taken steps to evaluate and protect this resource for the benefit of the community.

Municipal regulations regarding tree removal

The Howell Township Municipal Code includes a Tree Removal and Replacement Ordinance (Chapter 188, Sections 187-205) which regulates the indiscriminate cutting and removal of trees in order to maintain the aesthetic character of the township, control drainage and prevent erosion, and reduce air pollution. The code includes provisions for the protection of healthy trees, development of woodland management plans during the course of property development, and permit requirements for the removal of trees under different circumstances. Development plans must include an initial assessment of trees present on the property, specific efforts to preserve larger trees on the site, and replacement plantings. Information regarding definitions, prohibitions, permit requirements and procedures, fees, exceptions, penalties, and appeals is provided in the ordinance (Township of Howell, 2019).

Forestry Management Plan

Howell Township's Shade Tree Commission is responsible for the regulation, planting, and care of shade trees on public lands in the township, and also for review and comment on tree management plans prepared in conjunction with land development projects. A five-year Community Forestry Management Plan is prepared by the Commission that establishes objectives, strategies, and timelines for carrying out its mission. Goals in the current plan (2017-2021) focus on promoting a net increase in forest canopy on public and private land, continuation of training on tree-related topics for relevant township personnel, public education and outreach, and reduction of tree/sidewalk conflicts (Howell Township Shade Tree commission, 2016).

New Jersey Tree Recovery Campaign

New Jersey experienced extensive tree losses as a result of Hurricane Sandy in 2012. An assessment conducted by the state's Department of Environmental Protection determined that the superstorm had caused severe damage to various ecosystems including wetlands, riparian habitats and floodplains, forests, and open water (NJDEP Office of Science, 2015). The New Jersey Tree Recovery Campaign is a cooperative effort between the Arbor Day Foundation and the New Jersey State Forestry Service to provide trees to communities and homeowners who lost their urban canopy in the wake of the storm (Arbor Day Foundation, 2019a). Thousands of tree seedlings have been distributed to Howell residents as a result of the township's participation in the program (Howell Township Shade Tree Commission, 2016).

Tree City USA

Tree City USA is a nationwide program that provides cities and towns with a framework for healthy, sustainable urban forestry. Participating communities must have a tree board or department, a tree care ordinance, a forestry program with a budget of at least $2 per capita, and a celebration of Arbor Day. Some tangible benefits to participants include reduced energy consumption, reduced expenses for stormwater management and erosion control, and increased property values. Howell Township has been recognized as a Tree City Community for 21 years (Arbor Day Foundation, 2019b).

Specimen trees

The State of New Jersey maintains a list of record trees, but none are currently known from Howell Township. A number of champions and runners-up are listed for Monmouth County (NJ Forest Service, May 2019). Instructions for measuring and nominating trees for the list are available on the registry website.

Insect and disease threats specific to trees

A number of tree pests are established or incipient in New Jersey, as summarized in **Table 8.9**. Some, like the gypsy moth, are well-established throughout the northeast. Others are more recent invaders that are rapidly spreading throughout the state. The southern pine beetle had expanded its northern limits to south Jersey by 2010, but it was detected in eastern Long Island (NY) in 2014 and was well established there within two years (NYDEC, 2016). The emerald ash borer was initially found in New Jersey in 2014 and is rapidly spreading throughout the state and has been documented in the western portion of Monmouth County (NJ Department of Agriculture, 2019). Similarly, the spotted lanternfly was an accidental introduction to Berks County, Pennsylvania in 2014 and proliferated rapidly, crossing into New Jersey in 2018 (Rutgers, 2019). Although some of the pests included in the table are currently limited in scope, they may potentially become more problematic under the right circumstances. The NJ Forest Service (July 2019 and Undated) provides links with identification and management information for many of the tree-specific pests.

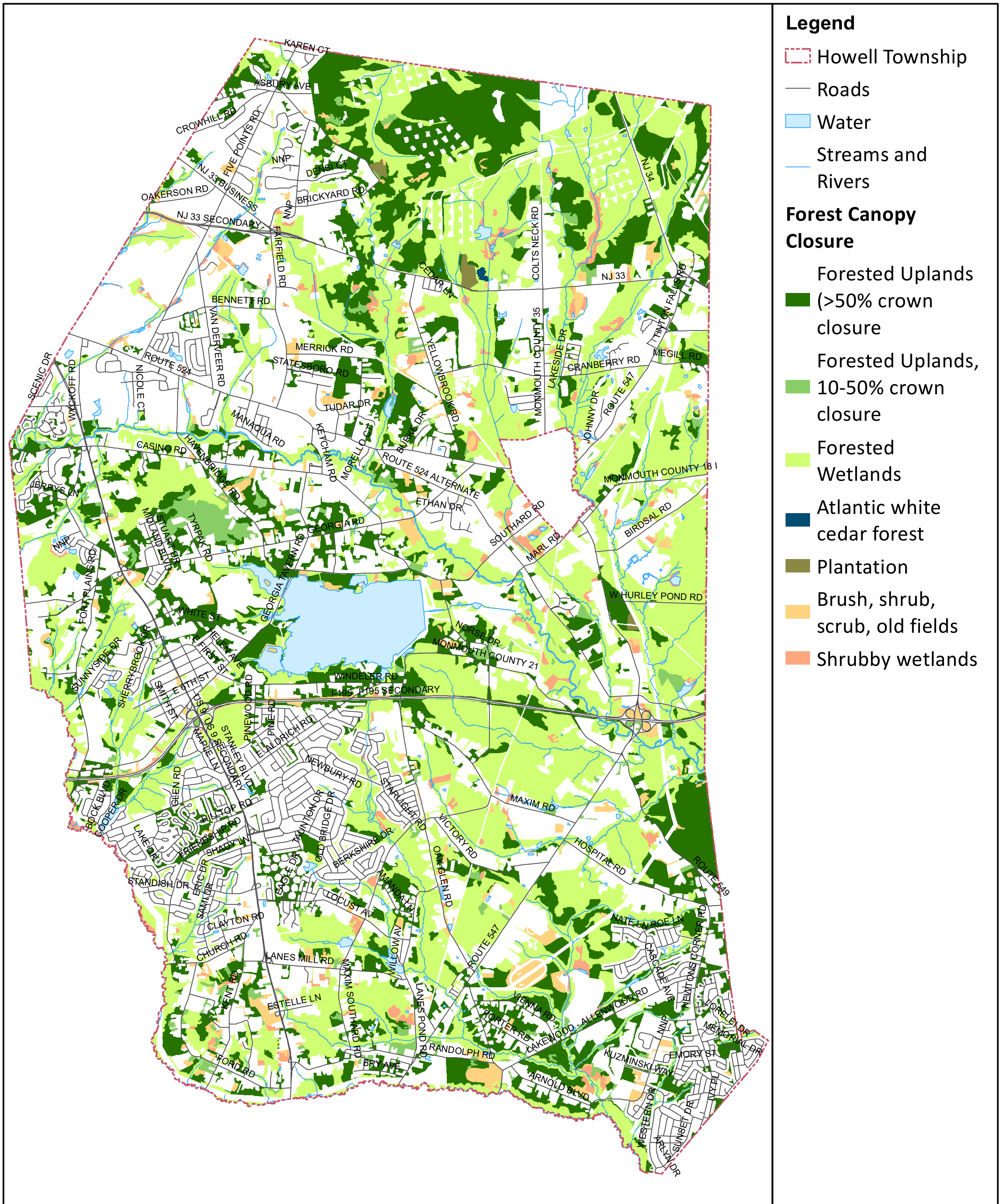


Figure 8.6. Howell Township, Forests and Canopy Closure

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Table 8.9. Insect and Disease Threats to New Jersey Trees

Pests		Susceptible species	Affected areas in NJ
Insects			
gypsy moth	*Lymantria dispar*	oaks and other deciduous species	statewide
hemlock wooly adelgid	*Adelges tsugae*	eastern hemlock	statewide
emerald ash borer	*Agrilus planipennis*	ash species	northern and central NJ
scarlet oak sawfly	*Caliroa quercuscoccineae*	oak species	northern counties
southern pine beetle	*Dendroctonus frontalis*	pine species	southern counties
Asian longhorned beetle	*Anoplophora glabripennis*	maples, willows, poplars, ash, horse chestnuts, elm, and buckeye trees	Union Co. and Middlesex Co.
eastern pine looper	*Lambdina pellucidaria*	pine species	Ocean Co. and Burlington Co.
spotted lanternfly	*Lycorma deliculata*	tree-of-heaven and other deciduous and commercial species	recently detected in western counties
gouty oak gall wasp	*Callirhytis quercuspunctata*	oak species, generally not fatal	undefined
Pathogens			
beech bark disease	*Nectria coccinea*	beeches	northern counties
bacterial leaf scorch	*Xylella fastidiosa*	oaks, sycamore, elms	southwestern counties
oak wilt	*Ceratocystis fagacearum*	oak species	yes, undefined
sudden oak death	*Phytophthora ramorum*	oaks and other deciduous species	not yet detected in NJ
thousand cankers disease	*Geosmithia sp.*	affects black walnut when the walnut twig beetle is present	not yet detected in NJ
Sources: NJ Forest Service, July 2019; NJ Forest Service, undated; and Rutgers, 2019			

Issues with overhead utility wires

Trees are the most common cause of electric utility outages. The U.S. Department of Energy requires electric companies to develop vegetation management programs, and in New Jersey, the responsibility for overseeing the implementation of those programs lies with the Board of Public Utilities (NJ Board of Public Utilities, 2019). The most recent state legislation concerning the role of utility companies in vegetation management (N.J.A.C. 14:5-9) was updated in 2014, and the newest rules are still in draft form. The rules address issues including maintenance cycles, technical standards, and public notice.

When landscaping in the vicinity of utility wires, maintenance issues may be reduced or avoided by planting appropriate species. The Arbor Day Foundation (2019c) offers guidelines for planting near powerlines in the form of a graphic as shown in **Figure 8.7**. A number of utility companies offer additional guidelines for determining tree height and distance from wires, and even offer a list of suggested species to be used (e.g. PECO 2019; PSE&G 2018). Although many of the suggested plantings are exotic species, some native plants on the list include redbud (*Cercis canadensis*), flowering dogwood (*Cornus florida*), fringe tree (*Chionanthus virginicus*), American hornbeam (*Carpinus caroliniana*), Washington hawthorne (*Crataegus phaenopyrum*), chokecherry (*Prunus virginiana*), and a variety of serviceberries (*Amelanchier spp*.).

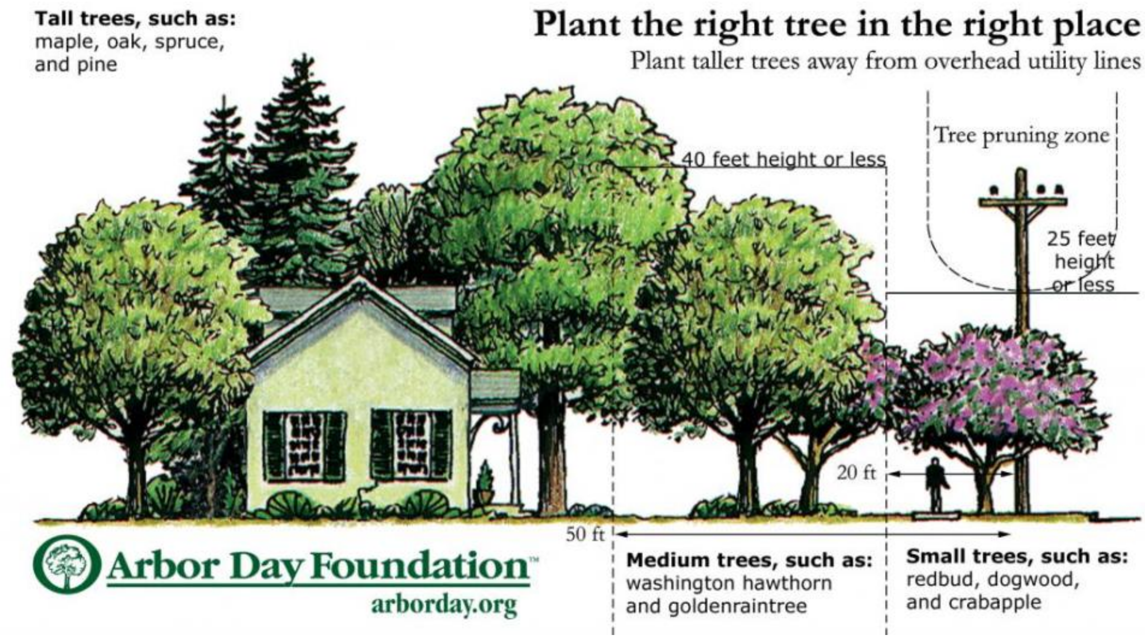

Figure 8.7 Guidelines for planting near overhead utility lines.
Image credit: of the Arbor Day Foundation (2019c).

8.1.5 Economic Value

New Jersey's natural ecosystems provide a wide array of benefits to the state's residents, including some which cannot be quantified but others which may be measured in terms of goods and services. A report on natural resource values in New Jersey assigned dollar values to the following ecosystem services (listed from highest to lowest $/year value): Nutrient cycling, disturbance regulation, water regulation, habitat/refugia, aesthetic/recreational, waste treatment, water supply, cultural/spiritual, gas/climate regulation, pollination, biological control and soil formation. By looking at the multiple values provided by various ecosystems around the state, the authors then projected a value in dollars per acre per year for each system. Estimated annual ecosystem service values for some land cover types in Howell Township are shown in **Table 8.10**. Estimates are based on statewide averages, and ecotourism was not included in the calculation of values (NJDEP, 2007).

Table 8.10. Approximate ecosystem service values for Howell Township.

Land Use Type	Total acreage in Howell Twp.	Estimated value per acre *	Projected Annual Value
Urban	13,869.83	$ 283.00	$ 3,925,161.89
Freshwater wetlands	13,474.46	$ 11,568.00	$ 155,872,553.28
Forested upland	7,519.10	$ 1,476.00	$ 11,098,191.60
Agriculture	2,838.25	$ 717.00	$ 2,035,025.25
Open water	1,016.31	$ 765.00	$ 777,477.15
Barren Land	431.01	$ -	$ -
Total:	**39,148.96**		**$ 173,708,409.17**
* Based on 2004 dollars (NJDEP, 2007)			

The estimation of ecosystem values is not an exact science, and different calculation methodologies may yield widely varying dollar amounts. Nevertheless, the example clearly shows that maintaining natural ecological zones can have significant consequences for a community, both in terms of economic benefits and quality of life.

8.2 WILDLIFE & WILDLIFE HABITAT

8.2.1 Native Wildlife Types/Species

Background

New Jersey hosts approximately 550 species of terrestrial and freshwater vertebrate wildlife (NJDEP 2004a, 2004b, 2016, April 2019). This high diversity in such a small state is partly due to New Jersey's geographic position where northern ecosystems reach their southern limit and where southern ecosystems reach their northern limit. In addition, the state provides a wide variety of habitats including mountains, valleys, rolling hills, wetlands, pinelands, beaches, estuaries, and rivers (NJDEP, January 19, 2012). The NJDEP websites offer checklists for the birds, mammals, reptiles, amphibians, and fish of New Jersey, with notes on the status of each (e.g. common or rare) (see **Internet Resources**). A variety of plant and animal species enjoy Howell Township's diverse habitat types.

Birds

To date, 391 species of birds have been documented in Monmouth County (Sullivan et al., 2009), but the list may be revised with additional sightings and surveys (see **Appendix D.3**). Fourteen percent of those species are only rare visitors to New Jersey and are not included on the NJDEP list of state birds. The Manasquan River Watershed has been designated as a New Jersey Important Bird Area as shown in **Figure 8.8**. The portion of the significant area within Howell Township extends from the Manasquan Reservoir to Allaire State Park, and includes a mix of private, state, and municipal lands that provide essential habitat for a variety of resident and migratory birds (Frank, 2010).

Endangered, threatened, and special concern birds are discussed in **Section 8.2.2,** and non-indigenous birds in **Section 8.2.3**. The Canada goose, a native species which may disproportionately affect the environment, is discussed below.

Canada Goose

The Canada goose (*Branta canadensis*) is one of New Jersey's most easily recognized birds, with its black head and neck, white check patch and undersides, brown back and large size (2'-3' tall, 10-12 lbs.). There are two distinct populations in NJ, migratory geese that visit the state in the winter and non-migratory geese, that nest in the state. New Jersey's resident population of resident Canada geese was recently estimated at 76,190 (APHIS, 2011).

Canada goose. Photo credit: J. Dodds

While many people enjoy the sight of a few geese, this high population of non-migrating geese can cause the following problems:

- overgrazing of parks, lawns, and athletic fields, causing erosion, and impacting aesthetics
- reduction in water quality caused by introduction of sediments and particulates from eroded shorelines as well as deposition of excessive nutrients in fecal matter
- degradation of natural habitats by reducing the diversity of native vegetation

- displacement of native waterfowl due to reduced availability of food, shelter, and nesting sites
- damage to agricultural lands, increasing erosion and decreasing crop yields
- accumulations of feces on land, creating a health risk from disease-causing organisms
- hazards to aircraft at airports
- aggression and attacks on humans (APHIS 2011; Rutgers 2013a).

Howell Township has recognized that large numbers of waterfowl congregating around lakes and ponds may cause a public health nuisance, and the feeding of waterfowl or other unconfined wildlife in parks or on other township properties is prohibited by ordinance (§57-13 - §57-17). As migratory game species, Canada geese are afforded federal and state protection. Therefore, any management techniques involving handling nests, eggs or birds require a permit (NJDEP Division of Fish and Wildlife, undated-a).

Mammals

Twenty-eight of the 89 mammals listed on the NJDEP checklist are restricted to marine environments, leaving 61 species that may be observed at various locations around the state (**Appendix D.4**). Some of the listed mammals are limited to specific regions within the state, while others enjoy a wide range. A mammal list is not available specifically for either Monmouth County or the Township of Howell. Endangered mammals are discussed in **Section 8.2.2,** and non-indigenous mammals in **Section 8.2.3**. One large native mammal that frequently clashes with the human population is discussed below.

White-tailed Deer

The white-tailed deer (*Odocoileus virginianus*), the largest herbivore living wild in New Jersey, is seen throughout all but the most urbanized areas of the state. Although the deer is a large animal, individuals tend to stay in a one square mile or less home range, one of the smallest ranges among wild ruminants (Burnett, 2004).

White-tailed Deer.
Photo credit: J. Dodds

Biologists have estimated that before the arrival of European settlers, there were about 8-11 white-tailed deer per square mile. By the early 1900's, New Jersey's deer herd was reduced to a handful by unregulated hunting. However, efforts to protect the deer herd were so successful that deer were considered over-populous by the 1920's (Latham et al., 2005). In addition, deer have been able to adapt to human-altered habitats. Studies have shown that deer densities above 10-15 per square mile have negative impacts on the diversity of understory vegetation and on the native songbird and wildflower populations that depend on a diverse understory, while deer populations in excess of 20 per square mile prevent tree regeneration (Latham et al., 2005). As of 2010, deer density in some parts of the state were estimated to be as high as 114 deer/mile^2 (NRCS, undated).

A herd of white-tailed deer.
Photo credit: J. Osborne

The state is divided into 70 Deer Management Zones (DMZs), with differing deer hunting regulations applied to different DMZs. Much of Howell Township falls within DMZ 16, which utilizes Regulation Set 5. Regulation Set 8 is applied to DMZ 50 and DMZ 51, which respectively include the northwest corner and southeast end of Howell Township, and a special set of regulations is applied to DMZ 39 which encompasses Earle Naval Weapons Station (NJDEP, August 2017). Regulation sets are posted annually on the state Division of Fish and Wildlife website (see Internet Resources).

An overabundance of deer results in excessive damage to agricultural crops, gardens and residential landscaping; an increased incidence of deer/vehicle collisions; prevention of forest regeneration (which impacts plants and animals dependent on the forest); and the potential for reduced deer health due to inadequate nutrition and the spread of disease (Honachefsky, 2000; Latham et al., 2005; Sauer, 1998). Despite these impacts, deer remain a natural part of the ecosystem, and are not solely responsible for diversity loss and habitat degradation. A management program should seek to balance the well-being and health of natural communities with the safety and economic well-being of its residents. Guidelines for developing a plan to both reduce the impacts of an existing deer population and manage herd size may be found in An Overview of White-Tailed Deer Status and Management in New Jersey (Rutgers, 2013b) and the Community Based Deer Management Manual for Municipalities (NJDEP Division of Fish and Wildlife, undated-b).

Reptiles and Amphibians

Of the 39 non-marine reptile species recorded in New Jersey, 31 have ranges which include Monmouth County, although five species of those are limited to the southern end of the county (**Appendix D.5**). Similarly, there are 34 species of amphibians in the state, 23 of which range into Monmouth County (**Appendix D.6**). Although lists of reptiles and amphibians (collectively known as herptiles) are not maintained by county, their potential presence in the Monmouth area can be extrapolated from the species range maps provided by the state's Division of Fish and Wildlife (NJDEP, Division of Fish & Wildlife, April 2, 2019). Endangered, threatened, and special concern herptiles are discussed in **Section 8.2.2,** and the non-indigenous species are covered in **Section 8.2.3**.

Wildlife of Vernal Pools

Vernal pools are defined as confined depressions, either natural or man-made, that maintain ponded water for part of the year, have no permanent outflow, and are devoid of breeding fish populations. These temporary wetlands provide habitat to many species of amphibians, several of which breed exclusively in vernal pools, as well as a multitude of insects, reptiles, plants, and other wildlife. Certification of a vernal pool may be achieved by documenting breeding activity of obligate vernal pool species (such as wood frogs or spotted salamanders (see **Table 8.11**); or by documenting both the presence of facultative species and photographic evidence that the pool goes dry or demonstrating the absence of fish (Tesauro, undated).

Five vernal pools in Howell Township are currently certified. An additional 88 sites have been identified as potential vernal pools within the township, as well as three more along the borders for which only part of the associated habitat is included in the township (see **Figure 8.9**). In some instances where habitat associated with potential vernal pools overlapped with confirmed vernal pool habitat, the habitat was mapped as vernal even though the pool had not been certified (NJDEP ONLM October 2018 and NJDEP Division of Fish and Wildlife ENSP, May 9, 2017).

Fish

The New Jersey Division of Fish and Wildlife (2016) currently reports a total of 90 freshwater fish species in the state (**Appendix D.7**), although one of those (the longnose gar) is considered extirpated. Roughly two-thirds of those species are native to the state, while the others have been introduced either accidentally or deliberately. Some species introduced as game fish have become naturalized, while others do not readily reproduce and are repeatedly stocked for recreational purposes (NJ Division of Fish & Wildlife, 2016). Endangered fish species are discussed in **Section 8.2.2,** and non-indigenous fish in **Section 8.2.3**.

Table 8.11. Obligate and Facultative Fauna Species Found in Vernal Habitats.

Obligate Vernal Pool Breeding Species	Facultative Vernal Pool Breeding Amphibians	Reptiles that Inhabit Vernal Pools on a Seasonal Basis
eastern tiger salamander *ENDANGERED*	green frog	wood turtle *THREATENED*
marbled salamander *Special Concern*	bullfrog	spotted turtle *Special Concern*
spotted salamander	pickerel frog	
Jefferson salamander *Special Concern*	southern leopard frog	southeastern mud turtle
blue-spotted salamander *ENDANGERED*	carpenter frog *Special Concern*	eastern painted turtle
wood frog	spring peeper	snapping turtle
eastern spadefoot toad *WAP-FS*	eastern cricket frog	
fairy shrimp (order Anostraca)	New Jersey chorus frog *WAP-FS*	
	upland chorus frog	
	northern gray treefrog	(These reptiles visit vernal pools primarily to eat the eggs and larvae of amphibians.)
	Cope's gray treefrog *ENDANGERED*	
	Pine Barrens treefrog *ENDANGERED*	
	four-toed salamander	
	long-tailed salamander *THREATENED*	
Note: Species in black are either known to occur in Howell Township or their ranges include Monmouth County; species in gray have ranges that do not include Monmouth County, therefore it would be unlikely to find them in Howell Township. Species labeled *WAP-FS* have not been formally listed in NJ, but have been identified as Focal Species for conservation in the state's Wildlife Action Plan (NJDEP, 2017).		
Sources: Kenney et al, undated; Gessner and Stiles, February 2001; N.J.A.C. 7:7A.		

Manasquan Reservoir and Echo Lake are listed as sites for recreational fishing in Howell Township, along with 23 other locations in Monmouth County (NJDEP, July 19, 2019). Permits are required for boats on the Manasquan Reservoir, which is stocked with warm water species, including hybrid striped bass, largemouth bass, muskellunge, black crappie, bluegill sunfish and brown bullheads. Echo Lake is stocked with trout three times during the season and Mingamahone Creek is stocked five times. The North Branch Manasquan River is part of the Brook Trout Conservation Zone, which restricts spring trout fishing to catch and release only (NJDEP Division of Fish and Wildlife, January 2019). While the Manasquan River is also included on the list of fishable trout waters, the only fishing access sites specified on the state list are in Wall Township (NJDEP Division of Fish and Wildlife, April 18, 2019).

8.2.2 Endangered, Threatened, or Special Concern Wildlife

Background

The health of an area's animal and plant populations can be an indicator of the health and sustainability of the environment for people. The decline or disappearance of one (or more) species may signal the deterioration of the habitat. Other species, and human health and welfare, may soon follow. Preserving the future of endangered and threatened species helps preserve our own species, benefiting human health and quality of life by protecting watersheds, preserving land in its natural state, and restoring wildlife habitat. Many people also place an intrinsic value on all species (Conserve Wildlife Foundation, 2002).

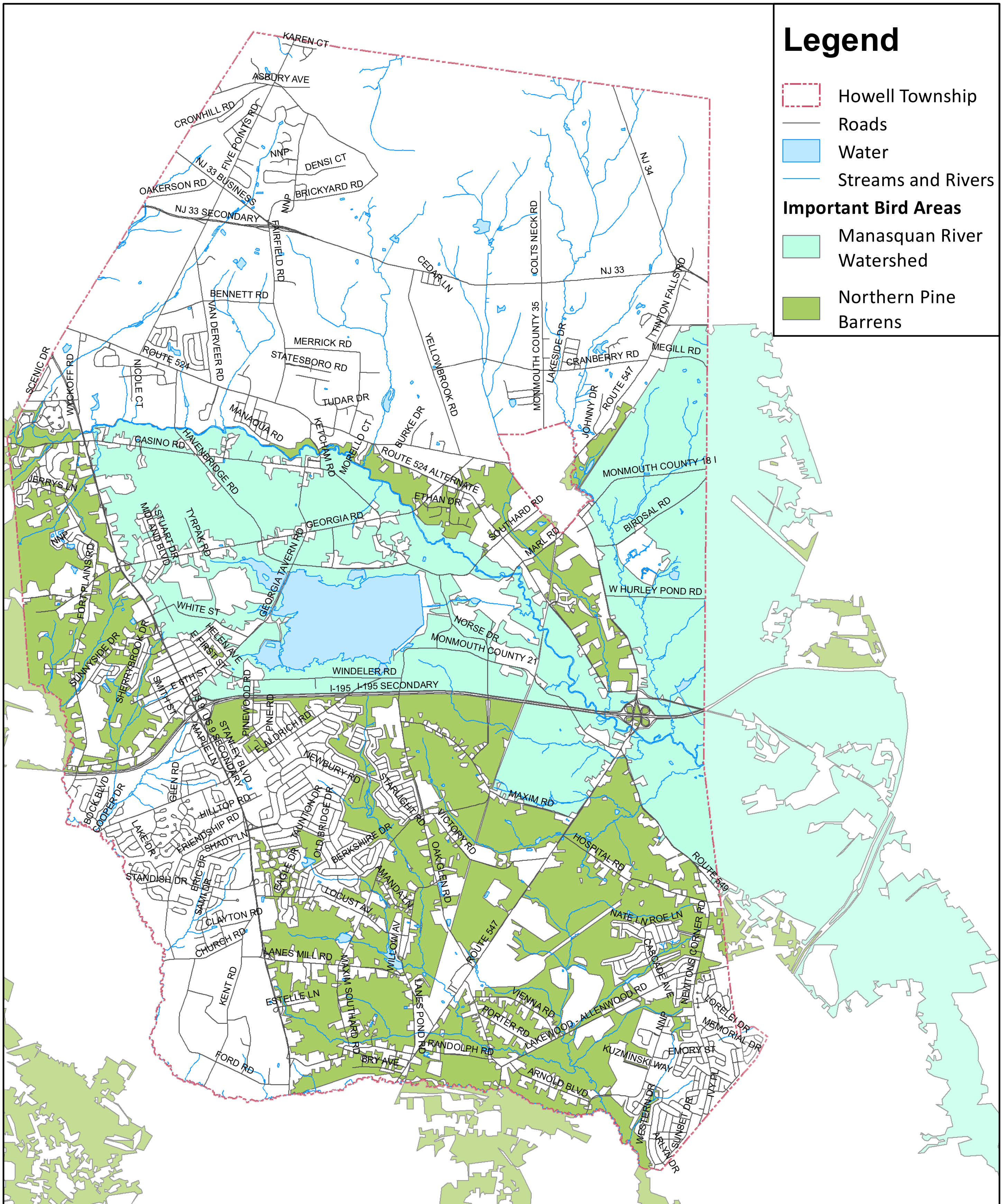

Figure 8.8. Howell Township, Important Bird Areas (Audubon Society)

Data Sources: NJDEP, NJDOT, Audubon Society
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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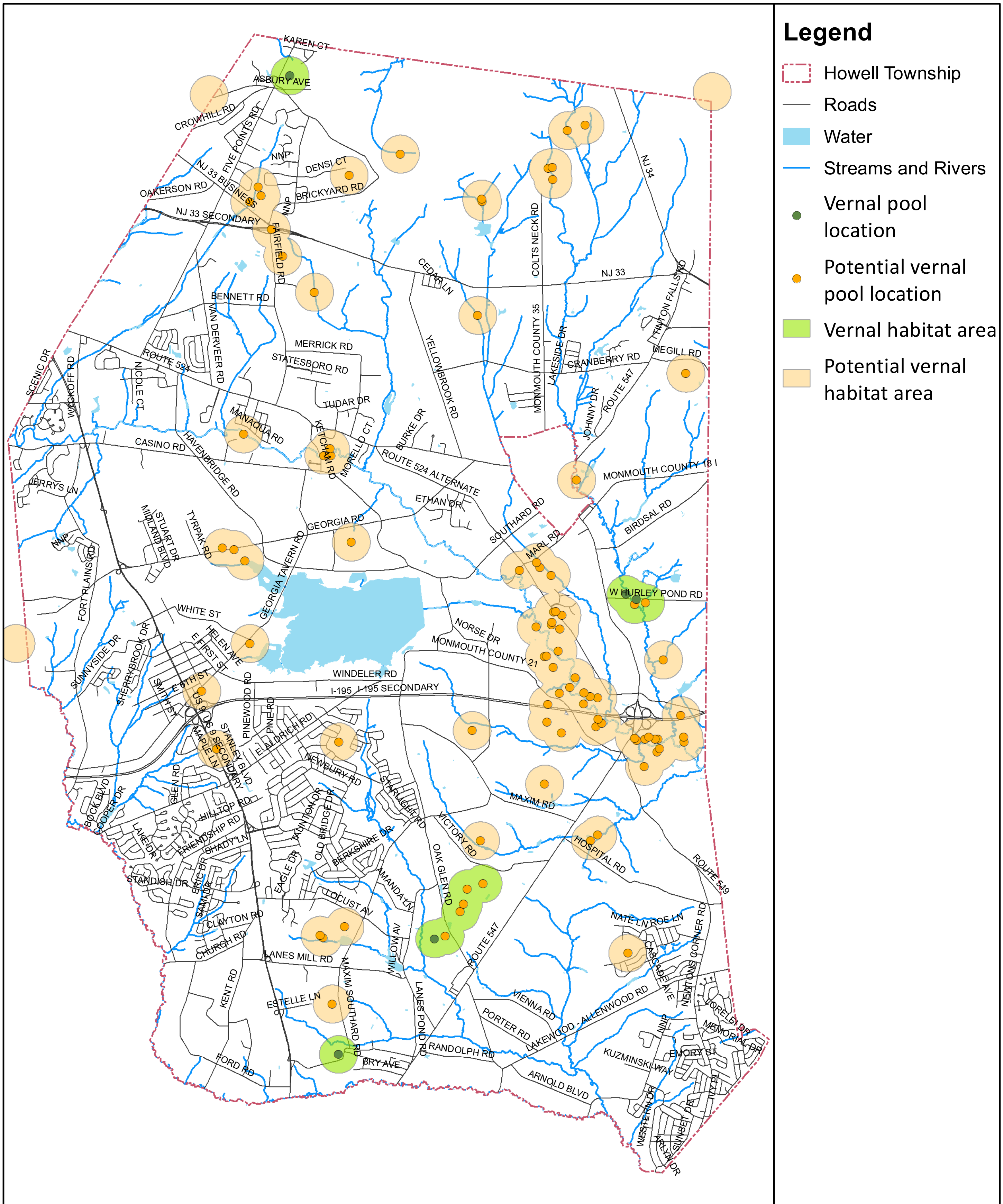

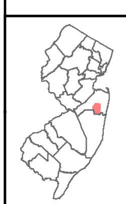

Figure 8.9. Howell Township, Vernal Habitat

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Howell Township ERI
2020

Many species are naturally rare in parts of their range, especially at the periphery. New Jersey often lies at the southern periphery of the range for many "northern" species and at the northern edge of the range of many "southern" species. Therefore, a species considered rare or imperiled within the state of New Jersey is not necessarily in danger of extinction worldwide. In addition, many rare species depend on large tracts of continuous undisturbed habitat to survive. If these habitats are interrupted by developed areas, the patches may become too small to support certain species.

The NJ Endangered Species Conservation Act was signed into law on December 14, 1973 (N.J.S.A. 23:2A-1 - 15), preceding the federal Endangered Species Act by two weeks. This milestone legislation established laws to protect and restore the state's endangered and threatened wildlife whose survival in New Jersey is imperiled by loss of habitat, over-exploitation, pollution, or other impacts (NJDEP, October 6, 2004). In February 2012, NJDEP updated the Endangered and Nongame Species rules (N.J.A.C. 7:25), revising the species list based on science, upgrading the status of some recovering species, and adding some declining species to the list (NJDEP Division of Fish and Wildlife, March 20, 2018).

Table 8.12 presents the definitions used by NJDEP in describing the status of rare animal species. In order to better document the status or change in status of species, NJDEP solicits information from the general public concerning sightings of endangered, threatened, and special concern species. People should use the appropriate reporting forms (see **Internet Resources** and **Appendix D.8)**.

Table 8.12. Definitions of Animal Species Status

STATE STATUS	STATE STATUS DEFINITION
Animals: Two animal lists provide state status codes after the Endangered and Nongame Species Conservation Act of 1973 (N.J.S.A. 23:2A-13 et. seq.): the list of endangered species (N.J.A.C. 7:25-4.13) and the list defining status of indigenous, nongame wildlife species of New Jersey (N.J.A.C. 7:25-4.17(a)). The status of animal species is determined by the Endangered and Nongame Species Program (ENSP), with the review and approval of the Endangered and Nongame Species Advisory Committee. Status for animals separated by a slash(/) indicate a dual status. First status refers to the state breeding population, and the second status refers to the migratory or winter population.	
E	An **endangered species** is one whose prospects for survival within the state are in immediate danger due to one or many factors - a loss of habitat, over exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.
T	A **threatened species** is a species that may become endangered if conditions surrounding the species begin to or continue to deteriorate.
SC	The term **Special Concern** applies to animal species that warrant special attention because of some evidence of decline, inherent vulnerability to environmental deterioration, or habitat modification that would result in their becoming a Threatened species. This category would also be applied to species that meet the foregoing criteria and for which there is little understanding of their current population status in the state.
S	A **stable species** is one whose population is not undergoing any long-term increase/decrease within its natural cycle.
U	An **undetermined species** is one about which there is not enough information available to determine the status.

ELEMENT RANKS	The Nature Conservancy developed a ranking system for use in identifying elements (rare species and ecological communities) of natural diversity most endangered with extinction. Each element is ranked according to its global, national, and state (or subnational in other countries) rarity. These ranks are used to prioritize conservation work so that the most endangered elements receive attention first. Definitions for element ranks are after The Nature Conservancy (1982: Chapter 4, 4.1-1 through 4.4.1.3-3).
GLOBAL RANK	**GLOBAL ELEMENT RANK DEFINITION**
G1	**Critically imperiled globally** because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2	**Imperiled globally** because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3	Either **very rare and local throughout its range or found locally** (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.
G4	**Apparently secure globally**; although it may be quite rare in parts of its range, especially at the periphery.
G5	**Demonstrably secure globally**; although it may be quite rare in parts of its range, especially at the periphery.
GH	Of **historical occurrence** throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.
STATE RANK	**STATE ELEMENT RANK DEFINITION**
B	Refers to the **breeding** population of the element in the state.
N	Refers to the **non-breeding** population of the element in the state.
Note: To express *uncertainty*, the most likely rank is assigned, and a question mark added (e.g., G2?). A range is indicated by combining two ranks (e.g., G1G2, S1S3).	
Source: NJDEP Division of Fish and Wildlife, March 22, 2010	

Inventory

The NJDEP Division of Fish and Wildlife, Endangered and Nongame Species Program's (ENSP) mission is: "To actively conserve New Jersey's biological diversity by maintaining and enhancing endangered and nongame wildlife populations within healthy functioning ecosystems." The program is responsible for the protection and management of New Jersey's wildlife, including 50 endangered, 36 threatened and 100 species currently listed as special concern (NJDEP Division of Fish and Wildlife, March 20, 2018 and February 21, 2012). For state-wide species lists, see **Internet Resources**.

A search of NJDEP Division of Parks and Forestry *Natural Heritage Database* in August 2019 revealed the documented presence of 24 imperiled animal species in Howell Township (see **Table 8.12** for code definitions and **Table 8.13** for list**)**. Special Concern animal species, which warrant concern due to evidence of decline or vulnerability, include eleven birds, one reptile and one insect. State Threatened fauna includes five birds, one reptile and one amphibian. State Endangered animals include one mammal, two birds, and one reptile that is also listed as a Federally Threatened Species. Three additional insects listed for the township have not yet been assigned a protection status, but are currently tracked by the Endangered and Nongame Species Program. The bald eagles at the Manasquan Reservoir were among the 204 nesting pairs monitored by the New Jersey Bald Eagle Project during 2018 (Smith and Clark, 2018).

Table 8.13. Natural Heritage Database Animal Species in Howell Township

Class	Common Name	Scientific Name	Feature Type	LP Rank	Protection Status	Global Rank	State Rank
Species Onsite Based on Landscape Patches							
Amphibia	Pine Barrens Treefrog	*Hyla andersonii*	Occupied habitat	3	State Threatened	G4	S2
	Pine Barrens Treefrog	*Hyla andersonii*	Vernal Pool Breeding	3	State Threatened	G4	S2
Aves	Bald Eagle	*Haliaeetus leucocephalus*	Foraging	4	State Endangered	G5	S1B, S2N
	Bald Eagle	*Haliaeetus leucocephalus*	Nest	4	State Endangered	G5	S1B, S2N
	Bald Eagle	*Haliaeetus leucocephalus*	Wintering	4	State Endangered	G5	S1B, S2N
	Barred Owl	*Strix varia*	Breeding sighting	3	State Threatened	G5	S2B, S2N
	Black-crowned Night Heron	*Nycticorax nycticorax*	Foraging	3	State Threatened	G5	S2B, S3N
	Brown Thrasher	*Toxostoma rufum*	Breeding sighting	2	Special Concern	G5	S3B, S4N
	Cooper's Hawk	*Accipiter cooperii*	Breeding Sighting	2	Special Concern	G5	S3B, S4N
	Cooper's Hawk	*Accipiter cooperii*	Nest	2	Special Concern	G5	S3B, S4N
	Glossy Ibis	*Plegadis falcinellus*	Foraging	2	Special Concern	G5	S3B, S4N
	Grasshopper Sparrow	*Ammodramus savannarum*	Breeding sighting	3	State Threatened	G5	S2B, S3N
	Great blue heron	*Ardea herodias*	Foraging	2	Special Concern	G5	S3B, S4N
	Hooded Warbler	*Setophaga (Wilsonia) citrina*	Breeding sighting	2	Special Concern	G5	S3B, S4N
	Little Blue Heron	*Egretta caerulea*	Foraging	2	Special Concern	G5	S3B, S3N
	Northern Parula	*Setophaga (Parula) americana*	Breeding sighting	2	Special Concern	G5	S3B, S4N
	Osprey	*Pandion haliaetus*	Foraging	3	State Threatened	G5	S2B, S4N
	Osprey	*Pandion haliaetus*	Nest	3	State Threatened	G5	S2B, S4N
	Red-headed Woodpecker	*Melanerpes erythrocephalus*	Breeding sighting	3	State Threatened	G5	S2B, S2N
	Red-shouldered Hawk	*Buteo lineatus*	Breeding sighting	4	State Endangered	G5	S1B, S3N
	Snowy Egret	*Egretta thula*	Foraging	2	Special	G5	S3B,

Class	Common Name	Scientific Name	Feature Type	LP Rank	Protection Status	Global Rank	State Rank
					Concern		S4N
	Tricolored Heron	*Egretta tricolor*	Foraging	2	Special Concern	G5	S3B, S3N
	Veery	*Catharus fuscescens*	Breeding sighting	2	Special Concern	G5	S3B, S4N
	Wood thrush	*Hylocichla mustelina*	Breeding sighting	2	Special Concern	G4	S3B, S4N
Insecta	Pine Barrens Bluet	*Enallagma recurvatum*	Occupied habitat	2	Special Concern	G3	S3
Mammalia	Bobcat	*Lynx rufus*	Live Individual Sighting	4	State Endangered	G5	S2
Reptilia	Bog Turtle	*Gleptymys muhlenbergii*	Occupied habitat	5	Federally threatened, State Endangered	G3	S1
	Eastern box turtle	*Terrapene c. carolina*	Occupied habitat	2	Special Concern	G5T5	S3
	Wood Turtle	*Gleptymys insculpta*	Occupied habitat	3	State Threatened	G3	S2
Additional species tracked by Endangered and Nongame Species Program							
Insecta	New Jersey Pine Barrens Tiger Beetle	*Cicindela patruela consentanea*				G3T1T3	S2S3
	Placentia Tiger Moth	*Apantesis (Grammia) placentia*				G3G4	S1S3
	Coastal Bog Metarranthis	*Metarranthis pilosaria*				G3G4	S3S4
Note: See **Table 8.11** for Global and State Rank definitions, and **Table 8.14** for Landscape Project Rank definitions.							
Source: Natural Heritage Program, August 27, 2019.							

Examination of eBird records from four locations in Howell Township shows 33 noteworthy bird species in addition to those documented through the Natural Heritage Program (**Table 8.14**). Five species with a state status label of WAP-FS in the table are not presently listed, but have been identified as Focal Species of Greatest Conservation Need in the recently updated state Wildlife Action Plan (NJDEP, 2017). The plan is discussed further below.

Table 8.14. Rare Bird Species reported on eBird from sites in Howell Township.
Seventeen of the 50 species (marked with an asterisk*) are also included in **Table 8.13** above.

NJ Status	Common name	Scientific name	Date of Most Recent Observation through 10/9/19			
			Manasquan Reservoir	Environmental Center at MR	MR Cove Nature Trail	Chestnut Point Field
Ebr, Tnb	Bald Eagle*	*Haliaeetus leucocephalus*	18-Sep-19	14-Aug-19	13-Jan-19	16-Jul-17
Ebr, SCnb	Northern Harrier	*Circus cyaneus*	2-May-19	25-Jan-14	20-Oct-13	9-Apr-17
Ebr, SCnb	Peregrine Falcon	*Falco peregrines*	26-Aug-14	18-Dec-17		15-Sep-15
Ebr, SCnb	Pied-billed Grebe	*Podilymbus podiceps*	4-Oct-19	19-Mar-19	13-Jan-19	19-Nov-17
Ebr, SCnb	Red-shouldered Hawk*	*Buteo lineatus*	17-Apr-19	13-Mar-19		17-Jan-13
Ebr, SCnb	Golden-winged Warbler	*Vermivora chrysoptera*			20-Aug-09	
T	American Kestrel	*Falco sparverius*	3-Sep-17	29-Mar-16		21-Apr-17
T	Barred Owl*	*Strix varia*	2-Aug-16			
T	Red-headed Woodpecker*	*Melanerpes erythrocephalus*	19-Apr-03			
Tbr, SCnb	Black-crowned Night-Heron*	*Nycticorax nycticorax*	25-Apr-11		14-Apr-11	
Tbr, SCnb	Bobolink	*Dolichonyx oryzivorus*				26-Sep-14
Tbr, SCnb	Grasshopper Sparrow*	*Ammodramus savannarum*	25-May-19			17-Jun-19
Tbr	Osprey*	*Pandion haliaetus*	26-Sep-19	24-Sep-19	7-Jun-19	14-Oct-17
Tbr	Savannah Sparrow	*Passerculus sandwichensis*	4-Apr-19	25-Jan-14	26-Oct-13	14-Oct-17
SC	Common Nighthawk	*Chordeiles minor*				15-Sep-15
SC	Kentucky Warbler	*Geothlypis formosa*	10-May-97			
SC	Least Bittern	*Ixobrychus exilis*	25-May-09			17-Aug-14
SC	Little Blue Heron*	*Egretta caerulea*	6-Oct-19		20-Oct-13	25-Aug-17
SC	Sharp-shinned Hawk	*Accipiter striatus*	9-May-19	16-Apr-19	7-Oct-11	26-Oct-11
SCbr	Blackburnian Warbler	*Setophaga fusca*	14-May-18			
SCbr	Black-throated Blue	*Setophaga caerulescens*	19-May-19	8-May-19	7-Oct-11	15-Sep-15

NJ Status	Common name	Scientific name	Date of Most Recent Observation through 10/9/19			
			Manasquan Reservoir	Environmental Center at MR	MR Cove Nature Trail	Chestnut Point Field
	Warbler					
SCbr	Black-throated Green Warbler	*Setophaga virens*	19-May-19	24-Sep-19	9-Nov-13	15-Sep-15
SCbr	Blue-headed Vireo	*Vireo solitarius*	2-May-19		11-Apr-11	
SCbr	Broad-winged Hawk	*Buteo platypterus*	4-Aug-18			
SCbr	Brown Thrasher*	*Toxostoma rufum*	2-May-19	7-May-19	3-May-11	16-Jul-17
SCbr	Canada Warbler	*Cardellina canadensis*	25-May-19			
SCbr	Caspian Tern	*Hydroprogne caspia*	17-Apr-19			
SCbr	Cliff Swallow	*Petrochelidon pyrrhonota*	16-May-11			30-Apr-16
SCbr	Common Tern	*Sterna hirundo*	25-Jul-19	30-Jul-19		
SCbr	Cooper's Hawk*	*Accipiter cooperii*	6-May-19	25-Apr-19	9-Nov-17	14-Oct-17
SCbr	Eastern Meadowlark	*Sturnella magna*	22-Apr-11			3-Apr-17
SCbr	Glossy Ibis*	*Plegadis falcinellus*	22-Aug-19			
SCbr	Great Blue Heron*	*Ardea herodias*	4-Oct-19	14-Aug-19	7-Jun-19	25-May-19
SCbr	Hooded Warbler	*Setophaga citrina*	19-May-19			
SCbr	Least Flycatcher	*Empidonax minimus*	7-Oct-16			3-Aug-14
SCbr	Nashville Warbler	*Oreothlypis ruficapilla*	11-Sep-17			15-Oct-15
SCbr	Northern Parula	*Setophaga americana*	19-May-19	24-Sep-19	15-Oct-13	15-Sep-15
SCbr	Snowy Egret*	*Egretta thula*	7-Oct-16	18-Apr-16	20-Oct-13	
SCbr	Spotted Sandpiper	*Actitis macularius*	30-Sep-19	30-Jul-19		5-May-12
SCbr	Veery*	*Catharus fuscescens*	24-May-18			
SCbr	Winter Wren	*Troglodytes hiemalis*	6-Oct-19	19-Mar-19	9-Nov-13	
SCbr	Wood Thrush*	*Hylocichla mustelina*	24-Aug-19	27-Jun-19	22-Jun-18	21-May-14
SCbr	Worm-eating Warbler	*Helmitheros vermivorum*	30-Apr-16	25-Apr-19		
SCnb	Sanderling	*Calidris alba*	12-Mar-03			

NJ Status	Common name	Scientific name	Date of Most Recent Observation through 10/9/19			
			Manasquan Reservoir	Environmental Center at MR	MR Cove Nature Trail	Chestnut Point Field
SCnb	Semipalmated Sandpiper	*Calidris pusilla*	22-Sep-16			
WAP-FS	American Woodcock	*Scolopax minor*	15-Mar-09			29-Feb-16
WAP-FS	Blue-winged Warbler	*Vermivora cyanoptera*	25-Aug-19			21-May-14
WAP-FS	Forster's Tern	*Sterna forsteri*	30-Sep-19	24-Sep-19		
WAP-FS	Prothonotary Warbler	*Protonotaria citrea*	11-May-19		22-Jun-18	
WAP-FS	Scarlet Tanager	*Piranga olivacea*	24-Aug-19	19-Aug-19	23-May-18	17-Jun-19
WAP-FS indicates a species that has not yet been formally listed in NJ, but has been identified as a Focal Species for conservation in the state's Wildlife Action Plan (NJDEP, 2017).						
Source: Sullivan et al., 2009. Site accessed October 9, 2019.						

A number of species included in **Table 8.14** above are only listed as Special Concern when they are breeding in the state, but may be routinely observed during spring and fall months as they travel between their breeding grounds and wintering sites. Nevertheless, if they are seen in the township during migration it indicates that habitat in Howell Township can offer food and/or temporary shelter as they make their long journey. A summary of the habitat requirements for each rare species documented in Howell Township is provided in **Appendix D.9**.

In addition to the rare bird species currently listed on eBird from Howell Township, another 29 Endangered, Threatened, Special Concern or Wildlife Action Plan Focal Species birds have been reported at other locations in Monmouth County (**Appendix D.10**). It is likely that some additional rare birds also utilize habitat within Howell Township.

State Wildlife Action Plan

NJDEP Division Fish and Wildlife prepared its first Wildlife Action Plan (WAP) in 2006, in response to the creation of a federal State Wildlife Grants program. The program was established by Congress in 2000 in order to help states develop a blueprint for the protection of species that are endangered, threatened, or have special conservation needs. In addition to making states eligible for conservation grants, the plans are designed to provide a planning tool for landowners and land managers. New Jersey's WAP was revised and updated in November of 2017 (NJDEP, 2017).

The emphasis of the updated Wildlife Action Plan was on the species of greatest conservation need (SGCN) in the state. A list of 3,700 vertebrate and invertebrate species was prioritized and reduced to a Focal SGCN list of 107 species most likely to benefit from concerted conservation action. The plan provided individual profiles for each of the 107 focal species. The Focal SGCN list includes 5 mammals, 29 birds, 15 reptiles, 7 amphibians, 12 fish, 33 insects and 6 freshwater mussels. Based on shared life history characteristics and habitat requirements, 77 of the focal species were consolidated into 18 groups or guilds and the remaining 30 species were ungrouped. For each guild or ungrouped species, specific threats were identified, and conservation goals were developed (NJDEP, 2017).

Mapping (The Landscape Project)

The state's *Landscape Project* (see **Figure 8.10**) is a pro-active, ecosystem-level approach to the long-term protection of rare species and their important habitats in New Jersey. Its goal is to protect New Jersey's biological diversity by maintaining and enhancing rare wildlife populations within healthy, functioning ecosystems. It provides users with peer reviewed, scientifically sound wildlife data that is easily accessible and can be used by state, county, and local governments, as well as nongovernmental conservation organizations and private landowners for planning, open space acquisition, and land-use regulation (NJDEP Division of Fish and Wildlife, 2017).

The NJDEP, Division of Fish and Wildlife, Endangered and Nongame Species Program is responsible for the Landscape Project. Version 3.3 was released in 2017. The dataset was created by intersecting endangered, threatened and priority species data with the 2012 Land Use/Land Cover GIS layer, which was derived from aerial photography. The resulting data layer identifies, delineates and ranks (based on the conservation status of species present) critical habitat statewide. **Table 8.15** lists rank definitions. Each habitat patch is coded for the number of special concern, state threatened, state endangered and federally listed species present.

Table 8.15. Landscape Project Habitat Rank Definitions

Rank	Definition
0	**No Suitable Habitat**
1	**Suitable Habitat** – Rank 1 is assigned to patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species.
2	**Special Concern** – Rank 2 is assigned to patches containing one or more occurrences of species considered to be species of special concern.
3	**State Threatened** – Rank 3 is assigned to patches containing one or more occurrences of State threatened species.
4	**State Endangered** – Rank 4 is assigned to patches with one or more occurrences of State endangered species.
5	**Federally Listed** – Rank 5 is assigned to patches containing one or more occurrences of wildlife listed as endangered and threatened pursuant to the Federal Endangered Species Act of 1973.
Source: NJDEP Division of Fish and Wildlife ENSP, May 9, 2017	

A significant portion of Howell Township (43.9%) is ranked as habitat for known occurrences of Federally Listed (0.4%), Endangered (15.3%), Threatened (18.5%) or Special Concern (9.7%) species according to the Landscape Project Version 3.3, and another 15.5% is ranked as potential habitat for priority species (see **Table 8.16** and **Figure 8.10)**.

Table 8.16. Landscape Project version 3.3 Acreage

Rank	Rank Name	Pinelands Acres	Piedmont Acres	Total Acres	Percent
0	No Suitable Habitat	14,150.43	1,745.80	15,896.08	40.6%
1	Habitat Specific Suitability	5,111.39	962.47	6,073.86	15.5%
2	Special Concern	3,353.91	457.51	3,811.41	9.7%
3	State Threatened	5,065.71	2,189.03	7,254.73	18.5%
4	State Endangered	5,042.71	930.57	5,973.28	15.3%
5	Federally Listed	139.45	0.00	139.45	0.4%
Total Ranked Acres		18,713.16	4,539.58	23,252.73	59.4%
			Total:	39,148.81	100.0%
Source: NJDEP Division of Fish and Wildlife ENSP, May 9, 2017					

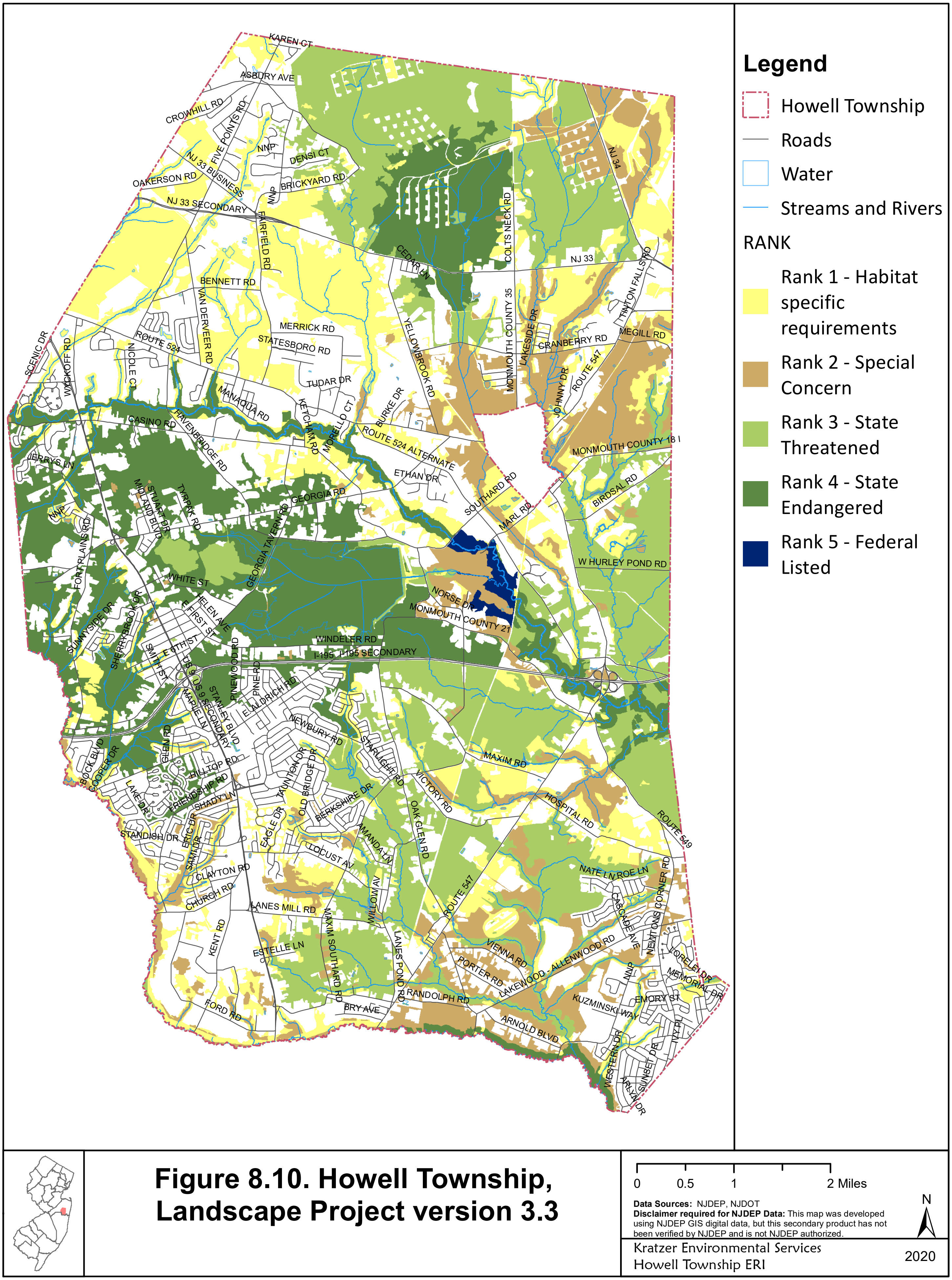

Figure 8.10. Howell Township, Landscape Project version 3.3

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Current Threats

Habitat loss, fragmentation and degradation are the most serious threats to the state's wildlife populations (NJDEP Division of Fish and Wildlife, 2017). Habitat loss results from permanent or long-term alterations of the landscape, typically due to development or change in the vegetative cover. Fragmentation refers to the breaking up of large patches of natural habitat into smaller parcels, which increases edge habitat while disproportionately reducing interior habitat. Fragmentation also results in the loss of essential wildlife travel corridors. Examples of degradation include pollution, stream channel alterations, changes in characteristic hydrology or temperature, erosion, dredging, and off-road vehicular traffic.

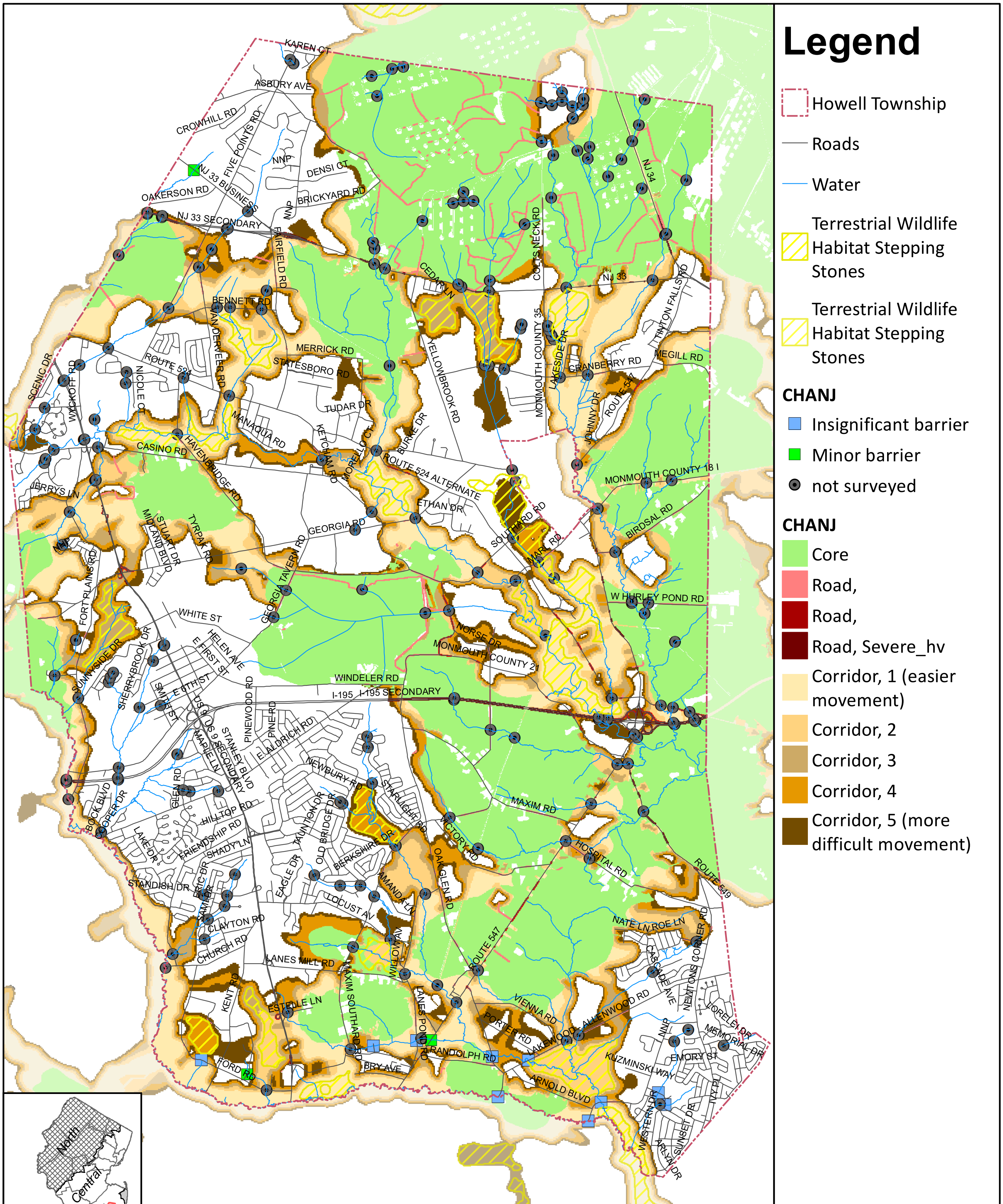
An NJDEP effort called Connecting Habitat Across New Jersey (CHANJ) is an effort to improve habitat connectivity for terrestrial wildlife across the state. The CHANJ mapping and guidance document helps to prioritize land protection, inform habitat restoration and management, and guide mitigation of road barrier effects on wildlife and their habitats. The CHANJ project has identified a significant amount of potential core habitat and corridors in Howell Township, as illustrated in **Figure 8.11** (NJDEP, November 1, 2018; NJDEP, May 7, 2019).

Road mortality is another danger to wildlife in New Jersey. Many aquatic and terrestrial wildlife species are known to cross beneath roadways at bridge spans and through medium and large culverts. The CHANJ project's tool, which is part of the North Atlantic Aquatic Connectivity Collaborative Road-Stream Crossing Assessments, provides an inventory of road crossings (shown on **Figure 8.11**). The goal of this project is to use volunteers to collect a variety of data associated with culverts and bridges, including structure dimensions and the presence of barriers, to characterize these road-stream crossings to help identify opportunities to improve safe passage for wildlife (NJDEP, April 18 2018).

Another significant threat to New Jersey's wildlife is invasive or overabundant species (NJDEP Division of Fish and Wildlife, 2017). Invasive and non-native species are discussed in **Section 8.2.3** below. Some examples of overabundant native species, white-tailed deer and non-migratory Canada geese, are discussed in **Section 8.2.1**. The unchecked spread of certain diseases can also cause an apparently stable species to rapidly decline. Populations of cave-roosting bats across the northeast were decimated by the introduction of a fungus that caused white-nose syndrome (Rutgers, 2019), and the effects of diseases such as ranavirus and snake fungal disease on the state's herptile populations are still being evaluated (Conserve Wildlife Foundation 2015, Northeast Wildlife Disease Cooperative 2017).

Litter, especially plastics, threatens wildlife directly through choking and entanglement and indirectly through the toxicity of the chemicals and biofilms associated with the breakdown of plastics. For example, osprey will add trash to their nesting material, which can entangle and even kill the young. About 267 marine animal species ingest plastic, which sometimes causes the animals' death. Researchers have found chemicals that result from the breakdown of plastics in the world's oceans, including bisphenol A (which has been shown to interfere with animals' reproductive systems) and styrene monomer (a suspected carcinogen) (Barry, August 20, 2009).

Beneficial insects, including pollinators, are vulnerable to threats from habitat loss and invasive species as well as the harmful effects of pesticides and herbicides. When chemicals are used to target pests and weeds, they may drift beyond the intended area and jeopardize beneficial insects. Bees and butterflies are also vulnerable to the systemic neonicotinoid pesticides, which remain harmful throughout the life of the plant treated with them (NJDEP, 2017).



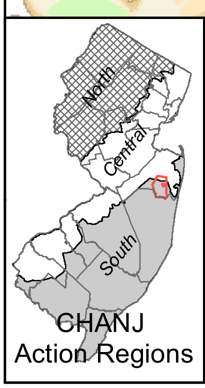


Figure 8.11. Howell Township, Connecting Habitat Across New Jersey (CHANJ)

0 0.5 1 2 Miles

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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8.2.3 Invasive & Non-native Wildlife

As with exotic plant species, the introduction of non-native animal species can have a devastating effect on natural communities. This most often occurs due to competition with native animals for limited resources such as food and shelter, but it may also be due to predation on native species.

Feral Cats

An example of an introduced species that preys on native wildlife is the feral cat (*Felis domesticus*), which is the sole mammal tracked by the Invasive Species Strike Team likely to occur in Howell Township. Feral cats are a widespread problem around the state, and are considered highly threatening to native communities (FoHVOS, 2018). Free-roaming domestic cats are visually and genetically indistinguishable from feral cats and pose the same threat to wildlife, but are protected by state statute (NJ Department of Health, 2016). A number of management options for the control of feral and free-roaming cats are reviewed by Hildreth et al. (2010). Some of their suggestions to repel or exclude cats are universally applicable, but others which focus on elimination of the animals are subject to state and local laws and may not be appropriate in many communities.

Recommendations specific to New Jersey include a combination of strong local ordinances, public education, and the establishment of "Managed Cat Colonies". The concept of managed cat colonies is an alternative to the elimination of established feral cats, instead focusing on management of the population until it is eventually reduced by attrition. Components of managed cat colonies include spaying and neutering, designated caretakers, and public ordinances establishing local requirements for the program. In addition to laying out the guidelines for establishing and regulating managed cat colonies, local ordinances should address the implementation and enforcement of licensing and vaccinations for pets, prohibitions against the feeding of feral cats and abandonment, and effective animal control. Public education focuses on responsible pet ownership such as spaying and neutering, keeping cats indoors, and prevention of abandonment (NJ Department of Health, 2016).

Other Invasive Fauna

Of the eight non-native resident bird species in New Jersey, seven occur in Monmouth County and six have been reported in Howell Township (**Table 8.17**).

Table 8.17. Non-native Resident Birds of Monmouth County

Common name	*Scientific name*	Threat Level**
brown-headed cowbird *	*Molothrus ater*	High
European starling *	*Sturnus vulgaris*	Moderate
house finch *	*Haemorhous mexicanus*	Mild
house sparrow *	*Passer domesticus*	Mild
monk parakeet	*Myiopsitta monachus*	-
mute swan *	*Cygnus olor*	High
rock pigeon *	*Columba livia*	-
* Species recorded in Howell Township **Threat levels are ranked by the Invasive Species Strike Team (FoHVOS, 2019).		
Source: Sullivan et al., 2009. Site accessed November 2019.		

Both the house finch and the house sparrow are classified as mildly threatening to natural communities. The European starling, which poses a moderate threat to native species, is frequently seen in large flocks: the high count for this species in Monmouth County was estimated at 10,500 birds in 2012 (Sullivan et al., 2009). The mute swan and brown-headed cowbird are both rated as highly threatening to native communities. In addition to competing with native birds for resources, the brown-headed cowbird is a brood parasite, laying its eggs in the nests of other bird species, which then raise the young cowbirds at the expense of their own offspring.

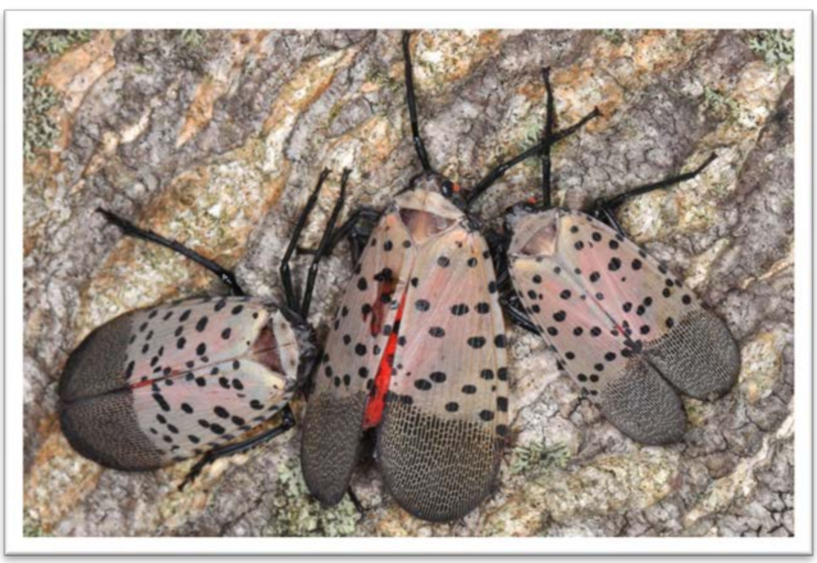
The sole invasive reptile likely to be encountered in Monmouth County is the red-eared slider, which is classified as highly threatening. This turtle is widespread in New Jersey, and may be found in ponds, lakes, swamps, streams, or slow-flowing rivers. No amphibians are currently tracked by the Invasive Species Strike Team.

The state Division of Fish and Wildlife (2016) lists nine species that pose a serious threat to freshwater resources, and which must be destroyed when encountered. Those invasive fish include the swamp eel, grass carp, bighead carp, silver carp, flathead catfish, brook stickleback, green sunfish, warmouth, and oriental weatherfish. The Invasive Species Strike Team tracks all of those species, and three additional freshwater fish. The northern snakehead (*Channa argus*) is not included on the state list of freshwater fish provided in **Appendix D.7**, although the Strike Team fact sheet states that it is widespread in New Jersey and lists its threat level as 'High'. The common carp is similarly ranked on the Strike Team list, but is not yet classified as a serious threat by Fish and Wildlife. The red-bellied pacu (*Piaractus brachypomus*) is a recent introduction into the state, and is ranked as a moderate threat.

The Invasive Species Strike Team additionally tracks a number of invertebrate species in the state, including 20 insects, 12 mollusks, 3 crabs, 7 worms, 4 crayfish, one arachnid and one jellyfish. Links to fact sheets with information about identification, threat levels and control measures for invasive animal species are also provided by the Strike Team (FoHVOS, 2018).

A rapidly growing concern in the northeast is the spotted lanternfly (*Lycorma deliculata*). Despite attempts to quarantine the insect in Pennsylvania, it made its way into New Jersey by 2018. As of September 2019, it was considered an infestation in eight of the nine counties in which it had been found. According to the New Jersey Department of Agriculture (2019), the lanternfly can impact over 70 different plant species including fruit trees, ornamental trees, woody trees, vegetables, herbs, and vines.

Other invasive insects that are a particular threat to tree health are discussed earlier in this chapter (see **Section 8.1.4**).



Spotted lanternflies. Photo credit: J. Dodds

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Deer Tolerant/Resistant Native Plants:
https://bhwp.org/wp-content/uploads/Deer-Tolerant_Resistant-Plants.pdf
Gardening for Butterflies: https://www.naba.org/chapters/nabanj/gardening.html
New Jersey Audubon Society: https://njaudubon.org/gardening-for-wildlife/
NJDEP Outdoor Classroom links: http://www.state.nj.us/dep/seeds/syhart/outclass.htm
USDA NRCS: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=nrcs143_023574

Native Plants

Bowman's Hill Wildflower Preserve: http://www.bhwp.org
Native Plant Society of NJ: http://www.npsnj.org/
USDA Plants Database: http://plants.usda.gov

NJDEP

Environmental Rules: http://www.nj.gov/dep/rules/nj_env_law.html
Rare Plants & Communities: http://www.state.nj.us/dep/parksandforests/natural/index.html

Rare Plant Report Form:
http://www.state.nj.us/dep/parksandforests/natural/heritage/natherrareplantspeciesreportform1_2008.doc

Invasive and Non-Native Vegetation

Invasive Species – New Jersey: http://www.invasivespeciesinfo.gov/unitedstates/nj.shtml
Native Plant Society of New Jersey – Invasive Species:
http://www.npsnj.org/pages/nativeplants_Plant_Lists.html
Invasive Species Strike Team (NJISST): https://www.fohvos.info/invasive-species-strike-team/
Forest Health: http://www.state.nj.us/dep/parksandforests/forest/njfs_forest_health.html

Checklists of Wildlife

Birds of NJ: http://www.state.nj.us/dep/fgw/chkbirds.htm
Butterflies of NJ: http://www.naba.org/chapters/nabanj/butterflies.html
Endangered & Threatened Wildlife of NJ: http://www.njfishandwildlife.com/tandespp.htm
Freshwater Fish Of NJ: http://www.njfishandwildlife.com/chkfish.htm
Mammals of NJ: http://www.state.nj.us/dep/fgw/chkmamls.htm
Reptiles and Amphibians of NJ: http://www.state.nj.us/dep/fgw/ensp/fieldguide_herps.htm
Species of Special Concern of NJ: http://www.njfishandwildlife.com/ensp/pdf/spclspp.pdf
Cornell Lab of Ornithology, All About Birds: http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/

Deer Management

Community Based Deer Management Manual for Municipalities.
https://www.state.nj.us/dep/fgw/pdf/cbdmp_manual.pdf
An Overview of White-Tailed Deer Status and Management in New Jersey. https://njaes.rutgers.edu/fs1202/
Deer Hunting Regulation Sets. https://www.njfishandwildlife.com/njregs.htm#hunting

Endangered Species

Conserve Wildlife Foundation of New Jersey: http://www.conservewildlifenj.org/
Division of Fish and Wildlife Home Page: http://www.njfishandwildlife.com/wildlife.htm
Environmental Rules: http://www.nj.gov/dep/rules/nj_env_law.html
Endangered and Nongame Species Program Home Page: http://www.state.nj.us/dep/fgw/ensphome.htm
Landscape Project: http://www.state.nj.us/dep/fgw/ensp/landscape/
NJ Wildlife Action Plan: https://www.state.nj.us/dep/fgw/ensp/wap/pdf/wap_plan17.pdf
North American Butterfly Association, North Jersey Butterfly Club: http://www.naba.org/chapters/nabanj/
Rare Wildlife Sighting Form: http://www.njfishandwildlife.com/ensp/rprtform.htm

Invasive and Non-Native Wildlife

Invasive Species – New Jersey: http://www.invasivespeciesinfo.gov/unitedstates/nj.shtml
Invasive Species Strike Team: https://www.fohvos.info/invasive-species-strike-team/
Forest Health: http://www.state.nj.us/dep/parksandforests/forest/njfs_forest_health.html
Spotted Lanternfly Management: https://www.nj.gov/agriculture/divisions/pi/prog/spottedlanternfly.html

9. OPEN SPACE AND FARMLAND

9.1 PUBLIC OPEN SPACE AND RECREATION

Echo Lake. Photo credit: D. Kratzer

9.1.1 Purposes & Funding

The purposes of open space preservation include:

- provide adequate active and passive recreation
- provide recreational and open space opportunities on an equal and accessible basis for all citizens
- protect the quantity and quality of surface and ground water
- protect sensitive environmental features such as wetlands, steep slopes, and critical habitats
- link community resources and support the community's need for safe, multi-modal circulation through a system of greenways and trails
- protect historic areas
- maintain plant and animal biodiversity
- minimize erosion or damage from flooding and
- maintain rural character (ANJEC, 2011).

Funding for open space comes from a variety of sources, including municipal, county, state and federal sources and private land trusts. Private land trusts are non-profit organizations that "can often act faster and be more creative in their real estate transactions than established government agencies" according to Howe (1989). Landowners are able to reap tax benefits through charitable donations to a land trust. Many successful open space purchases combine a number of funding sources and strategies.

Private land trusts working to preserve land in New Jersey and the Association of New Jersey Environmental Commissions (ANJEC) are sources for in-depth information concerning open space preservation through various funding, planning, and zoning techniques (see **Internet Resources**).

In 1987 Monmouth County voters approved a referendum question for an open space tax, making Monmouth the first county in New Jersey to establish an Open Space Trust Fund. Voters have approved increases to the Open Space Trust Fund in 1996, 2002, 2006 and 2017 to meet open space and recreation needs (Monmouth County Park System, September 5, 2017). The current rate is 2.75 cents per $100 of assessed property (Monmouth County Park System, 2019).

Howell Township presently levies a tax of 2 cents per $100 of assessed property for a municipal Open Space, Recreational, Farmland and Historic Preservation Trust Fund (Howell Township Tax Collector, 2019). The rate has remained the same since the voters approved a public question raising the rate by 1 cent on November 4, 2003 (Trust for Public Land and Land Trust Alliance, 2004; Howell Township Budget Archives, 2019).

Howell Township's 2017 Parks, Recreation and Open Space Master Plan Element defines four primary purposes of preserved open space:

- *Active recreation* - organized sports or leisure activities that usually require specialized fields or equipment and have a list of rules (examples: baseball, tennis)
- *Passive recreation* - less formal activities (examples: horseback riding, fishing, and hiking)
- *Conservations areas* - intended to remain (or be restored) in a natural state for wildlife refuges, as buffers between developments or to protect environmentally sensitive land and water resources
- *Preserved farmland* - intended to remain in agricultural use

Many parks accommodate more than one type of use. For instance, level areas may be used for ball fields, while wooded, steep slopes and a buffer surrounding streams should be reserved and protected for conservations purposes only (CME Associates, 2017).

9.1.2 Greenway Establishment & Maintenance

A *greenway* is a corridor of undeveloped land or open space, which often protects environmental features, such as a stream corridor, floodplain, forested ridgeline, or animal migration route, but which can also preserve a scenic view and provide recreational opportunities, such as parks or equestrian, biking and hiking trails. Greenway corridors also have the potential for positive economic impacts, by creating jobs, enhancing property values, expanding local businesses, attracting new businesses, increasing local tax revenues, decreasing local government expenditures, and promoting a local community. The publication Economic Impacts of Protecting Rivers, Trails and Greenway Corridors outlines procedures for analyzing economic impacts of a greenway project, and provides examples. Decision makers can benefit from recognition of potential economic impacts as well as intrinsic values of greenways in support of decisions that enhance the well-being of the community (National Park Service, 1995).

Garden State Greenways is an online planning tool designed for all those involved in conserving open space, farmland, and historic areas in New Jersey. It uses GIS to identify *hubs* **(**larger areas of undeveloped land with important natural resource values) and linear *connectors* between these hubs. The goal of the program is to help coordinate efforts of both private groups and government agencies (NJ Conservation Foundation, 2012).

Local governments often use a variety of planning and zoning techniques for establishing greenways, including creating a greenway map and adopting it as part of the Master Plan, creating a Greenway Overlay District, cluster zoning and Transfer of Development Rights. These strategies can be combined with land preservation, private land trusts, and conservation easements to meet the Township's open space and recreation goals. Before a greenway is established, issues of maintenance, public access and monitoring of easements must be addressed to ensure long-term success of the project (Howe, 1989).

According to the 2017 Parks, Recreation, and Open Space Master Plan Element, a significant objective of open space acquisition is to provide greenway linkages in the following areas:

- Manasquan River Greenway connecting Manasquan Reservoir and Allaire State Park, both north and south of Interstate Route 195
- Freehold-Allaire Greenway via an abandoned Freehold-Jamesburg railroad line
- Oak Glen Park to Soldier Memorial Park through the Bear Swamp
- Soldier Memorial Park to Allaire State Park to the Borough of Manasquan (CME Associates, 2017).

9.2 INVENTORY

9.2.1 Overview

An updated inventory of the preserved open space and recreation properties within the Township is presented in **Appendix E**, and the locations of the township's open spaces are shown in **Figure 9.1.** Note that the much of the 4,000 acres of Howell Township encompassed by the Naval Weapons Station Earle is undeveloped, but is not considered preserved open space. Using the acreage figures calculated by GIS, a total of 6,572.4acres of Open Space have been established in Howell Township (summarized in **Table 9.1**), which is approximately 16.8%of the Township's 39,149 acres. Nearly one third of the total preserved open space in Howell Township is managed by the township (32.2%). The remainder is managed by the county (40.4%) and the state (23.9%).

Table 9.1. Summary of Preserved Open and Recreational Space in Howell Township.

Name	GIS Acres*	Primary Use
Howell Township Parks		
Aldrich Lake Park	112.17	Passive recreation
Alfred E. Sauer Park at Echo Lake	21.88	Outdoor recreation
Ardena Acres Park	15.84	Neighborhood park
Ardena Schoolhouse/Arboretum	13.05	Passive recreation
Bear Swamp Natural Area	434.96	Passive recreation
Big Woods Natural Area	357.20	Passive recreation
Country Meadows Park	2.01	Neighborhood park
Deerwood Park	45.71	Athletics
Diamond Lane Park	18.49	Neighborhood park
Freedom Field	15.10	Athletics
Freewood Acres Park	22.37	Neighborhood park
Hoffman Field	8.56	Athletics
Howell Organic Community Garden	15.65	Community garden
Metedeconk/Palomino Court	4.28	Playground
Monmouth Ridings Park	1.14	Playground
Oak Glen Park	118.74	Athletics and off leash dog area
Pearl Drive Park	0.34	Neighborhood park
Pride Park	15.99	Neighborhood park
Ramtown Manor Park	10.26	Neighborhood park
Soldier Memorial Park [1]	52.10	Athletics
Stanford Brook Park	21.72	Playground
Tioga Park	2.94	Neighborhood park
West Farms Park	73.02	Neighborhood park
Winston Park	20.29	Neighborhood park
Howell Township Undeveloped Open Space		
Edgewood Park	13.97	Neighborhood park
Heathermeade Park	1.55	Neighborhood park
Lake Louise	59.24	Neighborhood park
Long Brook/Manasquan River Greenway	12.16	Greenway (undeveloped)
Manasquan Reservoir	57.11	Reservoir buffer
Manasquan River Greenway	70.61	Greenway (undeveloped)
Priscilla Lane Park	1.26	Neighborhood park

Name	GIS Acres*	Primary Use
Unnamed parcels	498.27	Unspecified
Open Space managed by Monmouth County		
Howell Park	302.32	Golf course
Manasquan Reservoir [2]	1,392.78	Water supply and outdoor recreation
Manasquan River Greenway	312.41	Greenway with river access
Metedeconk River Greenway	76.80	Greenway (undeveloped)
Pinnacle Tract	141.47	
Yellow Brook Tract	370.31	Outdoor recreation (undeveloped)
In acquisition process	61.61	
Open Space managed by NJDEP Division of Parks and Forestry		
Allaire State Park	1,571.83	State Park
TOTAL ACRES:	6,347.47	
Permanent Preservation of Newspaper Lots		
Bear Swamp Natural Area Newspaper Subscription Lots	224.93	Passive recreation
TOTAL ACRES INCLUDING NEWSPAPER LOTS:	**6,572.4**	
*Acreage calculated by GIS may vary from deed acreage.		
[1] Soldier Memorial Park is separated from Bear Swamp Natural Area for this report.		
[2] Combines the county-managed tracts owned by NJ Water Supply Authority and Monmouth County		
Sources: NJDEP, September 17, 2019; NJDA SADC, July 20, 2018; NJDEP Bureau of GIS, 2020; CME Associates, 2017		

Bear Swamp Natural Area. Photo credit: J. Osborne

9.2.2 Municipal Open Space

Of the 2,117.98acres of township-managed lands, 46.0% (927.30 acres) have been developed and 54.0% (1,087.05 acres) are presently undeveloped. The primary uses of developed open space in Howell Township include passive recreation, athletic parks, neighborhood parks, and playgrounds.

Bear Swamp Natural Area is the largest township-owned area of open space (**Figure 9.2**). Parcels were acquired by Howell Township beginning in 1987. It was then discovered that 320 acres had been given in the 1920's as premiums to newspaper subscribers (Lake Restoration and Wildlife Management Committee. January 2012b). There were about 4,900 small “newspaper lots", most about 2,000 square feet, with paper streets designated on the old tax maps (**Figure 9.2**). Further complicating the matter, parcels were assigned to both recorded and unknown owners, and some were never given out (Lake Restoration and Wildlife Management Committee, January 2012b). This challenge hindered the acquisition of the newspaper lots, but acquisition was completed by 2008 (DVRPC, November 2008), although the lots are not included in the state's open space GIS layer.

The Township's goal for managing the properties is to maintain Bear Swamp Natural Area as a natural area set aside for passive recreation (CME Associates, 2017). The area supports habitat for rare and endangered species, including the pine barrens treefrog, encompasses an important water recharge area, has miles of trails for passive recreation, and serves as a greenway between Manasquan Reservoir and Allaire State Park (Lake Restoration and Wildlife Management Committee, January 2012a). Although 52 acres of the natural area have been converted to active recreation by the creation of Soldier Memorial Park, Bear Swamp Natural Area now contains approximately 600 acres (depending on which parcels are considered part of Bear Swamp) (CME Associates, 2017).

The 2017 Parks, Recreation and Open Space Master Plan Element states that the objective of expanding the Howell Township Park System is to, "Acquire new properties in strategic locations, such as along rivers and in areas that are adjacent to existing preserved areas of the Howell Township (CME Associates, 2017). The Plan provides information about the recreational facilities available at each township owned property (CME Associates, 2017).

Howell Organic Community Garden.
Photo credit: J. Osborne

Soldier Memorial Park.
Photo credit: J. Osborne

9.2.3 County Open Space

The Manasquan Reservoir, located in the center of Howell Township (**Figure 9.3)**, is one of the jewels of the county park system. Zink (2010) said it was the most visited park in the county, highlighting features including a visitor center, an environmental center, a five-mile perimeter trail, forests relatively undisturbed by invasive species, and nesting bald eagles. While the reservoir itself is owned by the New Jersey Water Supply Authority (1,052 acres, 770 of which are under water), Monmouth County leases the land and has acquired additional property. Some adjacent land in the reservoir's buffer zone (57.11 acres) is owned by Howell Township. The Manasquan Reservoir site is managed as an outdoor recreation area, offering a trail system and water based recreation such as boating and fishing. Plans to expand the park are noted in the county's Open Space Plan (Monmouth County Park System, 2019).

The 369-acre Yellow Brook Tract (**Figure 9.4**) is an undeveloped open space that was purchased for conservation purposes. It is located at the junction of the Pinelands and Piedmont Plains Landscape Regions and protects the lower watershed of the Yellow Brook, a major tributary of the Manasquan River. Two other Monmouth County conservation projects that are co-located in both Howell and Freehold Townships are the Manasquan River Greenway and the Metedeconk River Greenway. The Metedeconk River Greenway also extends into Ocean County, as the river serves as a county border (Zink, 2010). As with the Yellow Brook Tract, watershed protection was one primary reason for the establishment of the greenways. Another was habitat connectivity (see discussion of CHANJ in **Section 8.2.2**). All three of these projects are ongoing, and plans for additional acquisitions are discussed in the county plan (Monmouth County Park System, 2019). Monmouth County's plans for open space acquisition in Howell Township are consistent with the core habitats and corridors identified as priorities for protection shown in **Figure 8.11** in the preceding chapter.

Howell Park was built as a county golf course on the site of an old dairy farm (Zink, 2010). Approximately 40% of the park's acreage was preserved as forest to help protect the Manasquan River Watershed and is currently used for passive recreation. Potential expansion of the park would also contribute to the development of the Manasquan River Greenway (Monmouth County Park System, 2019).

An interactive trail map App is available for Monmouth County parks (see **Internet Resources**).

9.2.4 State Open Space

Allaire State Park (**Figure 9.5**) occupies 3,080 acres in total. Just over half of the park (51%) is located in Howell Township, and the rest is in Wall Township. Historic Allaire Village, just east of the township line, was once known as the Howell Works and was a production site for pig and cast iron in the early 19th century. Much of the park remains in a natural state, protecting a section of the Manasquan River as well as native flora and fauna (NJDEP Parks and Forestry, 2019).

9.3 PRESERVED FARMLAND

The goal of Howell Township's farmland preservation program is "To preserve, to the maximum extent practical, Howell's agricultural industry and further enhance the promotion of farmland preservation within the township." Of the township's two-cent per $100 assessed property value tax dedicated to fund farmland preservation, open space, and passive recreational projects, one cent is allocated for farmland preservation projects only (Monmouth County Planning Board and Birdsall Services Group, May 2011).

Based on the 2015 land use data, farmland accounts for about 7.2% of the total land in Howell Township, with a total of 2,838.25 acres actively farmed (see **Figure 2.4** and **Table 2.2** and **Table 9.2).** The types of farmland, as tracked by the NJ Division of Taxation (which is not the same as the land use types from the GIS coverage), are summarized in **Table 9.2** (NJ Division of Taxation, 2019).

1¢ of Howell Township's 2¢ Open Space, Recreational, Farmland and Historic Preservation Trust Fund tax is dedicated to farmland preservation.
(Monmouth County Planning Board and Birdsall Services Group, May 2011)

Farm on Merrick Road, 1969.
Photo credit: L. Doud

Farm on Merrick Road, 2020.
Photo credit: L. Doud

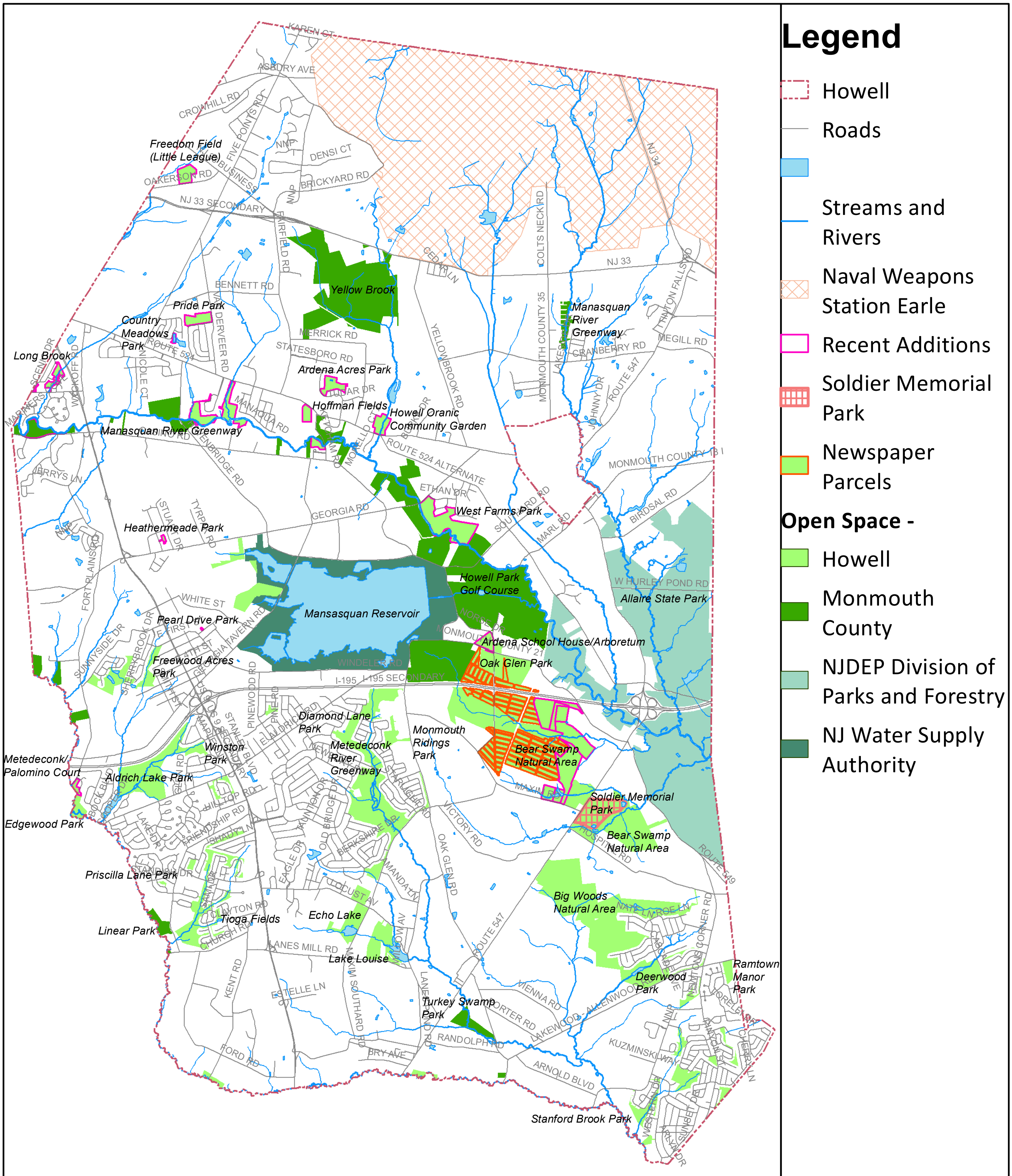
Twenty-two farms representing one quarter (25.8%) of the township's farmland has been preserved (**Table 9.3 and Figure 9.6**). The 732 acres of preserved farmland accounts for 1.9% of the land in Howell.

Combined totals of preserved open space and farmland yield a collective 6,976.86 acres that have been protected in Howell, which is 17.8% of the land in the township. Plans for the preservation of additional lands in support of conservation objectives such as the creation of greenways to link existing open spaces and the protection of environmentally sensitive areas are outlined in the Parks, Recreation and Open Space element of Howell Township's Master Plan (CME Associates, 2017).

Table 9.2. Howell Township Farmland Data Report (2019)

Cropland Harvested	**Cropland Pastured**	**Permanent Pasture**
1,872 acres	259 acres	794 acres
Total Woodland Wetland	**Horse Boarding-Rehabilitation and Training**	**Renewable Energy**
2,447 acres	229 acres	42 acres
	Total Land Devoted to Agricultural or Horticultural Use	5,643 acres
Source: NJ Division of Taxation, 2019		

Muddy Creek Farm, 2020.
Photo credit: J. Osborne



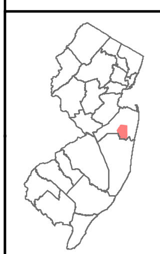


Figure 9.1. Howell Township, Open Space

Note: Always confirm accuracy of parcel ownership and preservation status with the Community Development office before relying on same.

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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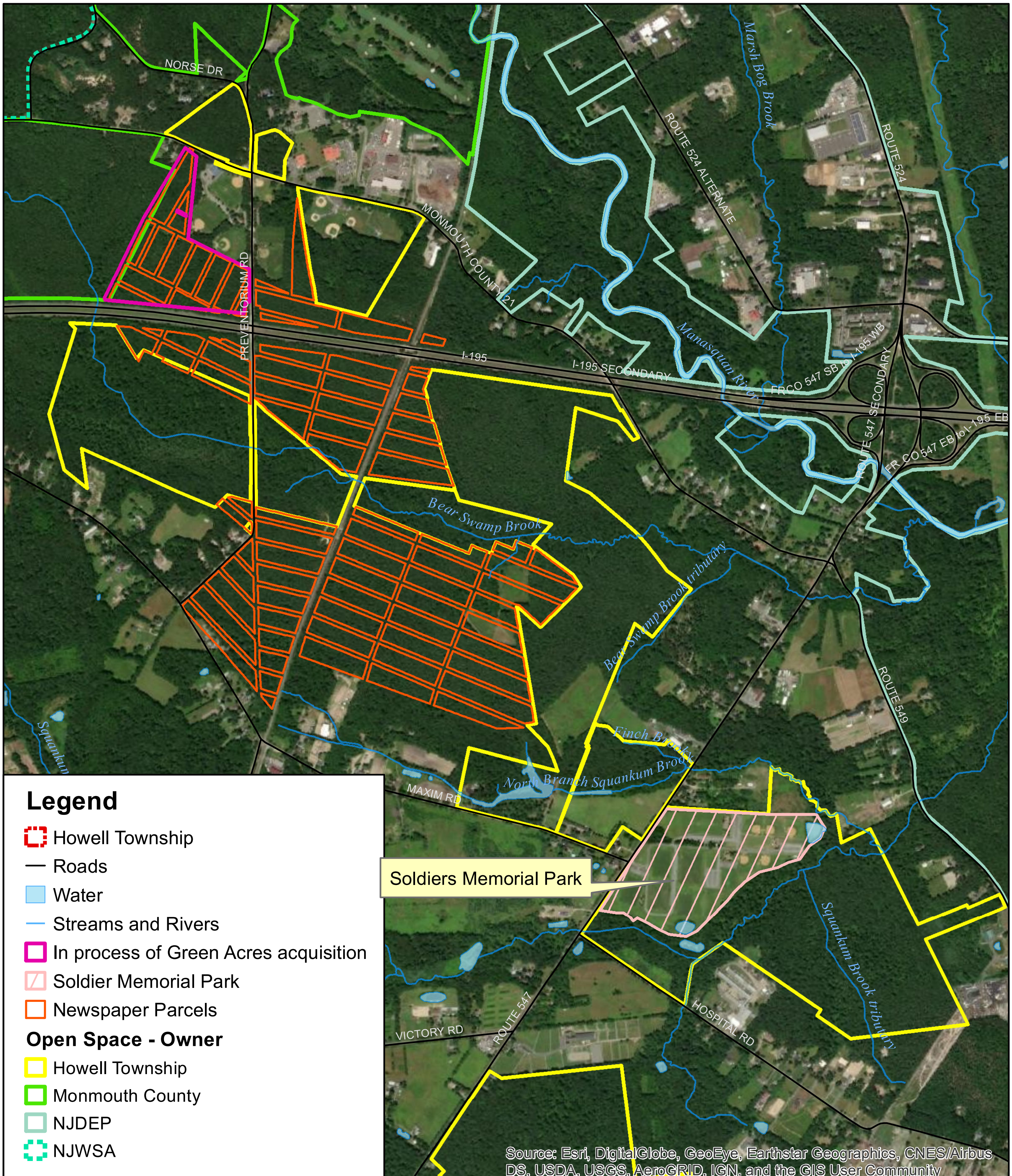
2020



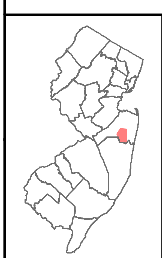


Figure 9.2. Howell Township, Bear Swamp Natural Area

0 0.125 0.25 0.5 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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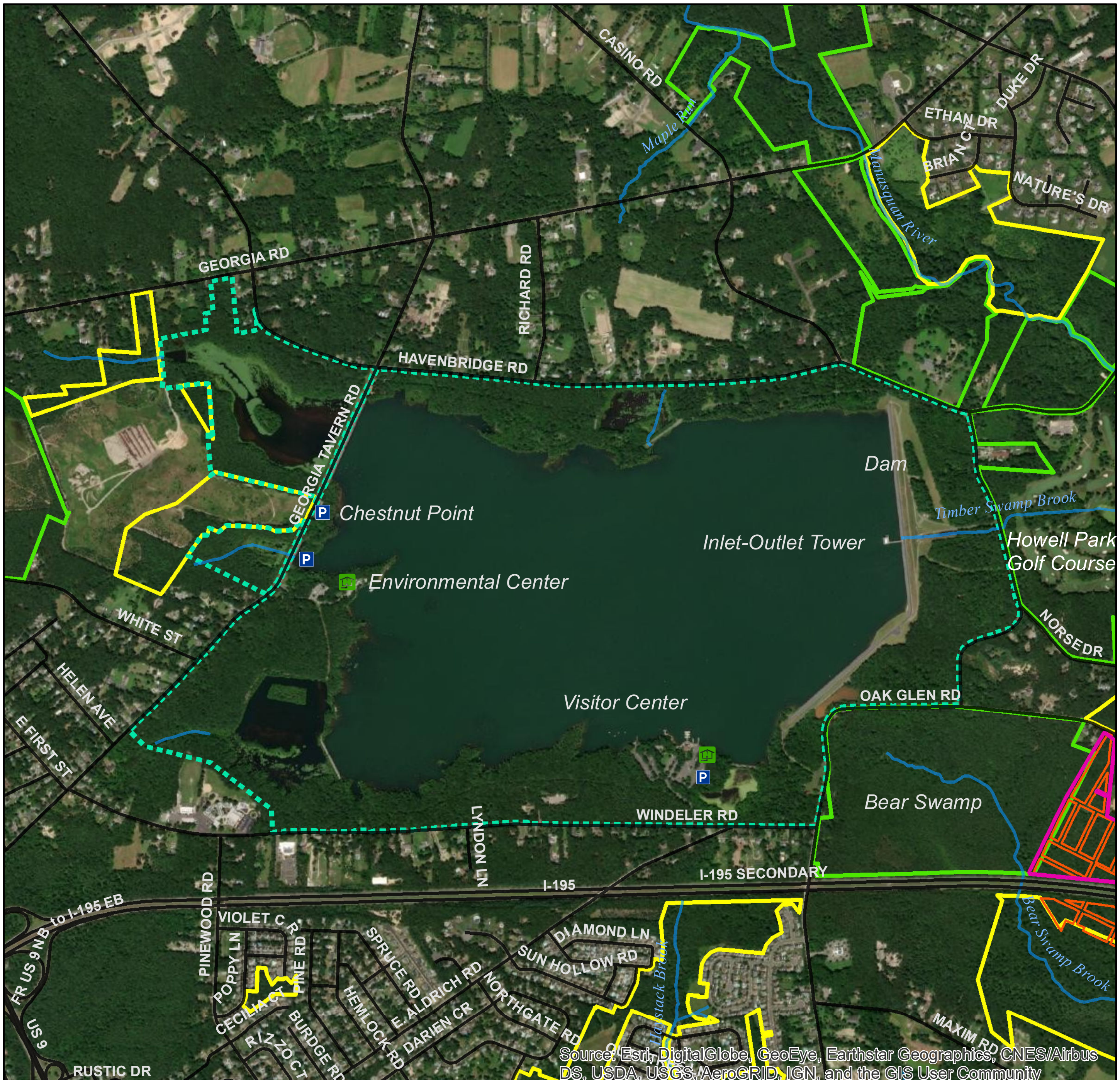


Legend

- Roads
- Streams and Rivers
- In process of Green Acres acquisition
- Newspaper Parcels

Open Space - Owner

- Howell Township
- Monmouth County
- NJDEP
- NJWSA

The Monmouth County Parks website for the Manasquan Reservoir provides details, including hours and a map: https://www.monmouthcountyparks.com/Page.aspx?ID=2531

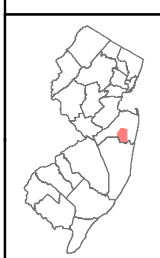


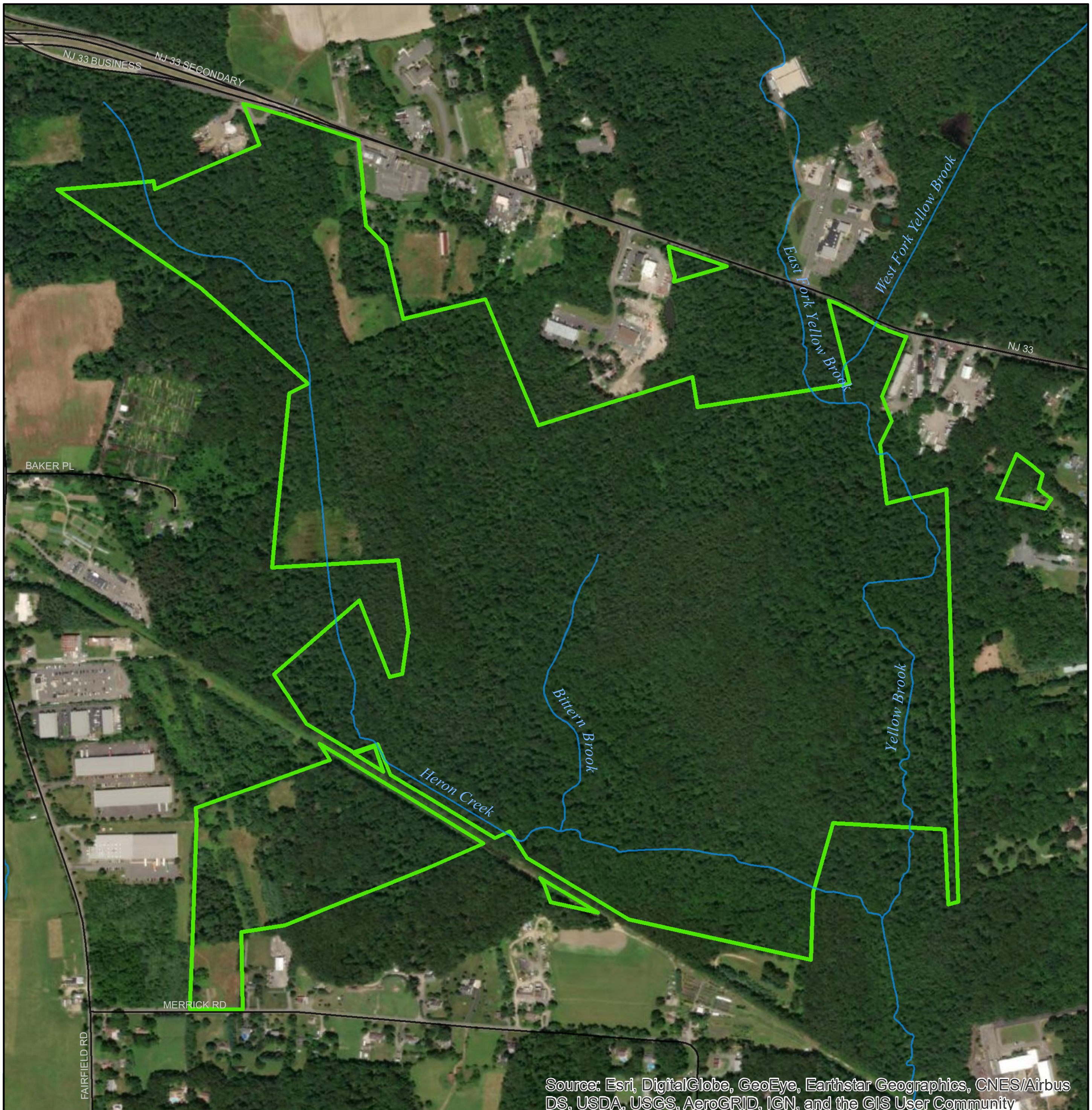
Figure 9.3. Howell Township, Open Space: Manasquan Reservoir

0 0.125 0.25 0.5 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI
2020



Legend

Roads

Streams and Rivers

Open Space - Owner

Monmouth County

Figure 9.4. Howell Township, Open Space: Yellow Brook

0 0.05 0.1 0.2 Miles

N

Data Sources: NJDEP, NJDOT

Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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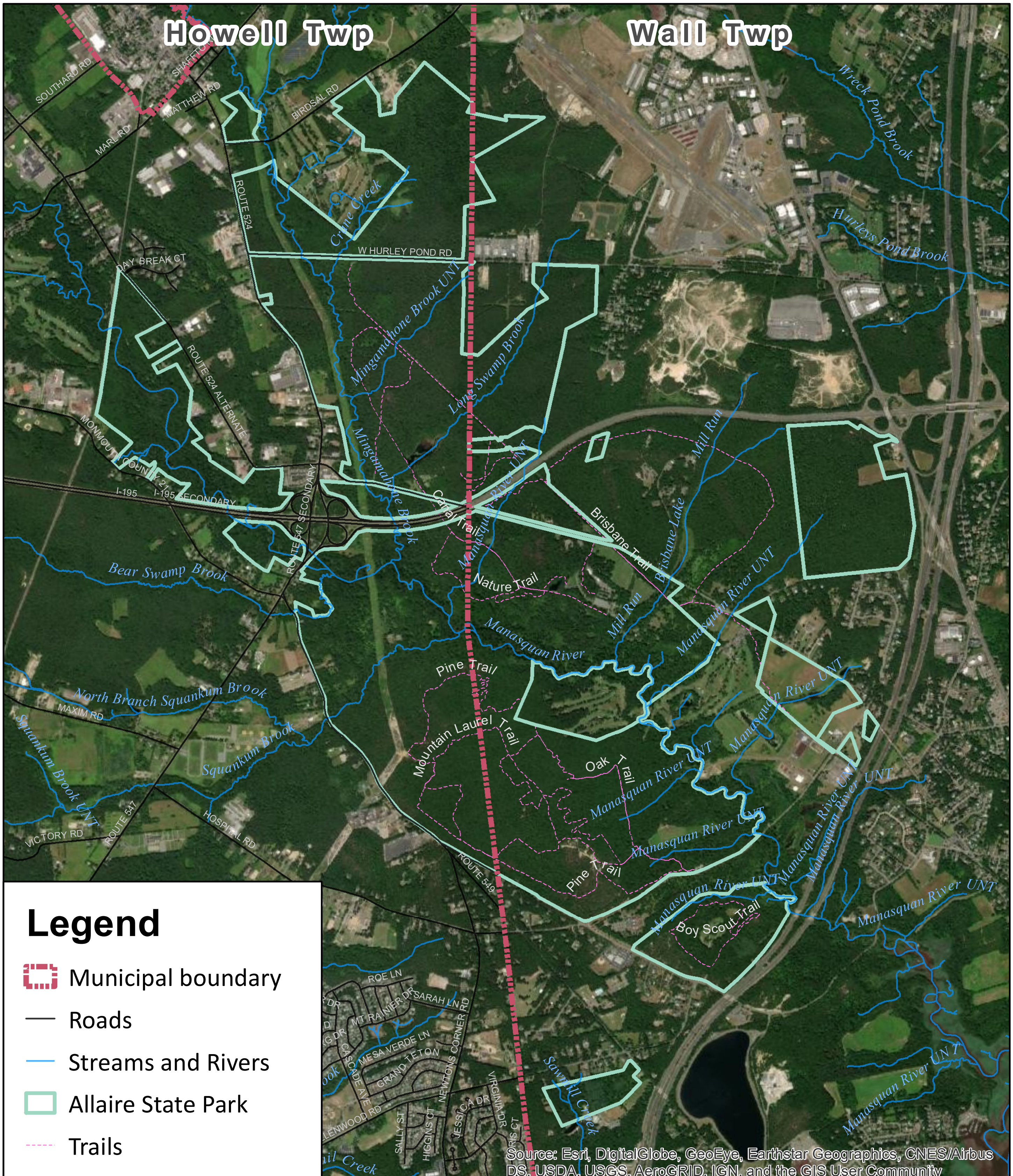
Howell Township ERI

2020



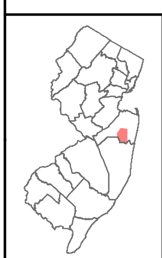
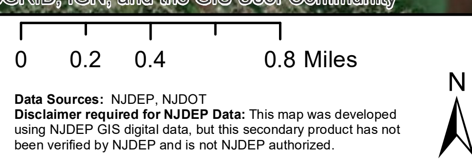


Figure 9.5. Howell Township, Open Space: Allaire State Park



Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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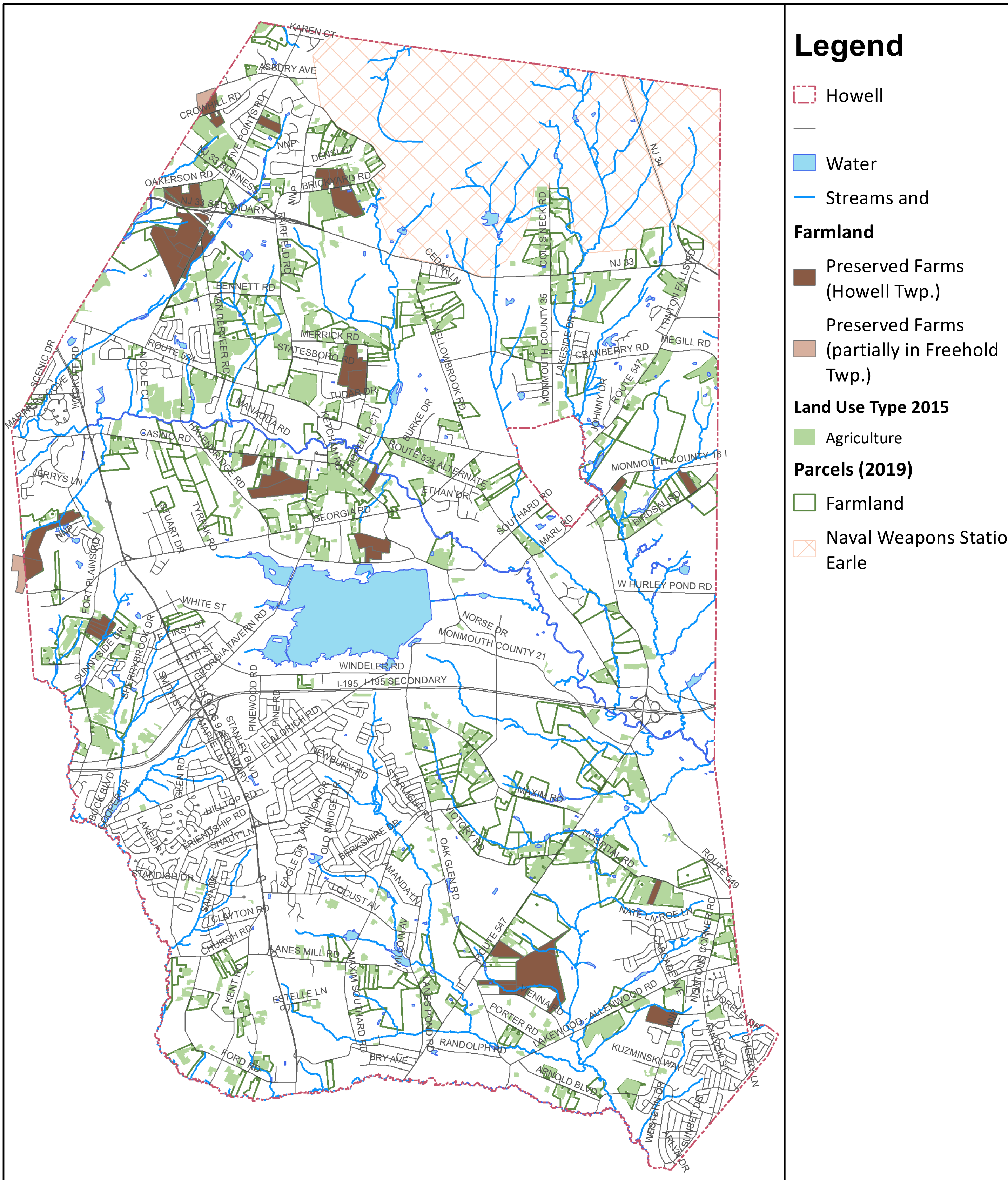
Howell Township ERI
2020

Table 9.3: Preserved Farmland in Howell Township.

Date Preserved	Block	Lot	Acres	Total Parcel	Owner(s) at time of preservation
10/13/1987	164	17	53.34	68.75	Meade, David
	164	21	4.97		
	166	3	10.44		
9/17/2001	178	8	35.85	62.82	Keymer, Susan
	178	14	21.84		
	178	15	5.13		
6/27/2003	3	20	25.25	25.25	Borshowsky, Paul
11/17/2004	156	6	9.99	9.99	Marchese, Michael & Susan
12/22/2004	176	42.05	11.59	46.88	Brocklebank, Wayne & Louise
	183	31	35.29		
12/29/2004	176	41	7.81	16.09	Giambrone, Arthur & Mona
	176	42.02	8.28		
9/26/2005	170	30.03	7.83	18.66	Elsie & Donald Archbold
	171	10.01	10.83		
1/20/2006	175	23.04	11.59	11.59	Linney, John & Lissa
4/28/2006	151	8	8.96	8.96	George & Anita Casale
6/2/2006	224	14	5.55	5.55	Peacock, Donald & Georginia
7/6/2006	224	33	11.14	11.14	Costigan, John/Crombie, Elizabeth
4/16/2007	135	9.03	6.09	26.96	Shapiro, Drew (Sunset Stables)
	135	9.04	6.05		
	135	9.05	6.08		
	135	9.06	8.74		
5/18/2007	138	30.01	26.49	43.93	John Cuddihy Jr.
	138	49	17.44		
6/29/2007	151	18	42.47	42.47	Plum Tree Holdings LLC (Dee K. Lee)
7/19/2007	42	59.01	9.01	9.01	Mark Shaffery & Doreen Schottman
9/26/2007	154	5.02	10.22	10.22	Fred & Jeann Aker/Phyllis Mazza
10/29/2007	138	30	15.65	15.65	Terpack, Mary: Estate of
11/16/2007	164	7.05	31.56	35.38	Okerson, Charles H
	164	13.01	3.82		
1/4/2008	42	6	96.39	147.94	Tullo Vaccaro Farm (T & T Realty)
	42	15	5.73		
	42	17	9.31		
	42	22	7.62		
	42	31	17.82		
	42	37	11.07		
1/13/2012	154	11	26.51	26.51	Clayton, Thomas & Emily/Monmouth C
5/25/2016	164	8.01	4.13	67.95	John D. Thompson, Sr. Family Limited
	164	15.01	45.00		
	164	16	9.61		
	168	38	9.21		
3/23/2018	151	12.02	19.78	20.62	Feigus, Brad & Barbara
	151	12.02	0.84		
Total Acres of Preserved Farmland				**732.32**	
* Preserved tracts include additional acreage in neighboring municipality (Freehold).					
Note: Acreage calculated by GIS may vary from deed acreage.					
Sources: NJDA SADC, July 20, 2018; NJDA SADC, January 29, 2020					



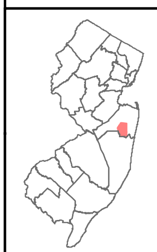


Figure 9.6. Howell Township, Farmland

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Howell Township ERI

2020

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Allaire State Park: https://www.state.nj.us/dep/parksandforests/parks/allaire.html

Association of New Jersey Environmental Commissions: http://anjec.org

Garden State Greenways: http://www.gardenstategreenways.org

Monmouth County Parks: https://www.monmouthcountyparks.com/

Trails Web Map: http://mcps.maps.arcgis.com/apps/Viewer/index.html?appid=29e4c94fe4de4c16b6bde3fcc3d355cd#!

Trails phone app (instructions): https://co.monmouth.nj.us/documents/130/lost_in_parks_app_instructions_updated_2_12_2018.pdf

Native Plant Society of New Jersey: http://www.npsnj.org

New Jersey Conservation Blueprint: https://www.njmap2.com/blueprint/

New Jersey Green Acres Program: http://www.nj.gov/dep/greenacres/index.html

New Jersey Natural Lands Trust: https://www.nj.gov/dep/njnlt/

NJDEP Green Acres Program: https://www.nj.gov/dep/greenacres/pdf/osrpg_2019.pdf

Rain Garden Manual: http://www.npsnj.org/pages/nativeplants_Rain_Gardens.html

Rutgers NJ Agricultural Experiment Station – information for farmers, gardeners, & consumers: http://njaes.rutgers.edu/

Winston Park tree planting. Photo credit: K. Diaz

10. Historical and Archeological Resources

10.1 History

10.1.1 Prehistory

The southeastern part of Monmouth County is located in New Jersey's outer coastal plain region, which was submerged beneath the ocean multiple times during the Tertiary Period of the Cenozoic Era (Collins and Anderson, 1994). A series of repeated invasions and withdrawals by the sea formed the characteristic soils of the region (see **Section 5**) and left behind a rich record of marine life in the form of fossils. Mollusk shells, shark teeth and the bones of prehistoric whales are abundant in Monmouth County, and fossil records of *Cimoliasaurus*, a short-necked sea reptile, have also been found in the region. Prior to that series of inundations, the area was inhabited by dinosaurs, and Monmouth County has also produced the fossilized remains of late Cretaceous Period inhabitants such as *Hadrosaurus*, *Ankylosaurus* and *Coelosaurus* (Gallagher, 1997).

Map showing the Lenapehoking region. Boundaries and rivers are from USGS data.
Image credit: Kmusser
https://commons.wikimedia.org/wiki/File:Lenapehoking.png

During the last glacial period when most of northern New Jersey was covered by an ice sheet, the lower part of the state was "a wind-swept tundra where great prehistoric beasts roamed" (Gallagher, 1997). Gallagher (1997) mentions an assortment of early vertebrate records from Monmouth County, including giant beaver teeth, giant ground sloth claws, elk-moose bones and antlers, and mastodon remains.

10.1.2 Native American

There is evidence that the area now known as Monmouth County has been inhabited by humans for thousands of years. Stone implements with fluted points characteristic of Paleo-American cultures were recovered at an archeological excavation site near Freehold, and radiocarbon dating indicated that the tools originated during the period from 7,041 B.C. through 5,939 B.C. Similar artifacts have been found at other locations in the county, including Farmingdale and Squankum (Marshall, 1982). A Paleo-American site in Howell Township, located south of Squankum-Yellowbrook Road, is one of the oldest known settlements in eastern North America (Usechack, 1999).

The earliest documented native inhabitants called the area Lenapehoking, which means land of the Lenape. Lenapehoking encompassed all of what is now New Jersey, eastern Pennsylvania, southeastern New York State, northern Delaware, and a small section of southeastern Connecticut (Lenape Lifeways, 2002). The Lenape people were peaceful and were skilled at agriculture, hunting, fishing, and shellfish harvesting. The original residents traveled with the seasons, moving to the shore areas for shellfish and cooler weather in the summers but maintaining permanent settlements inland for the rest of the year. They used polished local seashells (wampum) for trade with other tribes. Artifacts found along the Manasquan River suggest this was once a favorite fishing spot for the Lenape people (Usechack, 1999).

The people in the southern half of Lenapehoking, below the Raritan River and the Delaware Water Gap, spoke the Unami dialect of the Eastern Algonquin Delaware language (Lenape Lifeways, 2002). The Hominy Hills, which are part of the ridge that divides the inner and outer coastal plains at the Earle Naval Ammunition Depot, derive their name from 'Homhomonany', a Southern Unami word for herring stream or river. The Mingamahone Brook, which originates in the Hominy Hills, was named for a word that has been translated as 'big salt lick' or 'big dugout canoe' by various authors. Mingamahone Brook flows south to the Manasquan River, the Unami name of which means 'place to gather grass or reeds' (Grumet, 2014). Additional native place names and their derivations are still in use for numerous communities, waterways and roads throughout Monmouth County, including Assunpink, Chingarora, Conaskonk, Crosswicks, Hockhockson, Lahaway, Lenape, Luppatatong, Mahoras, Manalapan, Matawan, Matchaponix, Metedeconk, Mohingson, Narraticon, Navesink, Poricy, Port-au-Peck, Ramanessin, Ramapo, Raritan, Rumson, Shoppen, Squankum, Takanassee, Tepehemus, Tioga, Waackaack, Wanamassa, Weamaconk, Wemrock, Wickapecko and Wickatunk (Grumet, 2014).

10.1.3 From European Settlement to Recent History

Colonial Settlement

The first record of Europeans in Monmouth County was when Captain Henry Hudson's ship, the Half Moon, landed inside Sandy Hook in September of 1609. During the next half century, the area was settled by the Dutch until their claims were surrendered to England in 1664 (Ellis, 1885). The division of New Jersey into East and West Jersey in 1676 was soon followed by the 1683 subdivision of East Jersey into four counties, one of which was Monmouth County. Ten years later, Monmouth County was divided into Freehold, Middletown and Shrewsbury Townships, the last of which included what is now Howell Township as well as most of the land currently encompassed by Ocean County (Snyder, 1969).Early European settlers relied primarily on agriculture, so settlement corresponded approximately to locations with the best agricultural soils. One of the first colonial settlements within Howell Township was founded in the 1760s by a Methodist church society. After first holding meetings in a barn, a permanent structure for the Bethesda Methodist Church was constructed in 1779 on what is now Lakewood Road (DVRPC, 2008).

Early roads in the region were established along Lenape trailways, which were widened to accommodate horses and wagons. Local examples include Route 9 and Route 33. Some early settlements in what is now Howell Township were located in Lower Squankum, where a Quaker Meeting House was established in 1778, and at Blue Ball (presently called Adelphia but formerly named after a local tavern) (Usechak, 1999).

The land that is now the Borough of Farmingdale became the center of commerce in the 1800s, and contained

Historic Squankum United Methodist Church.
Photo credits: J. Osborne

churches, shops, taverns, and other buildings. Marriner's Tavern, built in 1747 and later changing its name to Our House Tavern, was locally significant during the Revolutionary War when both British and American troops were occasionally stationed there. The area was previously known as Marsh Bog and later Upper Squankum, before becoming known as Farmingdale in 1854 (DVRPC, 2008).

Bethel (now Southard) was settled in 1865 when Israel Reynolds donated land on which to build a Methodist Church. A schoolhouse and a store followed in 1870 and 1872, respectively. When a post office was opened in 1882, it reflected the locality's new name of Southard (Donahay, 1967). The Reynolds House and Outbuildings and the Southard Grange are now listed on the National Register of Historic Places (**Figure 10.1** and Table 10.4).

Township Incorporation

Howell Township was established on February 23, 1801 from a portion of the original Shrewsbury Township. According to Navarra (1996), Howell Township was named for New Jersey's third governor, Richard Howell. Howell served as governor from June 3, 1793 through October 31, 1801, and thus would have been in office at the time of the township's formation.

During the early years, several post offices were located in the township along a postal route that ran from Point Pleasant to Freehold (right). In 1830 the township population was 4,141, and in 1832 Howell included 11 stores, 10 sawmills, 5 gristmills, 2 fulling mills, 4 carding machines, 26 tanning vats, 2 distilleries, 1 operating furnace, 365 horses and mules, and 1400 cattle (Donahay, 1967).

Excerpt from regional map (Burr, 1839).

After Ocean County was established in 1850, southern sections of the original Howell Township were transferred to municipalities in the adjacent county, including portions to Brick Township in 1850, Dover Township in 1851, and Jackson and Lakewood Townships in 1929. Also in 1851, the eastern section of Howell Township became Wall Township. Wall originally extended east to the Atlantic Ocean, but between 1884 and 1939 the eastern portion of that township was repeatedly subdivided to form a number of smaller municipalities currently extending from Belmar to Brielle. On April 8, 1903, less than one percent (0.85%) of the land remaining in Howell Township was used to form Farmingdale Borough (Snyder, 1969), which is completely surrounded by Howell.

Agriculture

Agriculture continued to be the principal economic activity in the area throughout the early 1900s, when one of the busiest public markets in the state was located in Freehold Township. Until the 1950s, potatoes were a leading crop in the region. In the areas along Marsh Bog Brook, (Squankum), many cranberry bogs were farmed commercially from the late 1800s to early 1900s. However, saltwater intruded after the Point Pleasant Canal was opened in 1926. This resulted in the shutdown of many cranberry bogs between 1930 and 1950 (DVRPC, 2008).

Industry

In addition to agriculture, important colonial industries included making bricks, munitions, bog iron and marl. The area's abundance of clay provided the raw materials for making bricks. Several brick-making facilities operated in the area that is now Naval Weapons Station Earle. A large labor force was needed to dig and transport the clay, and to cut timber to fire the kilns. As resources became scarcer, Howell's brick-making companies ceased production by the late 1800s (DVRPC, 2008).

The region's slow moving, acidic waters and marshes yielded rust-resistant bog iron from natural deposits. In 1822, James P. Allaire purchased 5,000 acres in Howell Township and constructed a self-sufficient company town, which contained 70 buildings and a population of 500 at its height. The company, Howell Works, included a pig iron furnace and a three-mile long canal that powered the furnace. The iron was used mostly for the construction of ships, especially at Allaire's own shipping yards in New York, but was also used to manufacture stoves, cookware, pipes, and irons. Howell Works also produced hundreds of thousands of bricks every year. However, production declined and the ceased in 1840s due to competition from higher quality iron from Pennsylvania, combined with depleted timber resources needed to fuel the furnaces. Allaire Village was abandoned until it was purchased by Arthur Brisbane in 1907, leased to the Monmouth Council of the Boy Scouts between 1927 and 1947 and then donated to the State of NJ to make Allaire State Park in 1941 (DVRPC, 2008).

The discovery of a greensand marl deposit in 1830 transformed Howell from one of the poorest areas in the county to one of the most fertile districts in the state, reputedly boosting some local property values by a factor of 20 (Donahay, 1967). As the marl industry developed over the next several decades, so did the region, resulting in the establishment of additional businesses selling clay and topsoil and the expansion of rail and roadways to transport the commodities (Usechak, 1999).

Another notable industry in Howell during the latter part of the nineteenth century included the production of munitions and blasting powder that was transported to other states and used for excavating coal mines and building harbors, subways, and skyscraper foundations (Donahay, 1967). The Phoenix Powder Manufacturing Company manufactured gun powder at a plant in the northern area of Howell Township, while the Maxim Powder Company was located just west of Bear Swamp Natural Area. This area of Howell is named Maxim after inventor and entrepreneur Hudson Maxim (DVRPC, 2008).

Howell Preventorium

As mentioned above, Arthur Brisbane bought 5,000 acres in Howell Township in 1907, including Allaire Village, for the purpose of establishing a facility known as the Preventorium. In order to prevent children from contracting tuberculosis, a highly infectious disease, they could be quarantined at the Preventorium after they had been in contact with tuberculosis sufferers. Brisbane built the Preventorium (which is now the site of the Howell Municipal Complex) where up to 230 children were housed between 1912 and 1962 (DVRPC, 2008).

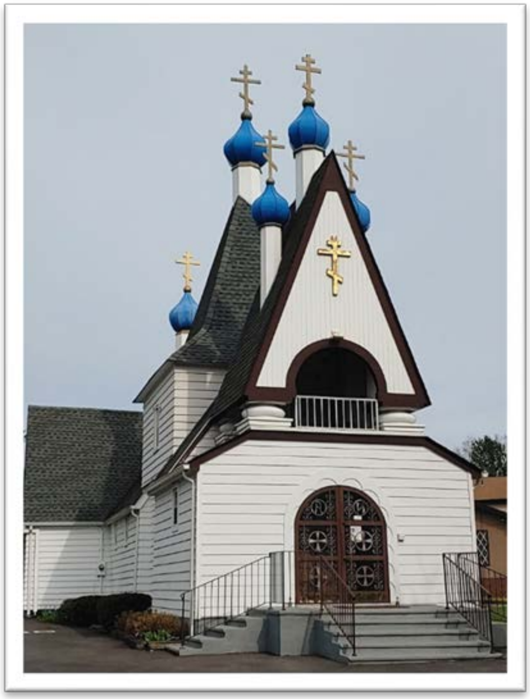
Naval Weapons Station Earle

During World War II, the US Government purchased about 10,000 acres of land in northern Howell Township and southern Colts Neck Township to provide munitions in the New York metropolitan region. Naval Weapons Station Earle was commissioned in 1943 and named for Rear Admiral Ralph Earle, who was responsible for the procurement, storage, and deployment of naval weapons in World War I. The Mainside section of the base is located in Howell and Colts Neck, while the Waterfront Area is on Sandy Hook Bay, and the two sections are connected by a 15 mile military road and railroad. The primary mission is to provide ammunition to the fleet, including logistics, testing, and engineering (Naval Weapons Station Earle, 2020).

Local Jewish History

Jewish people have lived in the area since the 1780s. Many Eastern European Jews moved to Monmouth County from New York City to escape persecution in the late nineteenth century. The Jewish Agricultural Society encouraged another Jewish migration to the area in the 1920s and 1930s, and focused on establishment and operation of poultry farms. As a result, Monmouth County was the leading egg producer in the nation in the 1930s (DVRPC, 2008). Many economic changes, as well as rapid suburbanization, led to the decline of Howell Township's poultry industry in the 1950s and 1960s (DVRPC, 2008).

Kalmyk and Russian Immigration



Our Lady of Tikhvin Church.
Photo credit: J. Osborne

Another group to immigrate and settle in Howell Township is the Kalmyks, an ethnic group originally from Mongolia who had migrated to the area that is now Russia in the seventeenth century. Because many of the Kalmyks sided with the Germans in World War II, many were sent to refugee camps and were denied citizenship and education. The US Board of Immigration Appeals allowed 571 Kalmyks to immigrate to the US in 1951. Most settled in either Philadelphia or the Freewood Acres section of Howell Township. Their traditional religion is Tibetan Buddhism, and they built Tashi Lhunpo Temple in Howell Township (DVRPC, 2008).

A group of Russians immigrants, known as the Old Believers, also settled in Howell Township's Freewood Acres. In seventeenth century Russia, the Old Believers originated in opposition to religious reforms in Russia (DVRPC, 2008). St. Alexander Nevsky Cathedral, Our Lady of Tikhvin Church and St. George's Church all display the distinctive cupolas (onion-shaped domes) of Russian architecture.

10.2 ARCHEOLOGICAL INVENTORY

The New Jersey Historic Preservation Office (HPO) catalogues locations of prehistoric or historic occupation or activity possessing archaeological value. The archeological site grid dataset indicates the presence of archeological sites on a half-mile grid for informational purposes only and does not preclude the existence of other archaeological districts or sites as yet unidentified, unrecorded, or undocumented. Locations of the 30 archeological site grids that fall fully (23) or partially (7) within Howell Township are shown in **Figure 10.1** (NJDEP HPO, January 29, 2019a). Seven of the grids in the township have been determined to be eligible for listing in the National Register of Historic Places, primarily those associated with the Manasquan River east and southeast of the reservoir. Eligible archaeological sites, as well as those actually listed in the National Register, are referred to as archaeological historic properties. The presence of archaeological sites should be taken into consideration prior to embarking on a project that would disturb the ground or change the character of the property (NJDEP HPO, April 4, 2019).

10.3 HISTORIC INVENTORY

10.3.1 Historic Districts

The NJDEP Historic Preservation Office (HPO) defines Historic Districts as areas that possess a significant concentration, linkage, or continuity of buildings, sites, structures, or objects united historically or aesthetically by plan or physical development. Historic Districts include National Historic Landmarks; areas on the New Jersey or National Registers of Historic Places; areas determined eligible for inclusion in the registers; districts designated as Local Historic Districts by a local government; or areas that have been identified through a cultural resource survey or other documentation on file at the HPO.

Three historic districts are currently identified in Howell Township (see **Table 10.1** and **Figure 10.1**). Two railroad rights-of-way that pass through the township received opinions of eligibility from the State Historic Preservation Officer on June 30, 2008. The Freehold and Jamesburg Agricultural Railroad Historic District is co-located in five other Monmouth County municipalities (including Farmingdale Borough) and two municipalities in Middlesex County. The New Jersey Southern Railroad Historic District also extends into seven other municipalities in Monmouth County (including Farmingdale Borough, where the two districts connect) and four Ocean County municipalities (NJDEP HPO, December 30, 2019). The initial opinion of eligibility for the Naval Ammunition Depot at Earle was dated January 29, 2001, but a revised opinion on August 12, 2014 revised the extent of the Historic District at the Naval Weapons Station. Portions of the Naval Ammunition Depot Earle Historic District also fall within three other Monmouth County municipalities.

Table 10.1. Howell Township Historic Districts.

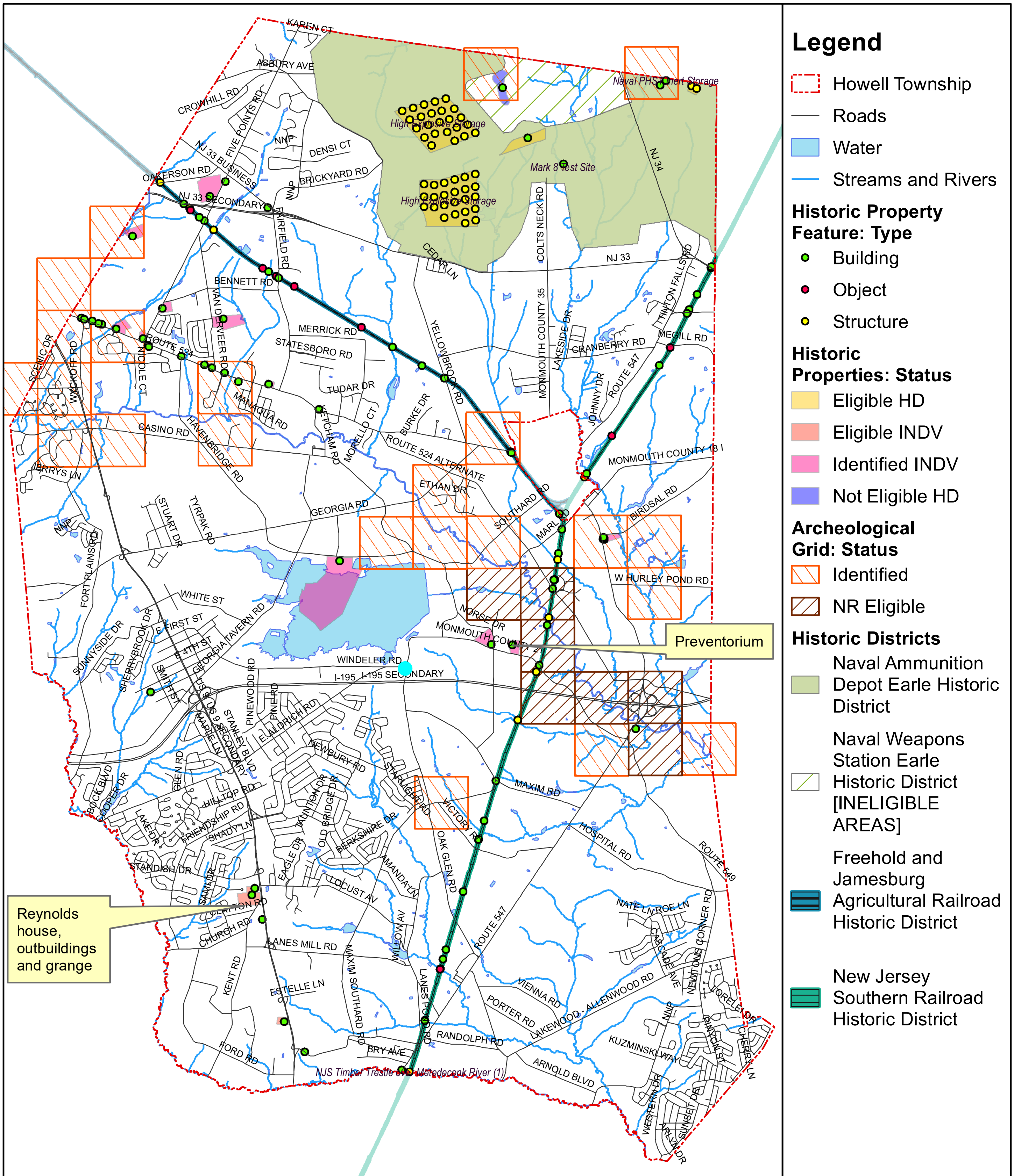
Name	Status	Intact	Description
Freehold and Jamesburg Agricultural Railroad Historic District	NR Eligible	Yes	Railroad right-of-way from Middlesex, South Brunswick Township to Monmouth, Farmingdale Borough
New Jersey Southern Railroad Historic District	NR Eligible	Yes	Railroad right-of-way from Monmouth, Red Bank Borough to Ocean, Lakewood Borough
Naval Ammunition Depot Earle Historic District	NR Eligible	Yes	Roughly bounded by NJ Route 33, Garden State Parkway and NJ Route 18
Naval Weapons Station Earle Historic District (excluded areas)	Not eligible	Yes	No longer eligible areas of NWS Earle
Source: NJDEP HPO, January 29, 2019b			

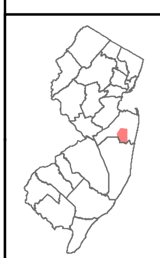
10.3.2 Historic Properties

According to the NJDEP HPO, Historic Properties are buildings, sites, structures, or objects that are evaluated as historically significant. These include properties that are on the National Historic Landmarks; included in the state or National Registers of Historic Places; determined Eligible for inclusion in the registers through the state or federal HPO processes; designated as Local Landmarks by local government; or identified through cultural resource survey or other documentation on file at the HPO. Properties on the current HPO inventory are shown in **Figure 10.1.**

Ardena Public School No. 2.
Photo credit: J. Osborne

Many of the historic properties in Howell Township are linked with the regional Historic Districts. Properties associated with historic railroad corridors are listed in **Table 10.2**, and those associated with the Earle Naval Weapons Station are listed in **Table 10.3**. Although connected by context, two of the railroad bridges and one building at Earle were also eligible as individual structures, as specified in the tables. Another building at Earle was no longer eligible following the 2014 revision discussed in **Section 10.3.1**.





Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 10.1. Howell Township, Historical and Archeological Resources

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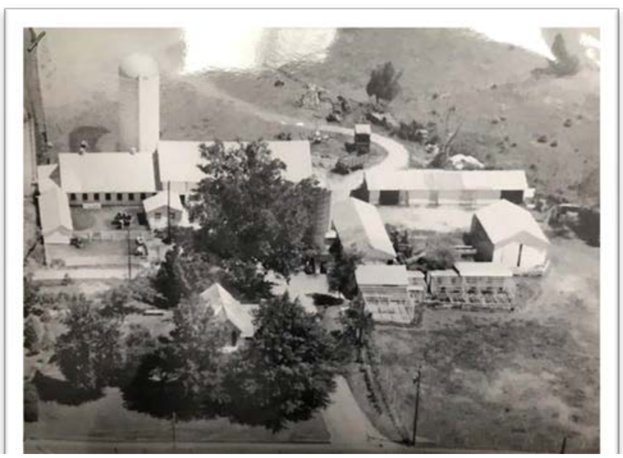
Table 10.2. Historic Properties Associated with Railroad Corridors.

Object ID	Historic Feature	Type	Intact	Eligibility
Freehold and Jamesburg Agricultural Railroad Historic District				
65018	F&JA Masonry Bridge over Long Brook (Killtime Brook)	Structure	Yes	Eligible as individual structure
65020	F&JA over Yellow Brook	Building	Yes	Eligible as part of Historic District
65213	F&JA Equipment Cabinet and Post	Structure	Yes	
65214	F&JA Concrete Block Wall	Structure	Yes	
65215	F&JA Milepost 20 MP20	Object	Yes	
65216	F&JA Equipment Cabinet	Building	Yes	
65217	F&JA Whistle Post	Object	Yes	
65218	F&JA Milepost 21 MP21	Object	Yes	
65219	F&JA Equipment Cabinet and Bell	Building	Yes	
65220	F&JA Whistle Post	Object	Yes	
65221	F&JA Milepost 22 MP22	Object	Yes	
65222	F&JA Equipment Cabinet	Building	Yes	
65223	F&JA Equipment Cabinet	Building	Yes	
65224	F&JA Equipment Cabinet	Building	Yes	
65225	F&JA Concrete Foundation	Building	Yes	
65226	F&JA Concrete Foundation	Building	Yes	
65372	F&JA Concrete Foundation	Building	Yes	
65373	F&JA Switch and Turnout	Building	Yes	
65374	F&JA Abandoned Siding	Building	Yes	
65375	F&JA Switch snf Turnout	Building	Removed	
65376	F&JA Concrete Foundation	Building	Yes	
65377	F&JA Concrete Foundation	Building	Yes	
65378	F&JA Concrete Foundation	Structure	Yes	
65414	F&JA Equipment Cabinet and Pipes	Building	Yes	
65560	F&JA Equipment Cabinet	Building	Yes	
65561	F&JA Equipment Cabinets	Building	Yes	
65562	F&JA Equipment Cabinet	Building	Yes	
65563	F&JA Equipment Cabinet and Manhole	Building	Yes	
65564	F&JA Equipment Cabinets	Building	Yes	
65579	NJ Route 33 over F&JA	Building	Yes	
65581	F&JA over Ardena Brook	Building	Yes	
New Jersey Southern Railroad Historic District				
Object ID	Historic Feature	Type	Intact	Eligibility
41649	NJS Stone Arch Bridge	Structure	Yes	Eligible as individual structure
65582	NJS Bridge over Manasquan River	Structure	Yes	Eligible as part of Historic District
65742	Route 33 Bridge over NJS	Structure	Yes	
65743	NJS Bridge over Mingamahone Brook	Structure	Yes	
65744	NJS Bridge over Marsh Bog Brook (2)	Structure	Yes	
65745	NJS Bridge over Bear Swamp Brook	Structure	Yes	
65746	NJS Bridge over Haystack Brook	Structure	Yes	
65938	NJS Concrete Foundations	Building	Yes	
65939	NJS McDowell Siding Switch	Building	Yes	
65940	McDowell Siding Switch	Building	Yes	
65941	NJS Equipment Cabinet and Plateform	Building	Yes	

Object ID	Historic Feature	Type	Intact	Eligibility
65942	NJS Equipment Cabinets	Building	Yes	
65943	NJS Milepost 49	Object	Yes	
65944	NJS Concrete Foundation	Building	Yes	
65945	NJS Milepost 50	Object	Yes	
65950	NJS Manhole	Building	Yes	
65955	NJS Manhole	Building	Yes	
65956	NJS Concrete Foundation	Building	Yes	
65957	NJS Concrete Foundation and	Building	Yes	
65958	NJS Equipment Cabinet, Concrete Foundation, and Manhole	Building	Yes	
65959	NJS Manhole	Building	Yes	
65960	NJS Manhole	Building	Yes	
65961	NJS Sign	Object	Yes	
65962	NJS Equipment Cabinet	Building	Yes	
65963	NJS Concrete Foundation	Building	Yes	
65964	NJS Concrete Foundation	Building	Yes	

Source: NJDEP HPO, January 29, 2019d



The Patterson Farm

Photo credits: The Patterson Farm

Table 10.3. Historic Properties Associated with the Earle Naval Weapons Station.

Object ID	Historic Feature	Type	Intact	Eligibility
71909	Dymaxion Deployment Unit, Building DDU (LBA-6)	Building	Yes	Eligible as individual structure
71842	Battery Truck Charging, Building GB-1	Building	Demolition proposed	Eligible as part of Historic District
71905	Ordnance Training Facility, Building S-179	Building	Demolished	
72056	Transfer Depot, Building HA-1	Building	Yes	
72049	Inert Storehouse, Building E-11	Structure	Yes	
72051	Inert Storehouse, Building E-12	Structure	Yes	
72057	High Explosive Storage Magazine, Building I-1	Structure	Yes	
72058	High Explosive Storage Magazine, Building I-2	Structure	Yes	
72059	High Explosive Storage Magazine, Building I-3	Structure	Yes	
72060	High Explosive Storage Magazine, Building I-4	Structure	Yes	
72061	High Explosive Storage Magazine, Building I-5	Structure	Yes	
72062	High Explosive Storage Magazine, Building I-6	Structure	Yes	
72065	High Explosive Storage Magazine, Building I-7	Structure	Yes	
72064	High Explosive Storage Magazine, Building I-8	Structure	Yes	
72066	High Explosive Storage Magazine, Building I-9	Structure	Yes	
72063	High Explosive Storage Magazine, Building I-10	Structure	Yes	
72067	High Explosive Storage Magazine, Building I-11	Structure	Yes	
72069	High Explosive Storage Magazine, Building I-12	Structure	Yes	
72070	High Explosive Storage Magazine, Building I-13	Structure	Yes	
72068	High Explosive Storage Magazine, Building I-14	Structure	Yes	
72071	High Explosive Storage Magazine, Building I-15	Structure	Yes	
72073	High Explosive Storage Magazine, Building I-16	Structure	Yes	
72074	High Explosive Storage Magazine, Building I-17	Structure	Yes	
72072	High Explosive Storage Magazine, Building I-18	Structure	Yes	
72075	High Explosive Storage Magazine, Building I-19	Structure	Yes	
72077	High Explosive Storage Magazine, Building I-20	Structure	Yes	
72076	High Explosive Storage Magazine, Building I-21	Structure	Yes	
72078	High Explosive Storage Magazine, Building I-22	Structure	Yes	
72080	High Explosive Storage Magazine, Building I-23	Structure	Yes	
72079	High Explosive Storage Magazine, Building I-24	Structure	Yes	
72103	High Explosive Storage Magazine, Building J-1	Structure	Yes	
72102	High Explosive Storage Magazine, Building J-2	Structure	Yes	
72098	High Explosive Storage Magazine, Building J-3	Structure	Yes	
72104	High Explosive Storage Magazine, Building J-4	Structure	Yes	
72101	High Explosive Storage Magazine, Building J-5	Structure	Yes	
72097	High Explosive Storage Magazine, Building J-6	Structure	Yes	
72096	High Explosive Storage Magazine, Building J-7	Structure	Yes	
72095	High Explosive Storage Magazine, Building J-8	Structure	Yes	
72094	High Explosive Storage Magazine, Building J-9	Structure	Yes	
72099	High Explosive Storage Magazine, Building J-10	Structure	Yes	
72093	High Explosive Storage Magazine, Building J-11	Structure	Yes	
72092	High Explosive Storage Magazine, Building J-12	Structure	Yes	
72091	High Explosive Storage Magazine, Building J-13	Structure	Yes	
72090	High Explosive Storage Magazine, Building J-14	Structure	Yes	

Object ID	Historic Feature	Type	Intact	Eligibility
72100	High Explosive Storage Magazine, Building J-15	Structure	Yes	
72089	High Explosive Storage Magazine, Building J-16	Structure	Yes	
72088	High Explosive Storage Magazine, Building J-17	Structure	Yes	
72087	High Explosive Storage Magazine, Building J-18	Structure	Yes	
72086	High Explosive Storage Magazine, Building J-19	Structure	Yes	
72084	High Explosive Storage Magazine, Building J-20	Structure	Yes	
72083	High Explosive Storage Magazine, Building J-21	Structure	Yes	
72085	High Explosive Storage Magazine, Building J-22	Structure	Yes	
72082	High Explosive Storage Magazine, Building J-23	Structure	Yes	
72081	High Explosive Storage Magazine, Building J-24	Structure	Yes	
71887	Ordnance Reworking (Mine/Depth Charge Reworking Facility), Building MA-1	Building	No	Not eligible
Sources: NJDEP HPO, January 29, 2019c and January 2019d				

Thirty-four additional properties listed in the township have been either determined eligible for the historic register or identified as of historic importance (see **Table 10.4** and **Figure 10.1**). The sites include dwellings, farms, places of worship, community centers, a schoolhouse, and a health center (NJDEP HPO, January 29, 2019c and January 29 2019d). The largest of the properties includes a single building, but most of the associated property is submerged below the Manasquan Reservoir.

Table 10.4. Additional Historic Properties in Howell Township.

Object ID	Property Name	Location	Intact
12	W. Dwinnell House	6460 US Route 9	Yes
13	Jerseyville Methodist Episcopal Church	Howell Road, near NJ Route 33	Yes
14	J. T. Reynolds House	US Route 9 and Kent Road	Yes
15	J. W. Reynolds House and Outbuildings	US Route 9 and Locust Avenue	Yes
16	Southard Grange	US Route 9	Yes
21643	MacKenzie House	427 Lakewood-Farmingdale Road	Yes
22979	Ardena Public School No. 2	NW cr. Preventorium Road and Old Tavern Road	Yes
22980	Farmingdale Tuberculosis Preventorium	East side Preventorium Road, 0.1 mi. north of Old Tavern Road	Yes
22981	All Cossacks Hall	SW cr. Windeler Road and Oak Glen Road	Yes
22982	(1319-22)	S. side Peskin Road, opposite Richard Road	mostly beneath reservoir
23419	(1319-17)	W. side Howell Road, 0.3 mi. south of State Hwy. 35	Yes
23420	(1319-27)	S. side State Highway 33, 0.1 mi. west of Fairfield Road	Yes
23421	(1319-16)	SE cr. Howell Road and Bennett Road	Yes
23422	R. Pittenger Farm	NW cr. Adelphia-Farmingdale Road and Howell Road	Yes
23474	(1319-4)	N. side Adelphia-Farmingdale Road, 0.3 mi. west of Howell Road	Yes
23475	T. Gulick Farm	E. side Halls Mill Road, opposite Three Brooks Road	Yes
23476	(1319-1-5)	N. side Adelphia-Farmingdale Road, 950'	Yes

Object ID	Property Name	Location	Intact
		east of Wyckoff Road	
23477	(1319-1-4)	N. side Adelphia-Farmingdale Road, 800' east of Wyckoff Road	Yes
23478	Bethesda Methodist Church	N. side Adelphia-Farmingdale Road, 450' east of Wyckoff Road	Yes
23479	(1319-1-1)	N. side Adelphia-Farmingdale Road, east of Freehold Township line	Yes
23480	(1319-1-2)	N. side Adelphia-Farmingdale Road, opposite Wyckoff Road	Yes
23481	Hall House	S. side Adelphia-Farmingdale Road, 250' east of Howell Road	Yes
23482	Hall House	S. side Adelphia-Farmingdale Road, 300' east of Howell Road	Yes
23483	(1319-29)	E. side Vanderveer Road, 0.5 mi. north of Adelphia-Farmingdale Road	Yes
23484	(1319-9)	NW cr. Adelphia-Farmingdale Road and Vanderveer Road	Yes
23485	John C. Patterson Farm	N. side Adelphia-Farmingdale Road, 0.1 mi. east of Vanderveer Road	Yes
23486	(1319-2)	N. side Adelphia-Farmingdale Road, 0.1 mi. west of Farmingdale Road	Yes
23487	First Baptist Church of Howell	S. side Adelphia-Farmingdale Road, 0.3 mi. east of Vanderveer Road	Yes
23488	(1319-5)	N. side Adelphia-Farmingdale Road, opposite Ketcham Road	Yes
23492	St. Alexander Nevesky Church	SE cr. Alexander Road and U.S. Highway 9	Yes
23625	Buddhist Temple (Choephel-Ling)	N. side Sixth Street 3 west of Smith Street	Yes
23794	J. Emmons House	N. side Adelphia-Farmingdale Road, opposite Havens Bridge Road	Yes
24272	Charles W. Patterson House	680 Adelphia Road	Yes
117565	Dwelling, garage, toll house & poultry house	154 Squankum Road	Yes
Sources: NJDEP HPO, January 29, 2019c and January 2019d			

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Monmouth County's Cultural & Heritage Virtual Tours:
https://monmouthnj.maps.arcgis.com/apps/MapSeries/index.html?appid=a7dd29b5bbc543c68a6cafbabed512a2

Native People of New Jersey: http://www.usgennet.org/usa/nj/state/Lenape.htm

New Jersey Comprehensive Statewide Historic Preservation Plan, 2013-2019:
http://www.nj.gov/dep/hpo/Index_HomePage_images_links/hpo_plan%202013_2019/hpoplan2014.pdf

New Jersey and National Registers of Historic Places: https://www.nj.gov/dep/hpo/1identify/nrsr_lists.htm

Railroad History: https://www.american-rails.com/nj.html

Ardena School.
Photo credit: J. Osborne

11. ENVIRONMENTAL ISSUES

11.1 DRINKING WATER QUALITY

11.1.1 Introduction

Water that contains pollutants has the potential to impact people's health. Contaminants can come from many sources, including naturally occurring elements such as arsenic and radon, and contamination from human activities such as farming, manufacturing processes and wastewater treatment plants. Depending on the contaminant type, concentration, and a person’s individual exposure, consuming polluted drinking water can cause people to experience health issues, including gastrointestinal illness, reproductive problems, and neurological disorders (NJDOH, 2020).

Drinking water quality is regulated by the NJDEP Bureau of Safe Drinking Water, under the Safe Drinking Water Act (N.J.S.A. 58:12A-1 et seq) and rules (N.J.A.C. 7:10). The New Jersey Ground Water Quality Standard rule (GWQS; N.J.A.C. 7:9C) sets numerical criteria for limits on discharges to ground water and standards for ground water remediation, and when these pollutant criteria are exceeded, is the basis for management actions necessary to restore or enhance ground water quality. Currently, there are water quality standards and monitoring requirements for over 100 constituents (NJDEP, September 4, 2018). In some cases, New Jersey water quality standards are set more stringently than the federal standards (NJDOH, 2020).

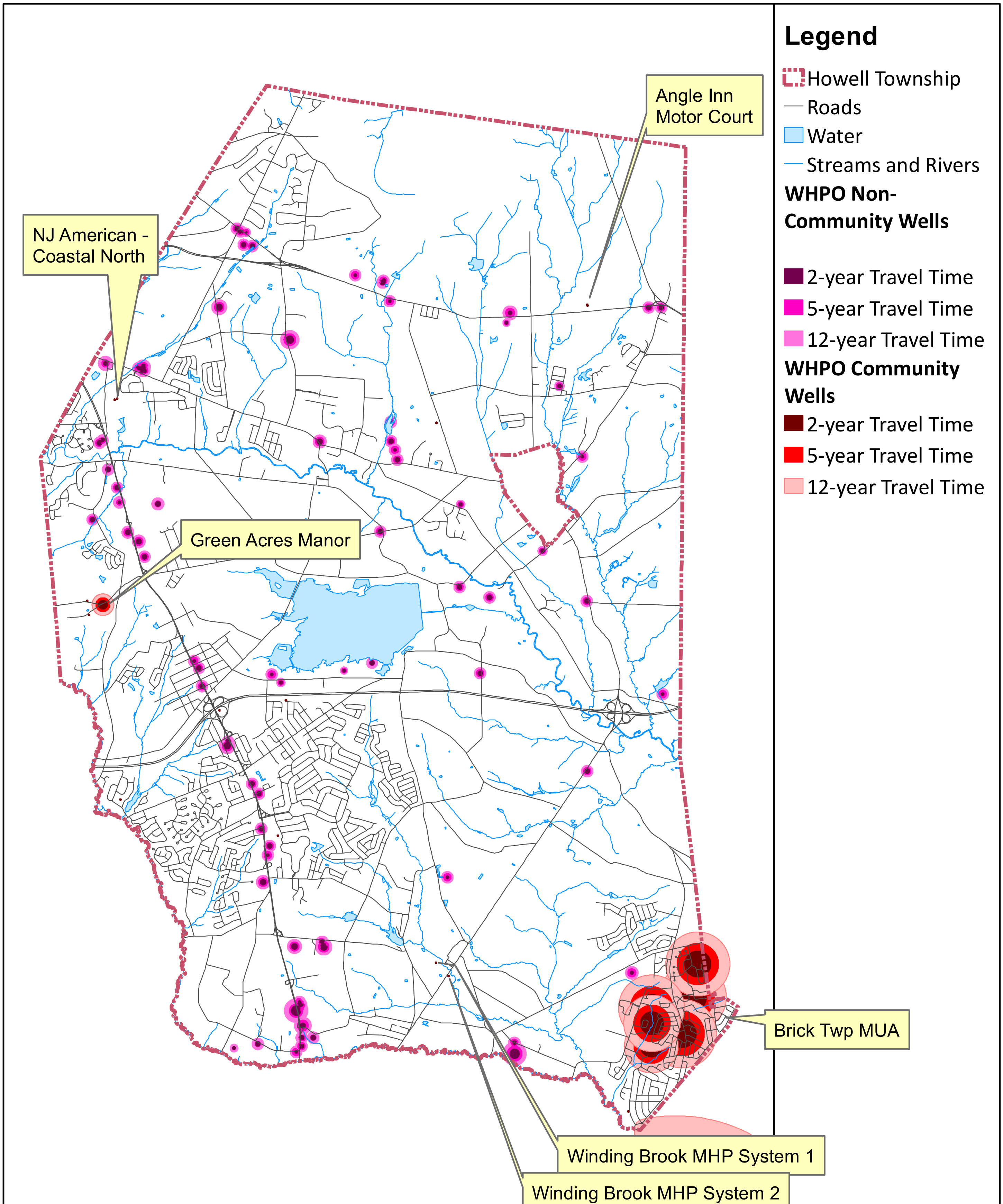
11.1.2 Well Head Protection Areas (WHPA)

Public Community Water Supply (PCWS) Wells are wells that supply potable water to public communities, and serve at least 15 connections used by year-round residents or which serve at least 25 year-round residents. In contrast, a *Public Non-Community Water Supply Well* is a public water supply well used by individuals other than year-round residents for at least sixty days of the year. Examples of non-transient non-community water supply wells include schools, factories, and office buildings, while transient non-community water supply wells include rest stop areas, restaurants, and motels. The locations of public wells within Howell Township are shown in **Figure 6.5.**

A *Well Head Protection Area* (WHPA) is an area calculated around these public wells that outlines the horizontal extent of ground water captured by a well pumping at a specific rate over two-, five-, and twelve-year periods of time for unconfined wells and a fifty foot radius delineated around each confined PCWS well (shown in **Figure 11.1**). WHPAs were delineated in response to the Safe Drinking Water Act Amendments of 1986 and 1996 as part of the Source Water Area Protection Program (SWAP). Within Howell Township, there are 27 WHPAs that have been calculated for public community water supply wells and 172 for public non-community water supply wells (NJGS, May 17, 2018; NJGS, February 19, 2015) (see **Figure 11.1**).

11.1.3 Source Water Assessment Program (SWAP)

The Federal Safe Drinking Water Act required states to establish a Source Water Assessment Program (SWAP) to provide for the protection of public water systems and to increase public knowledge of and participation in protecting the sources of public drinking water.



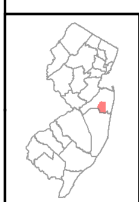


Figure 11.1. Howell Township, Public Community & Non-Community Wellhead Protection Areas

0 0.5 1 2 Miles

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Data Sources: NJDEP, NJDOT, NRCS
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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The NJDEP 1.) identified the area (known as the source water assessment area) that supplies water, 2.) inventoried any significant potential sources of contamination in the area; and 3.) analyzed how susceptible the drinking water source is to the potential sources of contamination (low, medium or high). The susceptibility rating does not indicate if the water source is actually contaminated, but is meant to inform water testing schedules and treatment and other actions that would prevent human consumption of unsafe water (NJDEP, December 2004). The results for the community water supplies serving Howell Township are presented in **Table 11.1.**

Table 11.1. Source Water Assessment Program

PWSID	Water System		Susceptibility*	Contaminant Category
Howell Township				
1319003	ANGLE INN MOBILE HOME PARK		High	Disinfection Byproduct Precursors
			Medium	Inorganics
			Low	all other categories
1319008	WINDING BROOK MHP SYS 1		High	none
			Medium	Radon and Disinfection Byproduct Precursors
			Low	all other categories
1319009	WINDING BROOK MHP SYSTEM 2		High	none
			Medium	inorganics and Disinfection Byproduct Precursors
			Low	all other categories
1319010	GREEN ACRES NJ MHC LLC		High	none
			Medium	Radon and Disinfection Byproduct Precursors
			Low	all other categories
1345001	NJ AMERICAN WATER – COASTAL NORTH	Well sources (12)	High	none
			Medium	8 wells for Inorganics; 9 for Radionuclides; 8 for Disinfection Byproduct Precursors
			Low	all other categories and wells
		Surface water sources (5)	High	5 for pathogens; 1 for nutrients; 3 for Inorganics; 5 for Disinfection Byproduct Precursors
			Medium	4 for nutrients; 2 for pesticides; 5 for VOCs; 2 for Inorganics;
			Low	3 for pesticides; 5 for radionuclides; 5 for radon
Farmingdale Borough				
1314001	FARMINGDALE WATER DEPT		High	none
			Medium	Inorganics and Disinfection Byproduct Precursors
			Low	all other categories
* Susceptibility for a contaminant category does **not** mean a customer is or will be consuming contaminated drinking water. The rating reflects the potential for contamination of source water, not the existence of contamination. Monitoring requirements may be customized based on the risk.				
Source: NJDEP Division of Water Supply and Geoscience, 2004; NJDEP, 2020a.				

11.1.4 Drinking Water Quality Reports

The Federal and New Jersey State Safe Drinking Water Regulations require routine monitoring of public water supplies for a number of contaminant categories. The results are available through the Drinking Water Watch and the water purveyor's annual Consumer Confidence Report which is mailed to all customers.

Water quality information for public systems is available online at NJDEP's Drinking Water Watch by entering the water system ID from **Table 11.1**. Some monitoring and reporting violations occurred, but no water quality violations were noted in the past five years for these water supplies (NJDEP, 2020b). The most recent Water Quality Report for New Jersey American Water is provided in **Appendix F** (also see **Internet Resources)**.

11.1.5 Private Well Testing Act

The New Jersey Private Well Testing Act (N.J.S.A. 58:12A-26 et seq.) and rules (N.J.A.C. 7:9E) mandate private well testing upon the sale of a house. The number of wells tested in a municipality reflects the number of real estate transactions involving homes with private wells. In Monmouth County, the well water must be tested for Primary Contaminants[20] (bacteria, volatile organic compounds, arsenic, lead. nitrates, mercury, and gross alpha) and Secondary Contaminants[21] (pH, iron, and manganese) (NJDEP, March 26, 2019).

While Howell Township is served primarily by public water systems, 1,277 private wells were tested between 2002 and 2014 pursuant to this regulation (see **Table 11.2**).

Table 11.2 NJ Private Well Testing Act Data Summary (Sept. 2002-April 2014) in Howell Township

Parameter	Number of Wells Exceeded/Sampled	% of Wells Exceeding MCL	MCL
Primary parameters			
Nitrate	11/1,277	0.9%	10 mg/l
Arsenic	Testing is not required under PWTA		5* µg/l
Gross Alpha	70/1,045	6.7%	(initial)[22] 5 pCi/L (final) 15 pCi/L
Mercury	1/1,277	0.1%,	2 µg/l
VOC	6/1,277	0.5%	*
Fecal coliform or E. coli	153/1,277	1.2%	0 colonies
Total Coliform	111/1,277	8.7%	
Secondary parameters			
pH	375/1,277	29.4%	6.5-8.5
Iron	659/1,277	51.6%	0.3 mg/l
Manganese	407/1,277	31.9%	0.05 mg/l
* MCLs vary for the 26 Volatile Organic Compounds (VOCs) required by the PWTA.			
Source: NJDEP, January 1, 2015; Atherholt et. al., April 2009			

11.1.6 Per- and Polyfluoroalkyl Substances (PFAS)

Chemicals that recently have been shown to occur in the environment and there is potential environmental or human health risk are known as *contaminants of emerging concern*. In many cases, new analytical capabilities or methods have to be developed that enable scientists to measure these contaminants. A current example is a class of substances known as *per- and polyfluoroalkyl substances* (PFAS). These synthetic (man-made) chemicals have been used in the manufacture of several commercially important products including non-stick cookware, metal plating and finishing, aqueous

[20] *Primary contaminants* are contaminants that may a cause potential health risk if consumed on a regular basis above the established maximum contaminant levels (MCLs).

[21] *Secondary parameters* are regulated by the State for aesthetic or other concerns (taste, odor, staining, scaling of home fixtures) rather than health effects. Whether or not these natural water quality parameters are a problem depends on the amount of the substance present.

[22] Results greater than 5 pCi/L requires a second gross alpha count. The MCL for gross alpha is 15 pCi/L.

film forming foams for firefighting and training, stain-resistant coatings, water resistant outdoor clothing, and grease proof food packaging.

PFAS can be toxic and can bioaccumulate in fish and/or humans. Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), for example, have been found at very low levels both in the environment and in the blood of the general population. Literature reviews of human health and non-human animal studies showed evidence that low blood levels of PFOA and PFOS had toxicological effects on the liver, immune system, endocrine system, metabolism, neurobehavioral toxicity, and effects on the developing fetus and/or offspring. Although the use of PFOA and PFOS has decreased significantly, they persist in the environment and are soluble and mobile in water (NJDEP Division of Water Supply, January 2007; NJDEP, April 1, 2019).

In 2006, the NJDEP's Bureau of Safe Drinking Water collected water samples from water systems throughout the state to determine whether PFOA or PFOS could be found in detectable concentrations. PFOA was detected in 78% of the 23 public water systems and PFOS was detected in 57% of the systems. One site was sampled in Howell Township, at the Manasquan Reservoir due to its proximity (within 10 miles) of the 3M facility. PFOS was not detected, but PFOA was measured as 0.011 micrograms per liter (µg/l) (NJDEP Division of Water Supply, January 2007).

In 2019, NJDEP proposed changes to the various drinking water rules to establish a maximum contaminant level (MCL) for PFOA of 0.014 µg/l and an MCL for PFOS of 0.013 µg/l. The proposal includes monitoring requirements for PFOA and PFOS for public community and public non-transient noncommunity water systems, and wells tested under the Private Well Testing Act. These updated rules are pending adoption (NJDEP. April 1, 2019). Data in the Drinking Water Watch for the public water systems within Howell Township show that, while present in many of the water samples, PFOA and PFOS levels have not exceeded the proposed MCLs (NJDEP, 2020b).

11.1.7 Lead in Drinking Water

Lead, even at low levels, can damage the nervous system, brain, and kidneys, particularly in infants and children. Whether the drinking water is from surface or ground water sources, lead is not normally found in drinking water at the source. However, lead can contaminate drinking water from corrosion of the service lines, plumbing and fixtures that contain lead. When lead is present in plumbing, the amount of lead that leaches into the water depends on a number of factors, including lead content of pipes, fixtures, and solder, water temperature, chloride levels, pH, and hardness. Actions to reduce possible exposure to lead include testing the water, testing children's blood levels, and running water for 30 seconds before use (NJDEP Division of Water Supply and Geoscience, February 18, 2020; NJDOH, No Date).

Run your water to flush out lead. Run water for 15-30 seconds or until it becomes cold or reaches a steady temperature before using it for drinking or cooking, if it hasn't been used for several hours. This flushes lead-containing water from the pipes. (NJDEP DWS, February 18, 2020)

11.2 FISH CONSUMPTION ADVISORIES

When toxic pollutants are present in surface water, they are consumed by the organisms that live in the water. The process of *bioaccumulation* is when there is an increase in concentration of certain fat-soluble chemicals, such as DDT and PCBs, in successively higher trophic levels of a food chain or web. For example, insects living in contaminated sediments may have accumulated a certain amount of a toxin. Fish, by eating many of these insects, then ingest the toxin into their own bodies. Anything that eats that contaminated fish, including humans and other predators, will absorb the toxin. When the concentration of toxin becomes high enough, the individual's health will be impacted.

The NJDEP samples fish for certain toxic pollutants and, when necessary, issues state and regional *fish consumption advisories*, to reduce exposure to dioxin, PCBs, and mercury. This information is intended to help individuals make an informed choice on the number of meals of fish to consume. The 2019 fish consumption advisories for fish caught in the immediate region or anywhere in the state are listed in **Table 11.3.** In addition, fish caught in waterbodies experiencing cyanobacteria harmful algal blooms should not be consumed (see **Section 11.2.3**) (NJDEP, November 2019). See the **Internet References** for more information, such as fish preparation guidelines and annual updates.

Table 11.3. 2019 Fish Consumption Advisories, Statewide Freshwater and Manasquan Reservoir

LOCATION	SPECIES	ADVISORY/PROHIBITION	
		Range of Recommended Meal Frequency (1)	
		General Population	High-Risk Individuals (2)
Manasquan Reservoir at Howell Township	Largemouth bass	No restrictions	One meal per week
	Chain pickerel	No restrictions	One meal per month
	Yellow perch	No restrictions	One meal per week
	Black crappie	One meal per week	One meal per month
	Bluegill sunfish	No restrictions	No restrictions
	Brown bullhead	No restrictions	One meal per week
	American eel	One meal per month	One meal per month
Statewide Freshwater – All water bodies except those listed separately	Trout - (Brown, Brook, Rainbow and Hybrid)	One meal per week	One meal per week
	Largemouth and Smallmouth bass	One meal per week	One meal per month
	Chain Pickerel	One meal per week	One meal per month
	Sunfish (bluegill, pumpkinseed, and redbreast)	No restrictions	One meal per week
	Yellow Bullhead	No restrictions	One meal per month
	Common Carp	One meal per month	Do not eat
Important Consumption Reminder: *Eat only the fillet portions of the fish. Use proper trimming techniques to remove fat, and cooking methods that allow juices to drain from the fish (e.g., baking broiling, frying, or grilling, and steaming).*			
(1) One meal is defined as an eight-ounce serving.			
(2) High-Risk Individuals include infants, children, pregnant women, nursing mothers and women of childbearing age.			
Source: NJDEP Division of Science and Research, 2019			
See interactive map for up to date fish advisories (including other waterbody specific advisories): http://njdep.maps.arcgis.com/apps/MapJournal/index.html?appid=922dff1885394cf19ccf1d9c8d52b4f0			

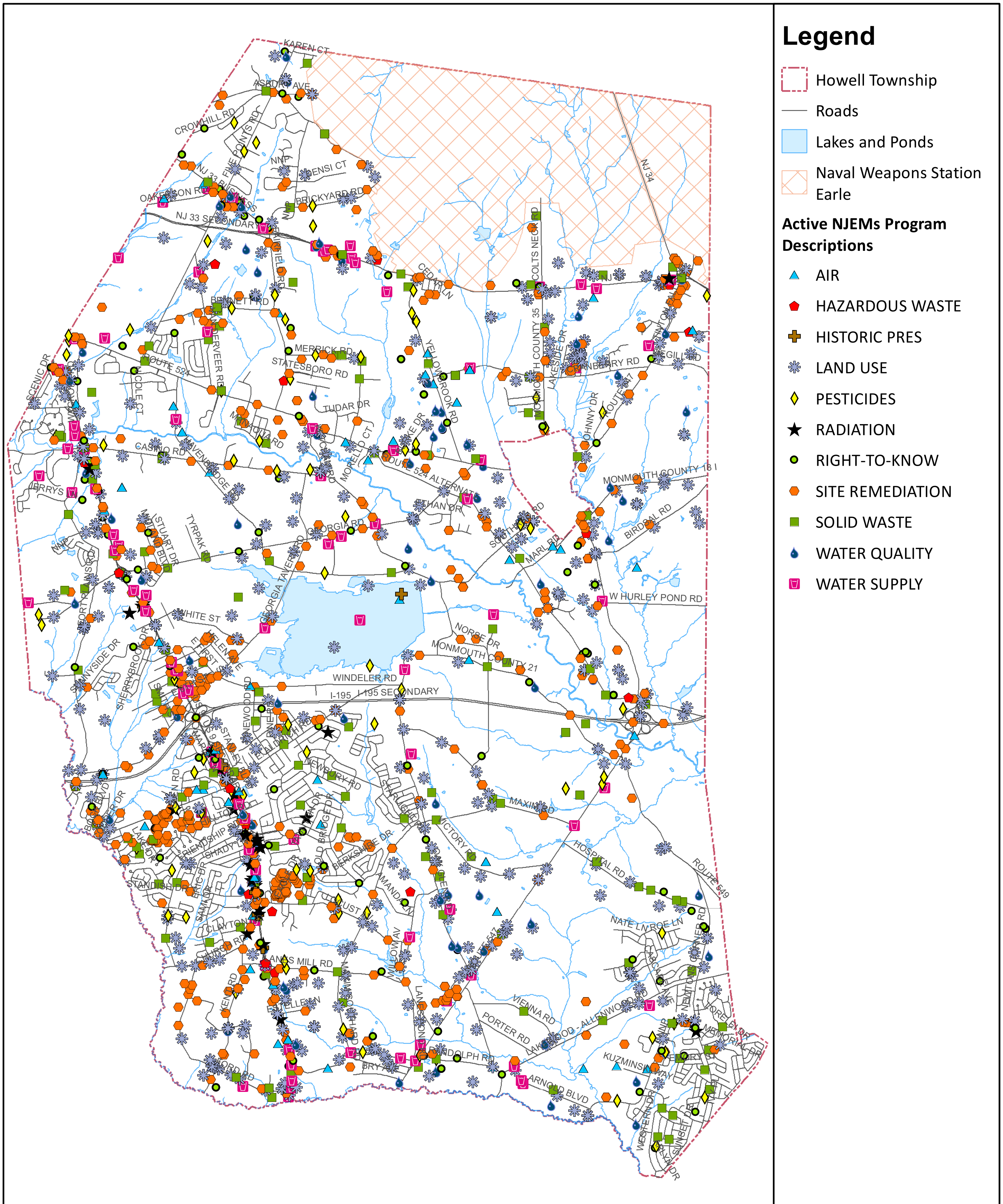
11.3 POLLUTION

11.3.1 Point Source Pollution

Point source pollution (as defined by N.J.A.C. 7:9B Surface Water Quality Standards) refers to discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture (NJDEP, April 6, 2020).

Point source discharges are regulated by NJDEP under the New Jersey Pollutant Discharge Elimination System (NJPDES) under the authority of the New Jersey Water Pollution Control Act (WPCA) N.J.S.A. 58:10A and NJPDES permit program regulations contained in N.J.A.C. 7:14A (NJDEP, October 5, 2010). There are no existing surface water discharges in Howell Township (NJDEP, August 7, 2019).

New Jersey Environmental Management System (NJEMS) Sites are points representing sites regulated by NJDEP under one or more regulatory permitting or enforcement programs. There are 2,590 NJEMS sites within Howell Township, shown in **Figure 11.2** (NJDEP, April 26, 2020) and **Table 11.4**.



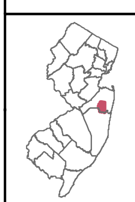


Figure 11.2. Howell Township, New Jersey Environmental Management System (NJEMS) Sites

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI

2020

Table 11.4. NJPDES Active Permit List in Howell Township

NJPDES Number	Name	Street Address	Permit Expiration Date	Discharge Category Description
NJ0034771	EMIL A SCHROTH INC	YELLOWBROOK RD & COPPER AVE Howell, NJ 07731	04/30/21	Stormwater (RF)
NJ0061824	ANGLE IN MOBILE HOME PARK	RT 33 Howell, NJ 07731	09/30/24	Discharge to Groundwater (GW)
NJ0275964	BEEHIVE HOME/HOWELL NJ	985 RT 33 Howell, NJ 07731	12/31/23	Discharge to Groundwater (GW)
NJG0072681	FIVE POINTS SQUARE	RT 33 Howell, NJ 077280000	10/31/23	Sanitary Subsurface Disposal (GP) (T1)
NJG0084271	GREEN ACRES MANOR	1 SNYDER RD Howell, NJ 077310000	10/31/23	Sanitary Subsurface Disposal (GP) (T1)
NJG0089630	ANGLE IN MOBILE HOME PARK	RT 33 Howell, NJ 07731	10/31/23	Sanitary Subsurface Disposal (GP) (T1)
NJG0107948	JOHN BLEWETT	246 HERBERTSVILLE RD Howell, NJ 077310000	09/30/18	Scrap Metal Processing (GP) (SM2)
NJG0115533	NJ TRANSIT/HOWELL BUS GARAGE	238 RT 9 N Howell, NJ 071052246	01/31/23	Basic Industrial Stormwater GP - NJ0088315 (5G2) (5G2)
NJG0117803	EASTERN CONCRETE MATERIALS INC	HOWELL FACILITY, 86 YELLOWBROOK RD Howell, NJ 07727	10/31/13	Concrete Products Manufacturing (GP) (CPM)
NJG0129755	HOWELL FACILITY	YELLOW BROOK RD Howell, NJ 077010000	04/30/14	Hot Mix Asphalt Producers (GP) (R4)
NJG0131377	DISANTI CONCRETE PRODUCTS INC	165 VICTORY RD Howell, NJ 077310632	10/31/13	Concrete Products Manufacturing (GP) (CPM)
NJG0139521	ARNOLD STEELE CO INC	79 RANDOLPH RD Howell, NJ 08701	01/31/23	Basic Industrial Stormwater GP - NJ0088315 (5G2) (5G2)
NJG0140996	NAGASAKI SUSHI HIBACHI & STEAK HOUSE REST	6950 US HWY 9 Howell, NJ 077313322	10/31/23	Sanitary Subsurface Disposal (GP) (T1)
NJG0142719	ANCHOR CONCRETE PRODUCTS INC	103 YELLOWBROOK RD Howell, NJ 07727	10/31/13	Concrete Products Manufacturing (GP) (CPM)
NJG0143847	COMPOUNDERS INC	15 MARL RD Howell, NJ 07731	01/31/23	Basic Industrial Stormwater GP - NJ0088315 (5G2) (5G2)
NJG0153940	HOWELL TWP	251 PREVENTORIUM Howell, NJ 077310580	12/31/22	Tier A Municipal Stormwater General Permit (R9)
NJG0162647	ROSANO HOWELL LAND LLC	ASBURY & TINTON FALLS RD Howell, NJ 07731	01/31/23	Basic Industrial Stormwater GP - NJ0088315 (5G2) (5G2)
NJG0166936	ROSANO HOWELL ASPHALT LLC	360 ASBURY RD AKA RT 547 Howell, NJ 07731	04/30/14	Hot Mix Asphalt Producers (GP) (R4)
NJG0189367	Sunnyside at Howell	2501 US Highway 9 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0193704	RESOURCE ENGINEERING LLC	34 RANDOLPH RD Howell, NJ 07731	11/30/14	Wood Recyclers (GP) (R7)

NJPDES Number	Name	Street Address	Permit Expiration Date	Discharge Category Description
NJG0222461	NORTHEAST PALLET RECYCLING LLC	133 YELLOWBROOK RD Howell, NJ 07731	01/31/23	Basic Industrial Stormwater GP - NJ0088315 (5G2) (5G2)
NJG0224782	Tropicana Commercial Center	Route 9 and Lanes Mill Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0225371	Garrote Place	436 Newtons Corner Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0227714	Woodmere at Howell	Michele Boulevard Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0229351	First Financial Federal Credit Union	389 Route 9 North Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0230448	HARVEST RIDGE AT HOWELL	West Farms Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0234184	NJDOT I-195 MEDIAN CROSSOVER PROTECTION - #22	I-195 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0237779	ROUTE 549 & 21 IMPROVEMENTS	CR 549 & 21 & Newton Corner's Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0240737	FOUR SEASONS AT MONMOUTH WOODS	West Farms Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0251691	NEW CONSTRUCTIOM	18 crestview ct Farmingdale, NJ 07727	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0255416	PROPOSED U-HAUL	1401-1429 U.S. 9 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0255742	MILL CLUB	19 Lanes Mill Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0256528	WILDBROOK ESTATE	Megill Road Howell, NJ 07727	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0257605	7 OAKS AT HOWELL LLC	Cranbury Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0259080	YELLOWBROOK ESTATES	Adelphia Farmingdale Rd & Yellowbrook Rd Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0259993	L&L PAVING / HOWELL	89 Yellowbrook Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0263630	PROPOSED RESIDENTIAL DWELLING	2971 Lakewood Allenwood Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0264253	FAZZIO HOLDINGS, LLC	215 Adelphia Rd Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0267783	TRANSMISSION MAIN PROJECT - ROUTE 3A	455 Oak Glen Rd Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0271829	ROSEN RESIDENCE	Lemon Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0272761	UNFI HOWELL	433 OAK GLN RD Howell, NJ 07731	01/31/23	Basic Industrial Stormwater GP - NJ0088315 (5G2) (5G2)

NJPDES Number	Name	Street Address	Permit Expiration Date	Discharge Category Description
NJG0273074	PALMER RESIDENCE	Squankum Yellow Brook Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0277860	HILLMAN PROPERTY	129 Arnold Blvd Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0278025	EMES EQUITIES, LLC	Hollywood Avenue Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0282359	IENTILE PROJECT	Route 33 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0282901	FIVE POINTS ROAD, LLC	Five Points Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0285471	PIONEER PIPE TEMPORARY LAYDOWN YARD	Oak Glen Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0287521	HOWELL FAMILY APARTMENTS	Fort Plains & West Farm Rd Howell, NJ 07727	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0287571	BEEHIVE HOME/HOWELL NJ	985 RT 33 Howell, NJ 07731	12/31/20	Sludge Quality Exempt (GP) (SXG)
NJG0287903	FREEWOOD ACRES & ROUTE 9 NORTH SANITARY SEWER	Multiple Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0289078	ERIN & SHANNON SCHIAVO	345 Colts Neck Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0289213	HOWELL TOWNSHIP BOE	495 ADELPHIA RD Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0291218	VIC GERARD GOLF CARS	281 Squankum Rd Farmingdale, NJ 07727	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0291633	SEA FREE PLAZA	Highway 33 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0294624	PROPOSED IMPROVEMENTS - HOWELL DEALERSHIP	999 Route 33 Howell, NJ 07828	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0299430	TRANSMISSION MAIN PROJECT	Lanes Mill Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0299553	ROSARIO 30 FIVE POINTS RD HOWELL	30 Five Points Road Howell, NJ 07728	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0299821	EMPORIO RETAIL AND WAREHOUSE	6601 Highway 9 South Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0300969	ASSOCIATED BUSINESS PARK	Okerson Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0301515	NJNG TRAINING FACILITY	401 Fairfield Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0301663	RECONSTRUCTION OF HL-73 & LAKE LOUISE DAM	Lanes Pond Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0302210	CAR TECH	1099 Route 33 Howell, NJ 07728	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0305308	WATER MAIN PROJECT HOWELL TO LAKEWOOD	SQUANKUM YELLOWBROOK RD	12/31/23	General Permit GW Petro Prod Cleanup

NJPDES Number	Name	Street Address	Permit Expiration Date	Discharge Category Description
		Howell, NJ 07727		(B4B)
NJG0306452	AQUATIC SERVICES	464 PREVENTORIUM RD Howell, NJ 07731	02/28/25	Pesticide Application Discharges (PGP)
NJG0308293	L&L PAVING COMANY	89 Yellowbrook Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0308668	390-402 COLTS NECK ROAD	390-402 Colts Neck Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0310263	BEEHIVE HOME/HOWELL NJ	985 RT 33 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0310301	PODVORTVHANY SUBDIVISION	Orchard Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0310531	NJAW DAG BLVD.-NICOLE CT. WATER MAIN REPLACEM	Dag Hammarskjold Blvd and, Nicole Court Howell, NJ 07728	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0312584	INTERSECTION IMPROVEMENTS CR 524 & KETCHAM RD	CR 524 and Ketcham Road Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0312614	211 BENNETT ROAD BARN	211 Bennett Road Freehold, NJ 07728	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0313955	SAVINO SAVO	Lots 23 & 24, Block 143 Howell, NJ 07728	02/28/22	Construction Activity Stormwater (GP) (5G3)
NJG0314447	FOUR SEASONS AT COLTS FARM	1191 NJSH Route 33 Howell, NJ 07731	02/28/22	Construction Activity Stormwater (GP) (5G3)
Source: NJDEP, 2020c				

11.3.2 Nonpoint Source Pollution

Approximately 13% of Howell Township is covered in impervious surfaces (NJDEP, September 30, 2018).

Nonpoint source or NPS pollution is any man-made or man-induced activity, factor, or condition, other than a point source, from which pollutants are or may be discharged. Nonpoint pollution may temporarily or permanently change any chemical, physical, or biological characteristic of water from what was or is the natural, pristine condition of such water.

Impervious surfaces are materials that prevent the infiltration of water into the soil (e.g. parking lots, roads, buildings, sidewalks, and compacted soil). The construction of impervious surfaces disrupts the natural water cycle, and is one of the more significant landscape impacts attributable to urbanization (Hasse and Lathrop, December 2016). When water flows off impervious surfaces, it is known as *stormwater*. Nonpoint source pollution is directly associated with stormwater.

An increase in impervious surface results in less water infiltrating to the soil and ground water, which instead runs off the surface and gains velocity. As the velocity of water increases, the amount that can infiltrate into the soil and ground water is reduced and scouring and erosion increase. The stormwater eventually discharges into streams and rivers, carrying pollutants that it has picked up along the way (e.g. trash, used motor oil, sediments, fertilizers, pesticides, pet droppings, etc.). The transport of these pollutants into local water bodies can result in the destruction of fish, wildlife, and habitats; threats to public health due to contaminated food and drinking water supplies; and losses of recreational and aesthetic values. In addition, increased stormwater results in greater frequency and magnitude of floods (Hasse and Lathrop, December 2016; Kaplan and Ayers, April 5, 2000). Studies have shown that the level where impacts begin to be seen is above 10% impervious surfaces, and that impacts become severe over 25 to 30% (Kaplan and Ayers, April 5, 2000).

NJDEP hired a contractor to map three classes of impervious surfaces (buildings, roads, and other impervious) through a semi-automated process based on digital aerial imagery, LiDAR[23], and several other data sets including land use/land cover, roads, and water features. The resulting impervious surface information is shown in **Figure 11.3** and **Table 11.5.** Howell Township has 4,929acres of impervious surface, which is 12.6% of the area (NJDEP, September 30, 2018).

Table 11.5. Impervious Surface in Howell Township

Impervious Surface Class	Acres	Percent
Buildings	1,159.2	3.00
Roads	1,732.0	4.4
Other (e.g. parking lots)	2,038.5	5.2
Total	*4,929.0*	*12.6*
Source: NJDEP, September 30, 2018		

New Jersey's Stormwater Management Rule (N.J.A.C. 7:8) aims to reduce runoff, flooding, erosion, and non-point pollution for public safety as well as ecological and biological integrity. There are requirements for stormwater management measures and regional and municipal stormwater management planning. Revisions of the Stormwater Management Rule, including green infrastructure requirements, were recently adopted (NJDEP, March 2, 2020).

All municipalities within the State are assigned either Tier A (more developed or coastal municipalities, including Howell) or Tier B (less developed and non-coastal) for permitting their Municipal Separate Storm Sewer System (MS4s) (NJDEP Bureau of Nonpoint Pollution Control, 2009).

The permits address stormwater quality related issues to new and existing development and redevelopment by requiring the preparation of a stormwater program and implementation of specific permit requirements referred to as Statewide Basic Requirements (SBRs). The Tier B Permit concentrates on new development and redevelopment projects and public education. The Tier A Permit has additional requirements aimed at controlling stormwater pollutants from existing development, such as public education, disposal of waste, solids and floatable controls, maintenance yard operations and employee training (NJDEP Bureau of Nonpoint Pollution Control, February 14, 2020).

Howell Township completed a Stormwater Management Plan in 2005, which was updated in 2007 (CME Associates, May 2007) which lists ordinances and other actions required by the MS4 permit (see **Internet Resources**). According to the New Jersey Hydrologic Modeling Database (2020), there are 264 stormwater basins in Howell township (see **Figure 11.3**) (USDA, 2020).

An important component of the stormwater pollution prevention program is education that emphasizes that all storm drains discharge to surface waters, i.e. streams, lakes and coastal waters. The township's stormwater infrastructure has been mapped and these maps are available on the township's Storm Water Pollution Prevention Program website (see **Internet Resources**).

11.3.3 Harmful Algal Blooms (HABs)

Certain environmental conditions, such as high nutrient concentrations, warm water temperatures and calm water can encourage a rapid increase and accumulation in the population of algae and algae-like bacteria in a waterbody. These *algal blooms* can form a thick coating or mat on the surface of the water, and can harm aquatic organisms by lowering the dissolved oxygen in the

Example Advisories if a HAB is present or suspected:

- Pets and livestock should not be allowed to drink or swim in the water.
- People should avoid swimming, wading, and watersports.
- Fish caught in the waterbody should not be eaten.
- People should not drink untreated water

(NJDEP, November 18, 2019).

[23] LiDar stands for **Li**ght **D**etection **a**nd **R**anging, which is a remote sensing method that uses a pulsed laser to precisely measure three-dimensional information about the shape of the Earth and its surface characteristics.

water column. “Nuisance blooms” may result in unattractive and unpleasant water and may have offensive odors, but are not dangerous to people.

However, some are *harmful algal blooms (HABs)* that can be dangerous to people, animals, or the ecology. HABs are caused by blooms of cyanobacteria which can produce and release chemicals (cyanotoxins) that can be toxic to humans and animals if ingested, inhaled, or if contacted by the skin or mucous membranes. In addition, these toxins can accumulate in fish and shellfish which can cause illness when consumed. HABs can occur in both the freshwater and marine water environments (NJDEP Division of Water Monitoring and Standards, November 2019). The Manasquan Reservoir experienced a confirmed HAB from August 7 to August 23, 2019 and then again from October 31 to November 7, 2019 (NJDEP, April 13, 2020).

The New Jersey Water Supply Authority (NJWSA) installed a continuous water monitoring sonde in the Manasquan Reservoir in 2017 and is developing a Cyanotoxin Management Plan (Desko, September 18, 2019).

In November 2019, Governor Phil Murphy and the NJDEP announced an initiative to reduce and prevent future harmful algal blooms in New Jersey which includes three elements: 1.) provides more than $13 million in funding to local communities to reduce harmful algal blooms; 2.) builds upon the state’s scientific expertise and enhance its capacity to respond to harmful algal bloom events; and 3.) increases communication with affected communities (NJDEP, November 18, 2019).

11.3.4 Noise

Noise pollution, defined as unwanted or excessive sound, is another undesirable by-product of modern life. It can be a nuisance, interfere with activities, and can cause physical damage. Transportation noise is among the most pervasive noise sources in our environment today, particularly for people who live within 500 feet of heavily traveled highways or within 100 to 200 feet of lightly traveled roads (Washington County Task Force, July 2005).

Federal highway noise criteria (which apply only to federal highways) range from 57 to 72 decibels (depending on adjacent land use) (USDOT, FHA, April 2006). New Jersey's Noise Control Act of 1971 authorized the NJDEP to develop regulations relating to the control and abatement of noise. While these regulations do not specify noise criteria, a sample municipal ordinance is provided with sound level standards of 50 decibels during nighttime (10:00 p.m. to 7:00 a.m.) and 65 decibels during daytime (NJDEP, 2017).

Howell Township’s noise ordinance states, “it is the policy of the Township of Howell to prevent excessive sound that may jeopardize the health, welfare, or safety of the citizens or degrade the quality of life” (Howell Township Code Chapter 208). With certain exceptions, maximum permissible A-weighted sound levels when measured outdoors are 50 dB at night and 65 dB during the day; and when measured indoors maximums are 40 dB at night and 55 dB during the day.

11.3.5 Lighting

Light pollution is defined as excess or inappropriate use of artificial light. Light pollution obstructs views of stars and planets, disrupts ecosystems, and impacts human health and safety. In fact, almost 99% of the sky in Europe and the United States is polluted by night lighting (International Dark Sky Association, 2020). Ecological impacts of light pollution range from contributing to algal blooms (by disrupting nocturnal foraging of zooplankton), disrupting feeding and mating of nocturnal animals such as frogs, bats, fireflies, and moths, and killing migrating birds (Rich and Longcore, 2006). Most migrating birds navigate at night by the moon and stars, and artificial lighting short-circuits their ability to navigate, causing millions of fatalities from collisions annually (Gauthreaux Jr. and Belser, 2006). Links between artificial light and human health, such as cancers, have also been documented. Surprisingly, the use of reduced and non-glaring lighting has not been shown to increase crime rates and, in fact, may improve human safety (International Dark Sky Association, 2020).

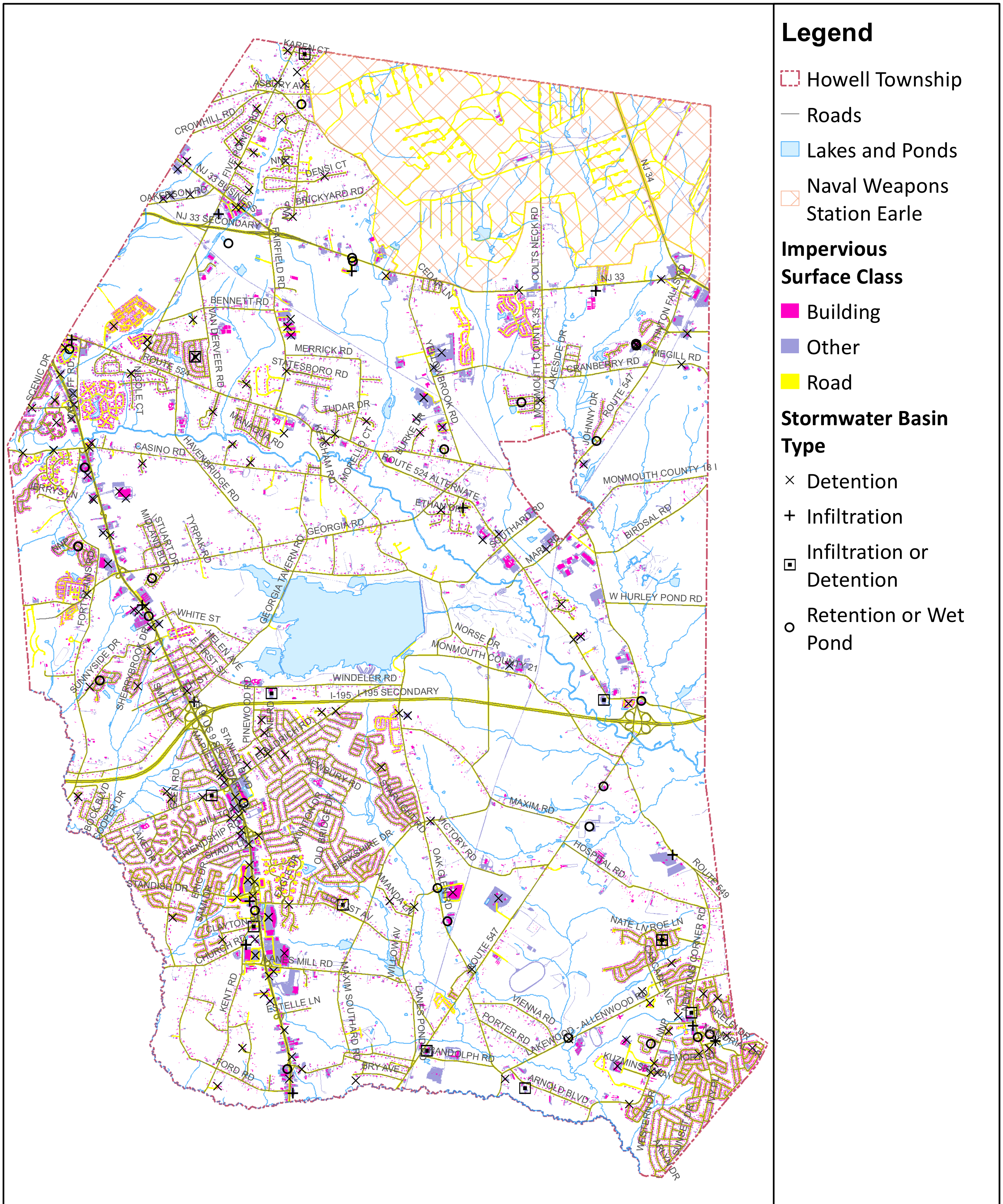


Figure 11.3. Howell Township, Impervious Surface and Stormwater Basins

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Howell Township is impacted by a number of sources of light pollution, especially the Route 9 corridor south of I-195. The sky is markedly brighter over all developed areas than over preserved areas. **Figure 11.4** shows a map of NASA's satellite data of average visible and infrared light (Visible Infrared Imaging Radiometer Suite (VIIRS) data) for New Jersey (on the left) and Howell Township (on the right).

Chapter 188-22 of the Howell Township code has the objective of minimizing undesirable off-site effects of lighting. It includes requirements such as focusing lighting downward, translucent fixtures and shielding. The average maximum light intensity is limited to 0.5 footcandle over the entire area and shall not shine directly into windows, streets, or driveways in such a manner as to create a nuisance (Township of Howell Code Chapter 188).

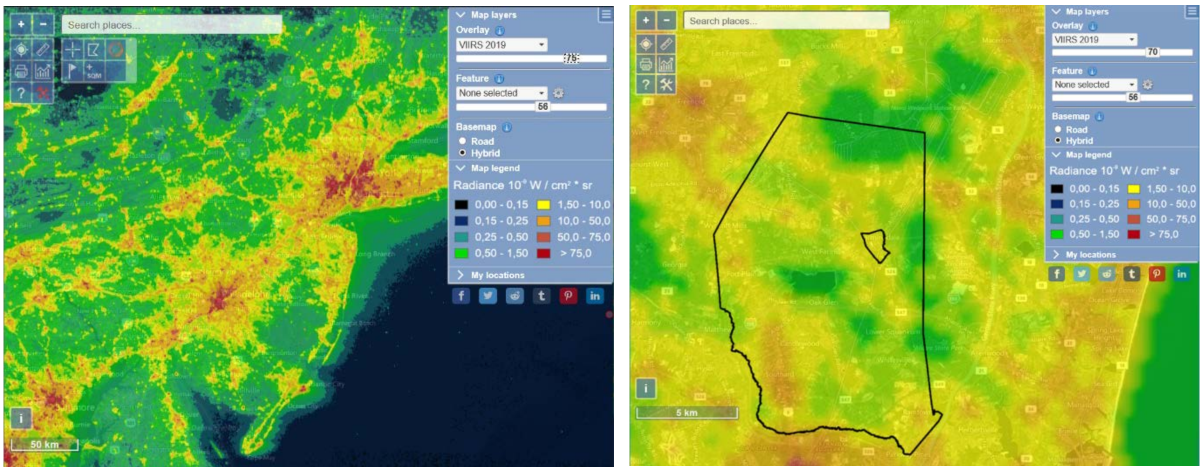

Figure 11.3. Light Pollution

Sources: Visible Infrared Imaging Radiometer Suite (VIIRS) data mapped by https://www.lightpollutionmap.info; Howell Township boundary is approximate.

11.4 CONTAMINATED SITES

In 2012, NJDEP adopted amendments, repeals, and new rules to implement site remediations through the *Site Remediation Reform Act (SRRA)*, N.J.S.A. 58:10C-1 et seq., and related amendments to the *Brownfield and Contaminated Sites Act (Brownfield Act)* N.J.S.A. 58:10B-1 et seq., the *Spill Compensation and Control Act (Spill Act),* N.J.S.A. 58:23-11 35 seq., the *Industrial Site Recovery Act (ISRA)*, N.J.S.A. 13:1K-6 et seq., and the *Underground Storage of Hazardous Substances Act (UST Act)*, N.J.S.A. 58:10A-21 et seq. This major shift requires remediations of contaminated sites to proceed under the supervision of a *Licensed Site Remediation Professional (LSRP)* (hired by the property owner) instead of NJDEP with the primary goal of reducing the threat of contamination to public health and the environment (NJDEP Site Remediation Program, May 7, 2012).

> "Much of the ground-water contamination in the United States is in shallow aquifers that are directly connected to surface water. In some settings where this is the case, ground water can be a major and potentially long-term contributor to contamination of surface water. Determining the contributions of ground water to contamination of streams and lakes is a critical step in developing effective water-management practices." (Winter et al., 1998)

Some key provisions create a licensing board and a code of ethics (including penalties for violations) for LSRPs; establish obligations of each person responsible for conducting remediation; and institute mandatory timeframes for the completion of key phases of site remediation. Changes adopted in 2019 expand the definition of what is considered "remediation," clarify notification obligations for LSRPs, increase public notification and outreach requirements, and allow NJDEP to modify direct oversight requirements when appropriate (NJDEP SRP, May 18, 2020).

11.4.1 Known Contaminated Sites

The NJDEP Site Remediation Program compiles a list of Known Contaminated Sites (KCS). The Known Contaminated Sites List (non-homeowner) for New Jersey (as required under N.J.S.A. 58:10-23.16-17 and also the New Residential Construction Off-Site Conditions Disclosure Act N.J.S.A 46:3C1 et seq.) contains sites defined as those sites and properties within the state where contamination of soil or ground water has been confirmed at levels equal to or greater than applicable standards. Sites identified in the Known Contaminated Sites list can undergo a variety of activities, ranging from relatively simple soil removals to highly complex remedial activities. This dataset is updated daily. It is important to note that the list may include sites where remediation is either currently under way, required but not yet initiated or has been completed (and no longer considered contaminated). In addition, new contaminated sites may have been identified since the creation of this list and are not included here (NJDEP SRP, February 22, 2020).

There are 46 active known contaminated sites within the Township of Howell. The sites are listed in **Table 11.6**, and their locations are shown on in **Figure 11.5** (NJDEP SRP, February 22, 2020). Two sites in Howell Township are currently on the National Priorities (Superfund) List (USEPA, May 31, 2020).

The state also lists 386 closed contaminated sites in Howell Township, which are not included in this report (NJDEP, 2020c). This includes 243 homeowner sites which often involve small heating oil discharges from leaking underground storage tanks (USTs) that are resolved relatively quickly.

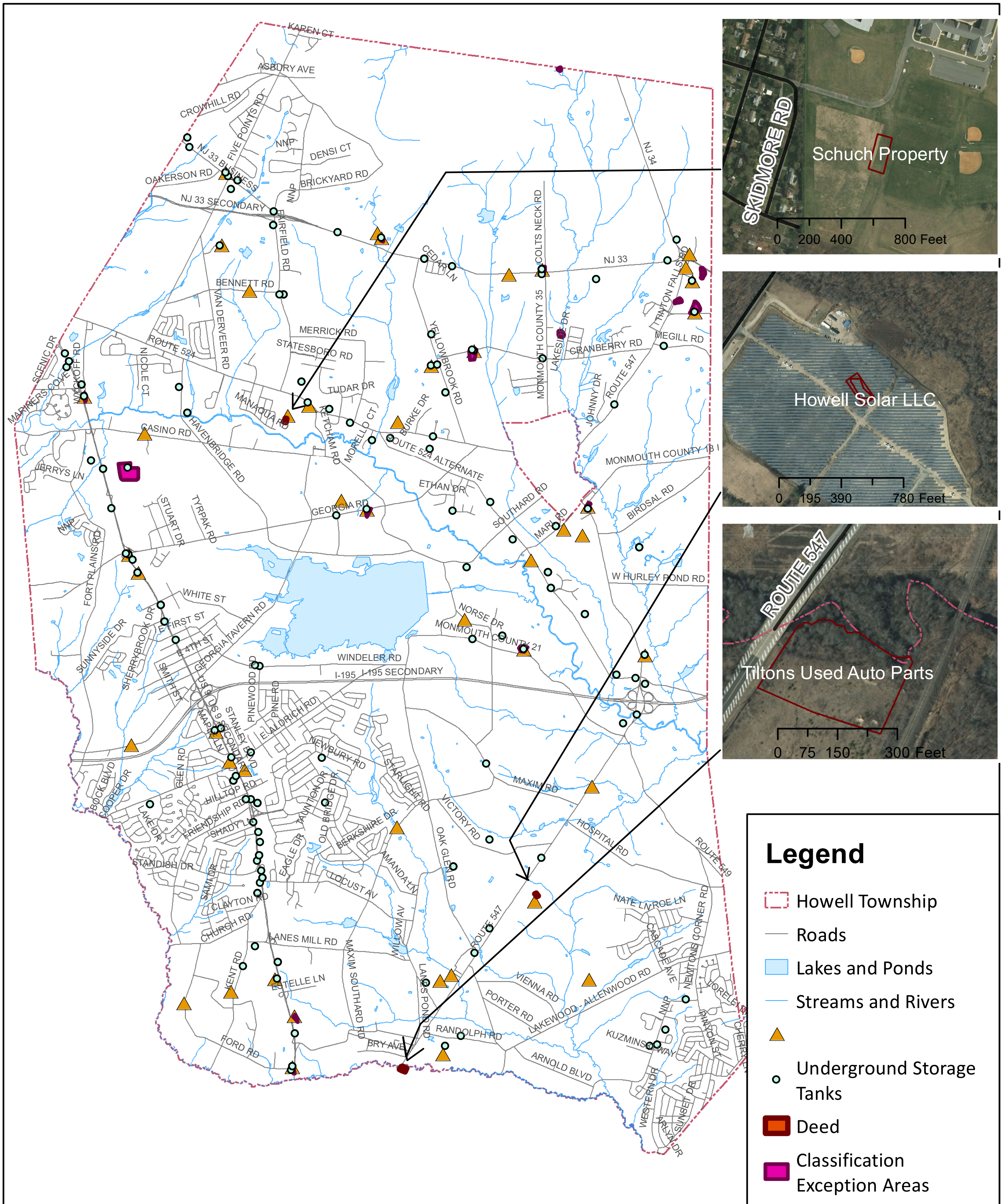

Figure 11.5. Howell Township, Contaminated Sites

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Table 11.6. Active Known Contaminated Sites in Howell Township

Program Interest Number	Site Name and Address	Lead Program*	Remedial Level**	CEA, Deed Notice or NPL Status
724693	130 FORD ROAD	UHOT	C1	
603820	232 KENT ROAD	UHOT	C2	
202366	70 NORSE DRIVE	UHOT	C1	
232250	792 HULSES CORNER ROAD	UHOT	C1	
196569	9 KENNEDY STREET	UHOT	C1	
G000026050	ALDRICH LAUNDRY 3810 RT 9	LSRP	C2	
004142	BP 905 RT 33 W	LSRP	C2	
019329	CHRIS INDUSTRIES VANDERVEER RD	LSRP	C2	
G000028569	COMPOUNDERS INCORPORATED 15 MARL RD	LSRP	C3	
218546	CONSOLIDATED FREIGHTWAYS 208 BENNETT RD	LSRP	C2	
461520	FORMER FLAME MOTEL 1144 RT 33	UHOT	C1	
G000004410	FREQUENCY ENGINEERING LABORATORIES LAKEWOOD RD	LSRP	D	
017625	GRATTONS GARAGE 288 SQUANKUM YELLOWBROOK RD	LSRP	C1	
835093	JCPL: 618 CASINO DRIVE 618 Casino Drive	LSRP	B	
775884	JOHN BLEWETT INC 246 HERBERTSVILLE RD	LSRP	C2	
158694	JOHN BLEWETT INC 2250 RT 9 S	LSRP	B	
023772	JUDCO CORP 5500 RT 9	LSRP	C2	
853455	KOVALY PROPERTY 361 Squankum Yellowbrook Road	LSRP	B	
717453	LANDMARK CLEANERS @ ALDRICH PLAZA 4031 RT 9	LSRP	C2	
018568	LARRABEE DISPATCH CENTER RANDOLPH RD & RTE 547	LSRP	C2	
662400	SOVRAN ACQUISITION LP UNCLE BOBS SELF STORAGE, 42 TINTON FALLS RD	LSRP	C2	
654505	TINTON FALLS RD & ELLIS AVE GROUND WATER CONT TINTON FALLS RD & ELLIS AVE	PUB FUNDED	C3	
G000041810	TRUMAN STREET @ WINDING BROOK MOBILE PARK, TRUMAN ST	UHOT	C1	
G000004595	WASTE DISPOSAL INCORPORATED LANDFILL 505 ALLENWOOD LAKEWOOD RD	PUB FUNDED	C3	
807533	WEST FARMS ROAD	LSRP	B	
002732	WORLD GAS- NEZIHE H SADIK INC 2001 RT 9 N	LSRP	C2	
Known Contaminated Sites (KCS) that are Classification Exception Areas				
032743	19 PETROLEUM 1175 RT 33 W	LSRP	C2	CEA Ongoing 7/16/2019

Program Interest Number	Site Name and Address	Lead Program*	Remedial Level**	CEA, Deed Notice or NPL Status
000975	BP SERVICE STATION 5146 695 RT 9 N & WYCKOFF RD	LSRP	C2	CEA Ongoing 7/27/2004
032459	HOWELL BD OF ED ADM BLDG 449 ADELPHIA RD	LSRP	C2	CEA Ongoing 2/24/2005
011741	HOWELL GARAGE 1251 RT 9 N	LSRP	C2	CEA Ongoing 1/31/2003
007864	HOWELL GAS INC 3400 RT 9 S	RAP		CEA Ongoing 12/7/1998
030017	HOWELL TWP PAL FACILITY W FARMS RD	LSRP	C2	CEA Ongoing 11/26/2003
018939	KELLE CHEVROLET 120 SOUTH MAIN ST	LSRP	C2	CEA Ongoing 8/3/2018
246217	LAKEWOOD CARPETING-SQUARE BLOCK MALL 6475 RT 9	LSRP	C2	CEA Ongoing 10/18/2019
032680	MONMOUTH CNTY FIRE ACADEMY 1027 RT 33	UHOT	C2	CEA Ongoing 8/22/2018
015707	MONMOUTH CNTY HWY DIST 5 CRANBURY RD	LSRP	C2	CEA Ongoing 12/27/1995
016965	OLDCASTLE PRECAST INC 89 YELLOWBROOK RD	LSRP	C2	CEA Ongoing 10/26/2018
019153	POLY ONE CORP 10 RUCKLE AVE	RAP		CEA Ongoing 2/13/2015
019058	ROSANO HOWELL ASPHALT PLANT ASBURY AVE	LSRP	D	CEA Ongoing 4/5/2016
006759	TOWNSHIP OF HOWELL 278 OLD TAVERN RD	LSRP	C2	CEA Ongoing 4/13/2019
Known Contaminated Sites (KCS) that have a Deed Notice				
034072	BP 6870 RT 9 S	LSRP	C2	CEA Ongoing 4/13/1999 Deed Notice Ongoing 9/9/2019
715298	HOWELL SOLAR LLC 829 LAKEWOOD FARMINGDALE RD	RAP		Deed Notice Ongoing 3/28/2016
193907	MONMOUTH COUNTY FIRE & POLICE ACADEMY TRAININ 1027 RT 33	LSRP	D	Deed Notice Ongoing Began: 4/16/2018
134887	SCHUCH PROPERTY ADELPHIA FARMINGDALE RD	RAP		Deed Notice Ongoing 1/17/2003
Known Contaminated Sites (KCS) that are on the National Priorities List (Superfund)				
G000003346	BOG CREEK FARM E ST & HERBERTSVILLE RD	PUB FUNDED	C3	*Information not provided in GIS layer*
G000008575	ZSCHIEGNER REFINING COMPANY 1442 MAXIM SUTHARD RD	PUB FUNDED	C1	NPL Final 3/6/1998
***Lead Program**				
LSRP - LSRP case. Case is being handled under the Licensed Site Remediation Professional (LSRP) program. **RAP -** Remedial Action Permit case. Restricted Use or Limited Restricted Use NFA/RAO case with an associated soil and/or ground water Remedial Action Permit. The case is now under the auspices of the Bureau of Remedial Action Permits, with biennial certification required. **PUB FUNDED -** NJDEP Publicly Funded case. Sites where targeted remediation is undertaken by the Department's Publicly Funded Element for situations where the responsible entity is unknown, unwilling, or unable to perform the necessary remediation to ensure that the health and safety of the public and/or the environment are not jeopardized. UHOT - Unregulated Heating Oil Tank Program case - Homeowner heating oil UST discharge cases				

Program Interest Number	Site Name and Address	Lead Program*	Remedial Level**	CEA, Deed Notice or NPL Status
****Remedial Levels:**				
A	An emergency action taken to stabilize an environmental and/or health threatening situation from the sudden or accidental release of hazardous substances.			
B	Single-phase remedial action in response to a single contaminant category affecting only soils. May be a subsite of a more complex case. Does not include ground water investigation or remediation.			
C1	A remedial action which does not involve formal design where the source is known/identified. May include the potential for (unconfirmed) ground water contamination.			
C2	A remedial action which consists of a formal engineering design phase, and is in response to a known source or release. Since the response is focused in scope and address a known, presumably quantifiable source, this remedial level is of relatively shorter duration than responses at sites of higher remedial levels. Usually involves cases where ground water contamination has been confirmed or is known to be present.			
C3	A multi-phased remedial action in response to an unknown and/or uncontrolled source or discharge to the soils and/or ground water. In this remedial level, the contamination is unquantified (or presumed unquantifiable) and, therefore, no determinable timeframe for the conclusion of the remedial actions is known.			
D	A multi-phased remedial action in response to multiple, unknown and/or uncontrolled sources or releases affecting multiple medium which includes known contamination of ground water. In this remedial level, the contamination is unquantified and, therefore, no determinable timeframe for the conclusion of the remedial actions is known.			
Sources: NJDEP SRP, March 6, 2007; NJDEP SRP, February 22, 2020				

11.4.2 Classification Exception Areas (CEA)

The Ground Water *Classification Exception Area* (CEA) dataset identifies those sites where ground water contamination has been identified and the NJDEP has established a Classification Exception Area (CEA). CEAs are institutional controls in geographically defined areas within which the New Jersey Ground Water Quality Standards (NJ GWQS) for specific contaminants have been exceeded. When a CEA is designated for an area, the constituent standards and designated aquifer uses are suspended for the term of the CEA. This data is intended to provide information to the public regarding areas of contaminated ground water to prevent inappropriate well placement, preventing potential health risks and can minimize unintended contaminant plume migration. Fifteen (15) of the Known Contaminated Sites listed in **Table 11.5** are CEAs, which are shown in **Figure 11.5**. Additional information about each CEA is presented in **Table 11.7** (NJDEP SRP, February 4, 2020a).

Table 11.7 Classification Exception Areas

Pref. ID	CEA Name & Address	Estab-lished	Description	Formation	Contaminants of Concern
007864	Exxon Service Station #38576 - Howell (Former) 3400 Route 9 S	1998	The CEA covers 12,443.76 square feet horizontally and extends off-site into Stanley Boulevard right-of-way following west-northwest ground water flow.	Quaternary Age	benzene, Trimethylbenzene (1,2,4-), Xylenes (total)
000975	BP Service Station #5146 695 Route 9 N	2004	Volatile organics plume. Ground water flow is to the south.	Kirkwood	benzene, MTBE, Ethylbenzene, Toluene, Xylenes (total)
034072	Hess Service Station #30207 Route 9 S & Ford Rd	1999	The CEA is a trapezium originating in the SE quadrant of the former Hess property and extending off-site SSE for approx. 350'. On site it is approx. 25' wide. The max. width to south is approx. 75'. Ground water flow is to the south.	Kirkwood	benzene, MTBE, TBA, Ethylbenzene, Toluene, Xylenes (total)

Pref. ID	CEA Name & Address	Estab-lished	Description	Formation	Contaminants of Concern
019153	Poly One Corp 10 Ruckle Ave	2015	The CEA is established for a portion of the site and travels offsite. Ground water flow direction is south and the horizontal extent is 92,075 sq.ft..	Kirkwood Fm	TCE, PCE, Dichloroethane (1,1-), Dichloroethene (1,1-), Dichloroethylene (cis-1,2)
019058	Rosano - Asphalt Plant CEA Asbury Ave	2016	CEA encompasses Rear and Front Asphalt Plant building and is delineated by MW-1 to the north and MW-17 and MW-18 to the south-southwest along Asbury Road. CEA based on field data and modeling. Ground water flow is to the south-southwest.	Kirkwood Fm	benzene, TCE, vinyl chloride, Dichloroethene (cis-1,2-), lead, arsenic
016965	Central Jersey Concrete Pipe Company 89 Yellowbrook Rd	2018	CEA encompasses a portion of site and extends offsite to the south beneath railroad tracks and portion of adjacent property. Boundaries based on field sampling data. Ground water flow is to the south-southwest.	Quaternary Age	PCE
019058	Rosano - Maintenance Garage CEA Asbury Ave	2016	CEA encompasses AOC S, the maintenance garage and a portion of the storage yard. Extends beneath Tinton Falls Road. Based on field data and modeling. Ground water flow is to the south-southwest.	Kirkwood Fm	benzene, MTBE, lead, Ethylbenzene, Toluene, Xylenes (total)
006759	Howell DPW - VOC CEA 278 Old Tavern Rd	2019	The CEA exists in the area around the maintenance garage. Ground water flow is to the east.	Kirkwood Fm	TCE, PCE, vinyl chloride
015100	Naval Weapons Station Earle - AOC 106B Route 34 (on border with Colts Neck)	1998	This CEA is for the area surrounding AOC 106B. Area of CEA is appox. .27 acres in size. CEA resulted from cleanup of a 1000 gal UST. UST removed in 1998. POL site. Ground water flow is to the northeast.	Kirkwood	benzene, naphthalene
011741	NJ Transit Howell Twp Bus Garage 238 Route 9 N	2003	benzene. Ground water flow is to the northwest.	Vincentown Fm	benzene
030017	Howell Twp PAL Facility W Farms Rd	2003	CEA extends to the property boundaries.	Cohansey Fm	benzene, Ethylbenzene, Xylenes (total)
032743	New Horizon Properties LLC - Semi Volatile CEA 1175 Route 33 W	2019	The CEA is defined by the site boundaries, covers 1.22 acres horizontally, follows north ground water flow, and is expected to remain on site. The CEA is delineated via fate and transport.	Quaternary Age	Benzo[a]pyrene, Bromodichloromethane, iron, sodium
246217	Lakewood Carpeting Square Block Mall 6475 Route 9	2019	The CEA is a 1-acre plume originating from a dry cleaner on the east side of Route 9, extending off-site to the southeast approx. 250 feet. Delineated by wells.	Kirkwood Fm	PCE
015707	Monmouth Co Highway District #5 Cranberry Rd	1995	The CEA/WRA boundaries are the property boundaries. Ground water flow is south-south-east	Vincentown Fm	benzene, naphthalene, lead, Ethylbenzene, Toluene, Xylenes

Pref. ID	CEA Name & Address	Estab-lished	Description	Formation	Contaminants of Concern
					(total)
032680	Monmouth County Fire Academy 1027 Route 33	2018	CEA is for benzene, VO TICs, 2-methylnaphthalene, and BN TICs. It is contained onsite (B: 183, L: 53). Vertical depth: 25 ftbgs, horizontal extent: 16060 sq ft. Ground water flow is southeast.	Vincentown Fm	benzene, Methylnaphthalene (2-)
018939	Exxon Service Station #36202 (Former) - VOC CEA 120 S Main St	2018	CEA covers approximately 23,779 square feet horizontally and extends off-site following northeast ground water flow.	Quaternary Age	benzene
Source: NJDEP SRP, February 4, 2020a					

11.4.3 Deed Notice

A *Deed Notice* is defined by NJSA 58:10B-13a as a "...notice to inform prospective holders of an interest in the property that contamination exists on the property at a level that may statutorily restrict certain uses of, or access to, all or part of that property...." The purpose of the deed notice GIS layer is to minimize any chance of exposure to contaminants remaining on the property (NJDEP, February 14, 2019b). There are 3 Deed Notice delineated within the Township of Howell, described in **Table 11.8,** and shown on **Figure 11.5**.

Table 11.8. Deed Notice Delineated Areas

Preferred ID Number	Name	ADDRESS	Block-Lot	Date Filed	Contaminants of Concern
G000009641	Tiltons Used Auto Parts (partially in Lakewood Twp)	685 Squankum Rd	172-9	2014	lead
715298	Howell Solar LLC	829 Lakewood Farmingdale Rd	42-36	2016	Benzo[a]pyrene
134887	Schuch Property	Adelphia Farmingdale Rd	152-71	2003	Dieldrin
Source: NJDEP SRP, February 4, 2020b					

11.4.4 Superfund Sites

Congress established the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, in 1980 in response to public attention on the risks to human health and the environment caused by contaminated sites. The goals of the US EPA's Superfund program include protecting human health and the environment by cleaning up contaminated sites and making the responsible parties pay for clean-up (US EPA, APRIL 10, 2020). Two superfund sites in Howell Township are described below.

Bog Creek Farm

Between 1973 and 1974, organic solvents and paint residues were dumped in a 4-acre area in the eastern part of Bog Creek Farm property. This contaminated the soil, sediment, surface water and ground water with volatile organic compounds (VOCs) and heavy metals. Sampling revealed that contamination had spread into ground water, a pond, a bog, and the north branch of Squankum Brook. Cleanup began in 1985 and 15,500 cubic yards of soil and sediments were incinerated. Originally expected to be completed in 8 to 10 years, EPA found that it would take decades longer. After 18,000 tons of contaminated soil were removed from the site, an automated long-term treatment facility was installed in 2010. The system operates continuously, extracts, treats, and reinjects ground water via the on-site water treatment plant to the Upper Kirkwood Aquifer. Contaminated sediments from the North Branch of Squankum Brook are dug up and incinerated. The ground water around the site is sampled on a quarterly basis and surface water and sediment are sampled on a semi-annual basis to monitor progress (US EPA, May 31, 2020).

Zschiegner Refining

From 1964 to 1992, the Zschiegner Refining Company operated as a precious metals recovery facility. In 1992, the Federal Drug Enforcement Administration raided the facility based on suspicions of illegal drug manufacturing. They discovered thousands of different chemicals (including peroxide, cyanide, caustics, and acids) improperly stored throughout the site, which created a potentially explosive/hazardous situation, and had contaminated soil, sediments, ground water and a building. During the initial clean up, about 2,000 gallons of chemicals were removed, and the site was added to the EPA's Superfund site list in 1988. Well water samples taken from private residential wells in 1998 did not find any contaminants at concentrations above state or federal health-based standards.

A long-term remedial design was finalized in 2007, and 10,425 cubic yards of contaminated upland soil and 15,351 cubic yards of contaminated wetland soil was excavated and disposed of off-site. Fieldwork for the remedial action is complete, although slightly elevated concentrations of site-related metals remain in the shallow ground water on the site. These concentrations are declining naturally, and monitoring of ground water continues with reduced frequency to ensure the effectiveness of the remediation (US EPA, May 31, 2020).

11.4.5 Underground Storage Tanks

Underground Storage Tanks (USTs) are regulated by NJDEP under N.J.A.C. 7:14B. This rule defines UST as a tank, or combination of tanks (and related equipment), used to contain an accumulation of hazardous substances, that is 10 percent or more beneath the surface of the ground (NJDEP, August 6, 2018). A GIS layer was developed to assist NJDEP Site Remediation and Enforcement programs in their efforts to manage UST facility registrations and inspections. Unregulated USTs (i.e. residential tanks) are not included in the map and the LSRP program does not apply to unregulated USTs (see **Internet Resources**).

The current GIS layer[24] lists 191 regulated USTs within Howell Township. Of these, 105 have been terminated, which means that all regulated USTs at the facility are closed and/or abandoned in place. The 21 marked "Effective" are in compliance and are active. For the remaining 65 facilities, an UST compliance inspection has been conducted by NJDEP Water Quality Enforcement inspectors or by staff from the local county health agency (NJDEP SRP, December 28, 2018; NJDEP, May 24, 2020).

11.5 SUSTAINABLE JERSEY

According to the organization's website, "Sustainable Jersey is a nonprofit organization that provides tools, training and financial incentives to support communities as they pursue sustainability programs. By supporting community efforts to reduce waste, cut greenhouse gas emissions, and improve environmental equity, Sustainable Jersey is empowering communities to build a better world for future generations" (Sustainable Jersey, 2020a).

Benefits of participation include:

- Save money – many actions help communities improve efficiency, cut waste, and stimulate their local economies.
- Grants – competitive grants are available to fund actions
- Access to training tools and expert guidance
- Recognition

[24] The database is updated weekly, and was accessed May 31, 2020 for this report. Additional UST facilities may exist, that are not included in the map. Current information may be viewed using NJ-GeoWeb at https://www.nj.gov/dep/gis/geowebsplash.htm. Select "Site Remediation Program" from the list.

- Conserve valuable resources and protect the environment.

The voluntary Sustainable Jersey certification is a significant achievement for municipal governments in New Jersey. Municipalities are awarded points for completing and documenting actions that increase sustainability. Eighty percent (453) of New Jersey's municipalities are listed as participating in the program, while 204 are currently certified at either the Bronze or Silver level, and one municipality has achieved a Gold Star.

Howell Organic Community Gardens.
Photo credit: J. Dodds

The Howell Township Green Team members are appointed annually by the Howell Town Council. "The Howell Township Green Team will advise the Township Council on ways to improve municipal operations with "Green" initiatives that make practical, environmental, and financial sense." (Howell Township, 2020).

Howell Township received a *Sustainable Jersey Community Bronze Certification* on October 19, 2018 with 220 points and was re-certified on October 12, 2015 with 185 points (see **Table 11.9**) (Sustainable Jersey, 2020b). Completion of a Natural Resource Inventory (also known as Environmental Resource Inventory) is a priority action for both bronze and silver certification levels and gains the municipality 20 points if the document is less than 10 years old. Howell Township's 2008 ERI was adopted in 2009, therefore this document will replace the earlier version.

Table 11.9. Sustainability Actions Implemented in Howell Township for Bronze Certification

Category	Action	Points	Comment
Animals in the Community	Companion Animal Management Pledge	5	
	Pledge Supporting NJ Wildlife Action Plan	10	
Community Partnership & Outreach	Create Green Team	10	Bronze mandatory
	Education for Sustainability Programs	10	
Direct Install	Outreach Campaign to Local Business Community	10	
Municipal Energy Audits and Upgrades	Energy Audits for One Building	20	
Farmland Preservation	Farmland Preservation Plans	10	
Food Production	Community Gardens	10	
Green Design	Green Building Policy/Resolution	5	
Natural Resources	Environmental Commission	10	
	Environmental Commission Site Plan Review	10	
	Natural Resource Inventory (2008)	20	Bronze Priority, Silver Priority
Natural Resource Protection Ordinances	Clustering Ordinance	10	
	Tree Protection Ordinance	10	
Green Purchasing Program	Recycled Paper	10	
Waste Management	Prescription Drug Safety and Disposal	10	Bronze Priority, Silver Priority
Recycling	Recycling Depot	10	
	Recycling Education & Enforcement	5	
	Total:	**185**	

Category	Action	Points	Comment
Source: Sustainable Jersey, 2020b			

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Water Quality Issues

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Pet Waste-Wildlife Feeding Ordinance O-05-31 https://www.twp.howell.nj.us/Archive.aspx?ADID=433

Litter Control Ordinance O-90-24 https://www.twp.howell.nj.us/Archive.aspx?ADID=432
Illicit Connection Ordinance O-05-32 https://www.twp.howell.nj.us/Archive.aspx?ADID=431
Containerized Yard Waste-Improper Disposal O-05-33 https://www.twp.howell.nj.us/Archive.aspx?ADID=430
Stormwater Control Ordinance O-06-14 https://www.twp.howell.nj.us/Archive.aspx?ADID=429

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Internet Resources: Environmental Issues

Water Quality Issues
Annual Consumer Confidence Reports
NJ AMERICAN WATER – COASTAL NORTH: http://amwater.com/njaw/water-quality/water-quality-reports/coastal-north
FARMINGDALE WATER DEPT: http://farmingdaleborough.org/departments/utilities

Current Air Quality Index for Monmouth County: https://airnow.gov/index.cfm?action=airnow.local_city&zipcode=07755&submit=Go

Drinking Water Watch: https://www9.state.nj.us/DEP_WaterWatch_public/index.jsp

Fish Advisories Home Page: http://www.state.nj.us/dep/dsr/njmainfish.htm
Fish Smart Eat Smart: https://www.nj.gov/dep/dsr/fishadvisories/Fish_Advisories_2019.pdf
StoryMap: https://njdep.maps.arcgis.com/apps/MapJournal/index.html?appid=922dff1885394cf19ccf1d9c8d52b4f0

Harmful Algal Blooms (HABs): https://www.state.nj.us/dep/hab/
Map App https://njdep.maps.arcgis.com/apps/webappviewer/index.html?id=508e5174c6d846bbbbd7a8080b158856
Reporting suspected HABs: 1-877- WARN DEP (1-877-927-6337) or https://www.state.nj.us/dep/wms/bfbm/cyanohabreporting.html

Lead in Drinking Water: http://www.nj.gov/dep/watersupply/dwc-lead.html

Learn about Water Quality (Fact sheets): https://www.state.nj.us/dep/watersupply/dwc_quality.html

NJ and Federal Drinking Water Standards (2018): https://www.nj.gov/dep/standards/drinking%20water.pdf

Pollution

Monmouth County Reclamation Center

Website: https://co.monmouth.nj.us/page.aspx?ID=186
Weekly Updates: https://co.monmouth.nj.us/page.aspx?ID=4879
Odor Complaint hotline: 732-922-2666

NJDEP Hotline: 1-877- WARN DEP (1-877-927-6337)

NJPDES Permitting: http://www.nj.gov/dep/dwq/database.htm

Underground Storage Tanks

NJDEP Guidelines for Homeowners: https://www.nj.gov/dep/watershedrestoration/waterbook_chp7.html

NJDEP Site Remediation Program: https://www.nj.gov/dep/srp/bust/

Stormwater

New Jersey's Stormwater Index: http://www.nj.gov/dep/dwq/fd.htm

NJDEP Municipal Stormwater Regulation Program: http://www.state.nj.us/dep/dwq/msrp_home.htm
Stormwater Best Management Practices Manual: http://www.njstormwater.org/bmp_manual2.htm
Clean Water NJ: http://www.cleanwaternj.org/index.htm
Multimedia Resources: http://www.cleanwaternj.org/multimedia.html
Green Infrastructure: http://www.nj.gov/dep/gi/

Township of Howell Stormwater Ordinances: https://www.twp.howell.nj.us/Archive.aspx?AMID=76

USEPA Nonpoint Source Pollution: http://water.epa.gov/polwaste/nps/index.cfm

Light Pollution

Light Pollution Map (VIIRS) data: https://www.lightpollutionmap.info

Simple Scale for Evaluating sky darkness: https://www.skyandtelescope.com/astronomy-resources/light-pollution-and-astronomy-the-bortle-dark-sky-scale/

Sustainability

New Jersey Board of Public Utilities (BPU): https://www.state.nj.us/bpu/
NJDEP Air Quality, Energy and Sustainability: https://www.state.nj.us/dep/aqes/index.html
NJDEP Bureau of Energy and Sustainability: https://www.state.nj.us/dep/aqes/bes.html
NJDEP Office of Sustainability: http://www.nj.gov/dep/aqes/sustainability.html
Sustainable Jersey: http://www.sustainablejersey.com/
USEPA Greener Living: https://www.epa.gov/environmental-topics/greener-living

Sustainable Energy

National Renewable Energy Laboratory PVWatts Calculator: https://pvwatts.nrel.gov/
New Jersey BPU: A Basic Guide to Solar Electric Systems: http://www.njcleanenergy.com/whysolar
NJDEP Clean Energy Technologies: https://www.state.nj.us/dep/aqes/osarit.html
NJDEP Solar Siting Analysis: https://njdep.maps.arcgis.com/apps/Cascade/index.html?appid=f5838c39491d4df188fffe192c8531a5
Solar Estimator: How much will solar panels cost for your home? https://www.solar-estimate.org/solar-panels/new-jersey
U.S. Department of Energy Alternative Fuels Data Center

Alternative fuels & advanced vehicles NJ Laws and Incentives: https://afdc.energy.gov/laws/state_summary?state=NJ
Plug-In Electric Vehicle Handbook for Public Charging Station Hosts: https://afdc.energy.gov/files/pdfs/51227.pdf
Vehicle Cost Calculator: https://afdc.energy.gov/calc/

12. Critical Environmental Areas

A useful definition of an "environmentally critical area" is provided in the Stormwater Management regulations (N.J.A.C. 7:8):

> "'Environmentally critical area' means an area or feature which is of significant environmental value, including, but not limited to: stream corridors; natural heritage priority sites; habitats of endangered or threatened species; large areas of contiguous open space or upland forest; steep slopes; and well head protection and groundwater recharge areas. Habitats of endangered or threatened species are identified using the Department's Landscape Project as approved by the Department's Endangered and Nongame Species Program." (NJDEP, June 20, 2016)

Throughout this document, many environmental and natural features of Howell Township have been documented, described, and mapped. One of the greatest values of mapping with GIS is to easily combine features in new ways. To accomplish this, **Figure 12.1** combines some of the mapped layers from previous sections, displaying features that make an area environmentally critical together on one map. Needless to say, Figure 12.1 is very busy, but it illustrates the distribution of natural resources throughout the township. Figure 12.2 shows the same environmental features, but all one color, and overlain with preserved open space to illustrate where Howell Township has protected its environmentally critical features.

Figures 12.1 and 12.2 combines the following:

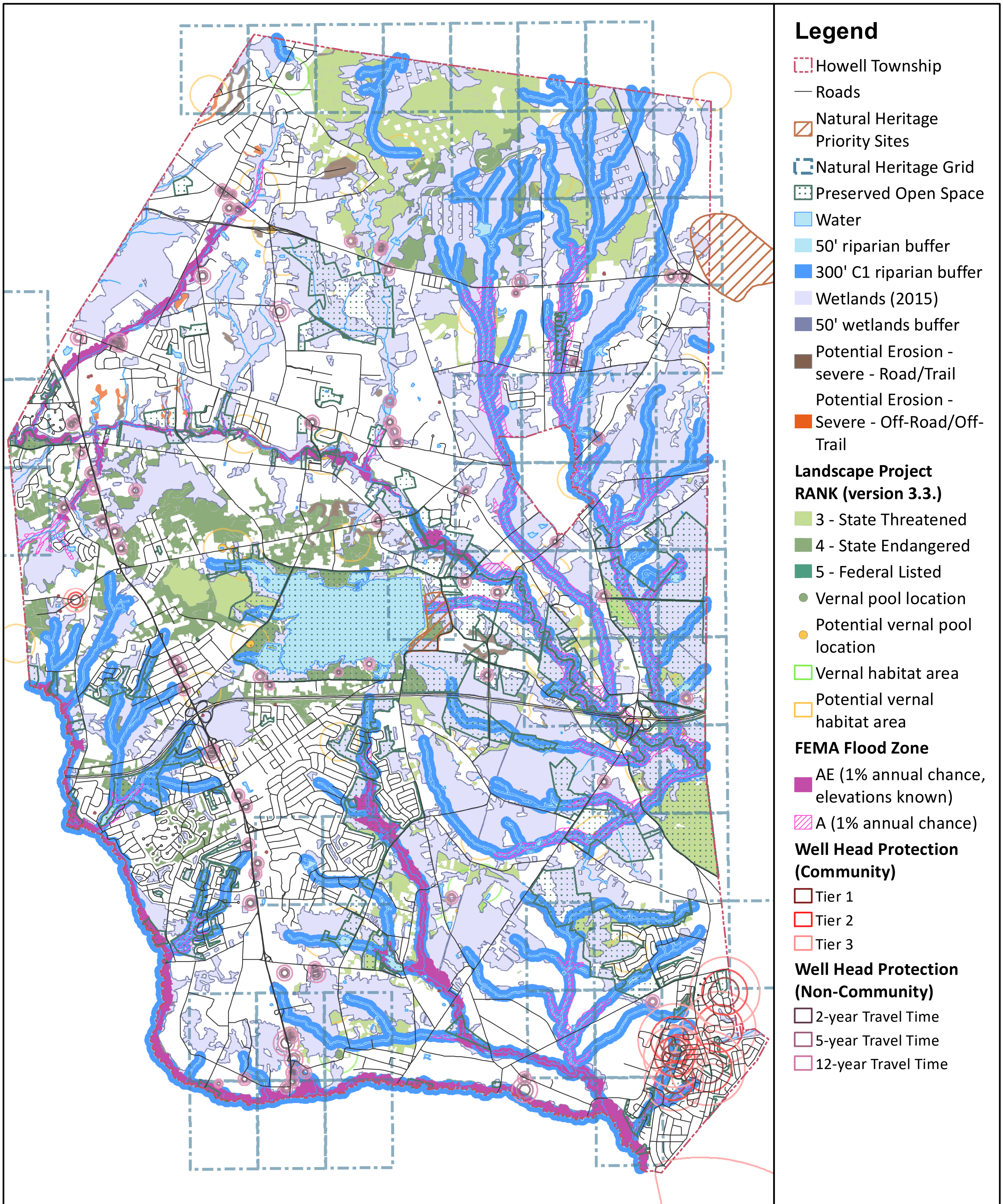
- Potential Erosion Hazard - Road / Trail (see **Section 5.4**)
- Streams and waterbodies (see S**ection 7.1**)
- 300' riparian buffer for C1 streams and 50' riparian buffer for other water (See **Section 7.2**)
- Flood Zones (see S**ection 7.3**)
- Wetlands and 50 foot wetlands buffers[25] (see S**ection 7.4**)
- Rare plant locations - Natural Heritage Priority Sites and Grid (see S**ection 8.1**)
- Rare, threatened, and endangered animal habitat (Rank 3, 4 and 5 habitats from Landscape Project version 3.3) (see S**ection 8.2**)
- Potential Vernal pools and habitat (Landscape Project version 3.3) (see S**ection 8.2**)
- Open space (see S**ection 9.3**)
- Well Head Protection Areas (Community and Non-community) (see S**ection 6.7**)

References: Critical Environmental Areas

NJDEP. Date last amended: June 20, 2016. N.J.A.C. 7:8 Stormwater Management. Courtesy copy: https://www.nj.gov/dep/rules/rules/njac7_8.pdf

Refer to the sections referenced above for more information about each individual layer and to **Appendix B** for the sources of GIS layers

[25] Wetlands and wetlands buffers are based on 2015 Land Use data, which is based on aerial photography. Note that an LOI from NJDEP is necessary to determine actual boundary of wetlands and wetland buffers.



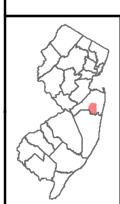


Figure 12.1. Howell Township, Critical Environmental Areas

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
Howell Township ERI

2020

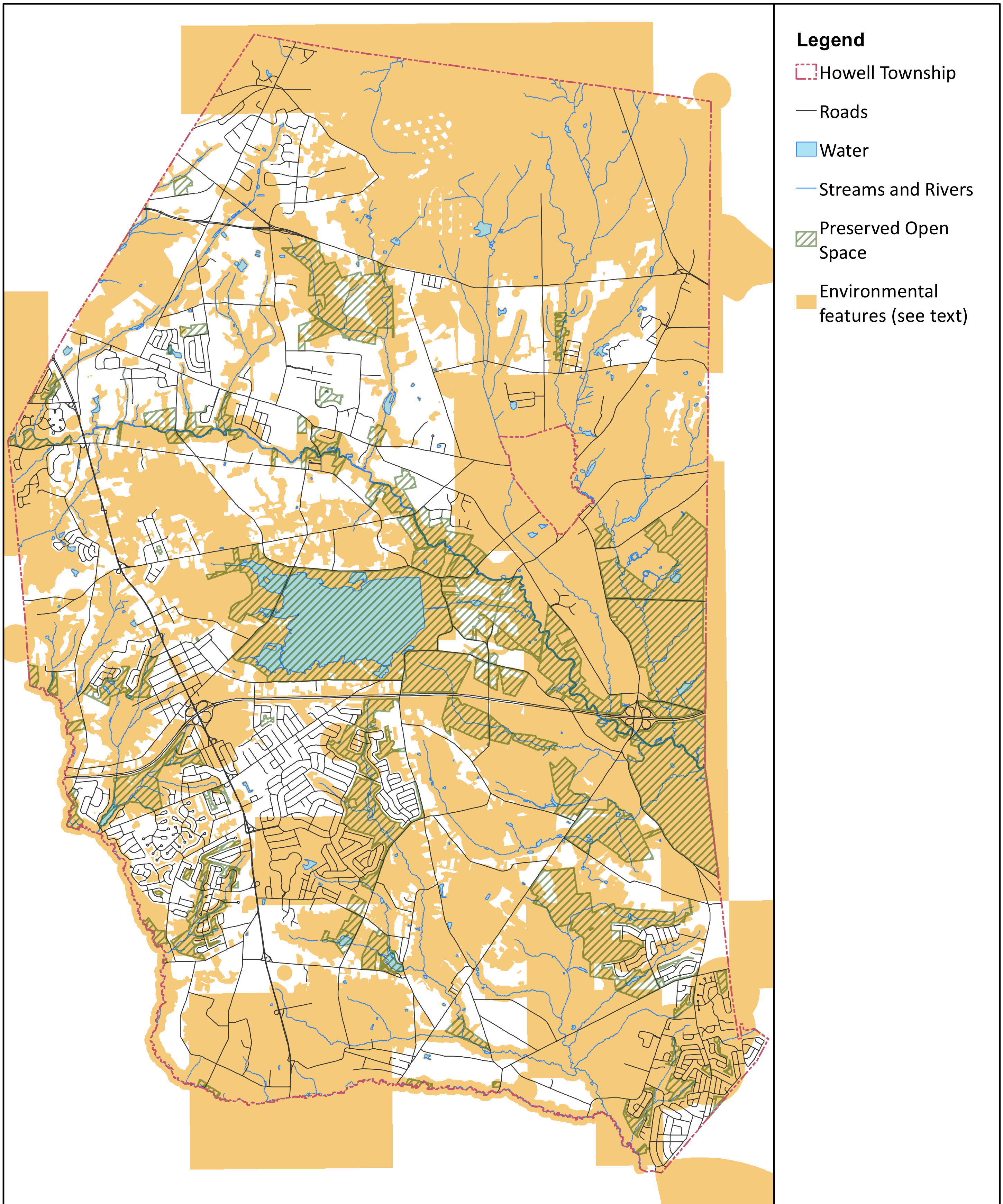


Figure 12.2. Howell Township, Critical Environmental Areas and Protected Areas

0 0.5 1 2 Miles

N

Data Sources: NJDEP, NJDOT
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Kratzer Environmental Services
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13. REGIONAL RELATIONSHIPS

13.1 MONMOUTH COUNTY MASTER PLAN

The 2016 Monmouth County Master Plan Theme is "Redevelopment, Revitalization, and Rediscovery." This represents the third comprehensive *Master Plan* for Monmouth County since the establishment of the Monmouth County Planning Board in 1954. The plan states that the first two plans had emphasized "growth management in an era of mass suburbanization," and that the new focus is on the "redevelopment, revitalization, and rediscovery of communities throughout the county. The new *Plan* recognizes that most of our municipalities have successfully planned for and have already established their desired physical form and character. As such, many of them now seek to maintain and/or enhance their distinct identities through more sustainable approaches in a time characterized by limited growth and constrained public finance" (Monmouth County Division of Planning, 2016).

The Monmouth County Master Plan endeavors to inform and guide decision makers in their planning and implementation activities over the next 10 years. The goals of the Master Plan are:

1. Promote a comprehensive approach to planning and coordinate these efforts among all levels of government and with our community stakeholders.
2. Promote the protection and conservation of natural and cultural resources to help guarantee our long-term sustainability.
3. Promote beneficial development and redevelopment that continues to support Monmouth County as a highly desirable place to live, work, play, and stay (Monmouth County Division of Planning, 2016).

The report is divided to address the 12 Primary Elements:

- NATURAL RESOURCES
- OPEN SPACE
- FARMLAND PRESERVATION
- ARTS, HISTORIC, & CULTURAL RESOURCES
- UTILITIES
- TRANSPORTATION & MOBILITY
- AGRICULTURAL & ECONOMIC DEVELOPMENT
- COMMUNITY DEVELOPMENT & HOUSING
- HEALTHY COMMUNITIES
- COMMUNITY RESILIENCY
- SUSTAINABLE PLACES
- PLANNING SERVICES, OUTREACH, & COORDINATION

Chapters for each of the 12 primary elements contain an introduction, a review of existing conditions, a discussion about Emerging Issues and Long Range Challenges, highlights of stakeholder actions and efforts, as well as a section on resources and funding opportunities. Specific objectives, stakeholder strategies and recommendations are presented (Monmouth County Division of Planning, 2016).

13.2 MONMOUTH COUNTY SCENIC ROADWAYS

Monmouth County Planning Board adopted The Monmouth County Scenic Roadway Plan in 2001. The purpose of the plan is "to identify those county roadways, or sections of county roadways, that possess such a high degree of visual quality that driving, biking or walking along these roadways is a pleasurable and enjoyable experience. The primary goal of this plan is to offer alternative design guidelines for roadways that are identified as "scenic" for use in the Monmouth County Planning Board's development review process and in the Monmouth County Capital Improvement Program. This plan is designed to serve as a growth management tool to guide the future development of land along scenic roadways and resources within Monmouth County."

County Scenic Roadway Strategies for Scenic Roadway Management

Table 13.1. County Scenic Roads in Howell Township

County Route #	Local Route Name	Milepost to Milepost	Total Miles
Route 18	Belmar Blvd.	0 to 1.45	1.45
Route 21	Southard Ave.	0 to 0.75	0.75
Route 21	Manassa Rd.	0.75 to 1.55	0.80
Route 21	Old Tavern Rd.	1.55 to 3.78	2.23
Route 21	Allenwood Rd.	3.78 to 4.1	0.32
Route 524	Allaire Rd.	26.5 to 27.25	0.75
Route 524A	Squankum-Yellowbrook Rd.	1.6 to 3.79	2.19
Route 547	Lakewood-Farmingdale Rd.	1.0 to 4.0	3.00
Route 549	Herbertsville Rd.	0 to 1.75	1.75
		Total Miles	13.24
Source: Monmouth County Planning Board, September 17, 2001			

13.3 MONMOUTH COUNTY AREAS OF SIGNIFICANT ENVIRONMENTAL QUALITY

Two key documents were prepared by the Monmouth County Environmental Council (MCEC) and used for describing and selecting the areas of significant environmental quality within the county. The initial *Natural Features Study for Monmouth County*, first published in 1975, was a county-wide inventory of natural features and resources intended to provide a sound environmental basis for future planning. One of the significant natural features discussed in the study was the New Jersey Pine Barrens. The Pine Barrens extends up into six Monmouth County townships, one of which is Howell. The report also included a list of 43 natural features within the county that were identified as significant due to their unique flora, fauna, scenery, water recharge potential, or archeologic/paleologic importance. Six of the features were fully or partially located in Howell Township (**Table 13.2**). An update to the countywide Natural Features Study is currently in the works (Monmouth County Division of Planning, 2016).

Table 13.2. Significant Natural Features in Howell Township.

Name	Designation	Description
Allaire State Park (in part)	Scenic, Wildlife habitat, Watershed/Floodplain, Recreational	Among many other plants and animals contains Ladies-tresses Orchids in nature area
Cedar Swamp	Wildlife habitat, Watershed/Floodplain	An Atlantic white cedar swamp assemblage located behind the Monmouth County Police and Fire Academy on Route 33
Howell Park	Scenic, Wildlife habitat, Geologic, Recreational	Contains an interesting fossil assemblage among other things

Name	Designation	Description
Manasquan River (in part)	Scenic, Wildlife habitat, Watershed/Floodplain, Recreational	Contains, among others, Dutchman's-breeches, wood anemone and spring beauty on Manasquan River floodplain
Orchid Colony (southwest of Allaire State Park)	Wildlife habitat	Unique orchid population along power line right-of-way
Polypod Brook (associated with Echo Lake)	Wildlife habitat, Watershed/Floodplain	Wide, clear stream of exceptional quality. Habitat for river otter.
Source: MCEC (Monmouth County Environmental Council), 1975		

In 1978, the *Monmouth County Unique Areas Study* expanded on a chapter of the Natural Features Study, producing a narrower list of sites with exceptional environmental or ecological significance in the county. Since 2007, the Unique Areas have been referred to as Areas of Significant Environmental Quality, although the reports were not formally reissued. In the Unique Areas Study, a total of 42 areas were identified as significant. Areas were grouped into six categories and include five Bogs, Marshes and Swamps, twelve Waterways, six Coastal Wetlands, five Lakes, Ponds and Reservoirs, eight Meadows, Parks and Forests, and six Archeological and Geologic Sites (MCEC, 1978).

Five of the 42 sites named in the Unique Areas Study are located in Howell Township (**Table 13.3**). The table includes the more detailed community descriptions from the study, and the original reference provides additional information regarding the characteristic flora and fauna at each location (MCEC, 1978).

Table 13.3. Unique Areas in Howell Township.

Name	Description
Bogs, Marshes and Swamps	
Cedar Swamp	Area is a dense cedar swamp with predominate hydric, marshy conditions, while the surrounding area is mesic in nature. Cedar grows naturally in swamp, hydric terrain, and is a “transitional” successional stage, ultimately being replaced as the swamp accumulates organic debris, fills in, and becomes more mesic.
Waterways	
Manasquan River (in part)	The Manasquan has no distinctly defined successional state, but is a low-lying upland woods whose major community is composed of oak, maple, and elm. The soil is mesic-hydric with mostly clays of high swelling potential and very poor drainage, interspersed with other more permeable clays and colloids
Polypod and Groundhog Brooks	The brooks are the same stream, but the name changes from Polypod to Groundhog east of Echo Lake. The brooks are a beech-maple community that appears to be perpetuating itself. Mesic to mesic-hydric soil conditions prevail consisting of clays with extremely poor drainage, although the area around Lake Louise has rapidly permeable sands, and Echo Lake has mostly shallower sands with good drainage.
Meadows, Parks and Forests	
Allaire State Park (in part)	The park can be divided into three main sections. The southern section is ‘semi’ pine barrens with xeric-mesic conditions, while the central section is mesic with maple and elm replacing the pines. Finally, there are small networks of streams and rivers throughout the park whose watershed-floodplain areas have mesic-hydric conditions. The soils throughout are mostly deep sands and rapidly permeable loess, although the floodplain along the Manasquan has the highest runoff potential and is composed of clays with nearly impermeable sub horizons. The soils along the eastern section of the park are shallower sands with good drainage.
Archaeological and Geologic Sites	

Name	Description
Paleo-Indian Site	Archeological: It is a prehistoric site dating back to approximately 9,000 BC, and during routine auger borings a Clovis-like projectile point was found, representative of one of the earliest known prehistoric cultures in North America. Further excavations revealed buried refuse, living floors, and other signs of prehistoric remains.
Source: MCEC (Monmouth County Environmental Council), 1978	

13.4 WATER SUPPLY PLANNING

The goal of statewide water supply planning, mandated by the Water Supply Management Act (N.J.S.A. 58:1A-1), is to improve the management and protection of the State's water supplies to ensure that the State's water supplies could withstand foreseeable drought and that aquifers are not depleted.

The first New Jersey Water Supply Plan (NJSWSP) was adopted in 1982, and was most recently updated in October 2017. The goal of this 5 year (2017-2022) NJSWSP is "to form the foundation of a 'living' resource able to be updated on a continuous basis as reliable new data becomes available and improved upon as new scientific methods are identified" (NJDEP, October 5, 2017).

Appendix B of the plan presents a discussion of the characteristics, status and trends, and potential availability of water from the confined aquifers of the state's Coastal Plain. The confined aquifers of the Coastal Plain provide approximately 40% of the ground water supply to the southern region of the state. According to the NJWSP, the future availability of this water supply is constrained by a number of factors, including:

- Regulations imposed in Water Supply Critical Areas 1 and 2 and any future revisions to those regulations
- The threat of saltwater intrusion in seaward and bayward margins of the aquifers
- Lack of stabilization of water levels within the aquifers
- The potential for impacts to wetlands and surface water in the outcrop areas of the aquifers
- Water-level interference with other users (NJDEP, October 5, 2017).

In the 1980s and 1990s, water level declines and saltwater intrusion in confined aquifers in the northern and central coastal plain led to the state declaring two areas of "critical water supply concern." Howell Township is within "Water Supply Critical Area 1." Within Water Supply Critical Areas 1 and 2 the state mandated reductions in use, restricted future use, and developed surface water supplies to supplement ground water supply.

A ground water model was completed in 2005 as part of a review and reassessment of the program. The studies conducted for the updated NJWSP lead to the following conclusions:

- Regional water-supply alternatives identified in the 1996 NJSWSP will continue to be endorsed.
- No additional water is available from the existing wells in the PRM, Englishtown and MLW aquifers.
- Wells in idealized locations in confined aquifers may yield a small amount (less than 1 MGD) of additional ground water.
- Aquifer storage and recovery methods may be able to provide the additional water needed to meet seasonal peak water demand.
- There is concern that aquifer withdrawals from confined aquifers between the boundaries of the Water Supply Critical Areas 1 and 2 could adversely impact other users, surface water, and known contaminated sites in the shallow hydrologic system (NJDEP, October 5, 2017).

13.5 WATER QUALITY MANAGEMENT PLANNING

In 2015, NJDEP released a new Continuing Planning Process (CPP) document, which was prepared pursuant to the federal Clean Water Act (CWA) and the New Jersey Water Pollution Control Act (WQPA), both of which require the NJDEP to formulate a continuing planning process (CPP) to achieve the water quality standards and maintain, improve, and protect water quality throughout the State. The CPP is intended to serve as an easily accessible planning tool, to be used not only as a listing of current NJDEP programs and rules relating to water quality, but as a resource for planning entities and members of the public on current policies and technical guidance on water quality issues, including:

- Establishing water quality standards and goals
- Assessing water quality and identify priority problems
- Water Quality Management Planning
- Identifying and controlling sources and causes of water quality impairment
- Intergovernmental Coordination (NJDEP Water Resources Management, November 6, 2015).

The *Water Quality Management Planning* rules at N.J.A.C 7:15 represent one component of the CPP. The current rules were adopted November 7, 2016, repealing, and replacing the prior rules from 2008. These rules focus on procedures for adopting new or amended areawide water quality management (WQM) plans, including *Wastewater Management Plans* (WMPs); lists of water quality limited (impaired) waters; and total maximum daily loads (TMDL) for impaired waters (the latter two topics are covered in **Section 7.2**). The CPP describes how these processes, along with other Department programs, integrate and unify water quality management planning processes, establish, and assess attainment of water quality goals and standards, and implement control measures necessary to maintain, improve, and protect water quality throughout the State. The rules establish a mechanism for determining whether proposed projects or activities are consistent with the statewide WQM Plan (see **Internet Resources**) (NJDEP Water Resources Management, November 6, 2015; NJDEP, November 7, 2016).

A *Wastewater Management Planning agency* or *WMP agency* is defined in the rule as a governmental entity that has wastewater management planning responsibility. The Monmouth County Board of Chosen Freeholders is the WMP agency for the Monmouth County WQM planning area. The Monmouth WQM planning area encompasses most of Monmouth County, including the northern half of Howell Township in the Manasquan, Navesink and Shark River watersheds. The Ocean County Board of Chosen Freeholders is the WMP agency for the Ocean County WQM planning area, which includes the area of Howell Township in the Metedeconk Watershed (NJDEP, March 4, 2020). These areas are shown in **Figure 13.1**.

One of the WQM agency's roles is to update the Wastewater Management Plan (WMP) at least once every 10 years for wastewater and certain other water quality concerns (NJDEP, March 18, 2020). The Manasquan River Regional Sewerage Authority Service Area (MRRSA) (see **Section 13.6**) collects untreated sewage from Howell Township (as well as Freehold Borough, Farmingdale Borough, and portions of Freehold and Wall Townships) and conveys the wastewater to Ocean County. The wastewater is treated by the Ocean County Utilities Authority (OCUA) at its Northern Ocean County Wastewater Treatment Facility[26] and discharged to the Atlantic Ocean. Within the designated sewer service area, individual subsurface sewage disposal systems (ISSDS) for individual residences can be constructed but must connect to sewer service when available (Monmouth County Division of Planning. February 21, 2012).

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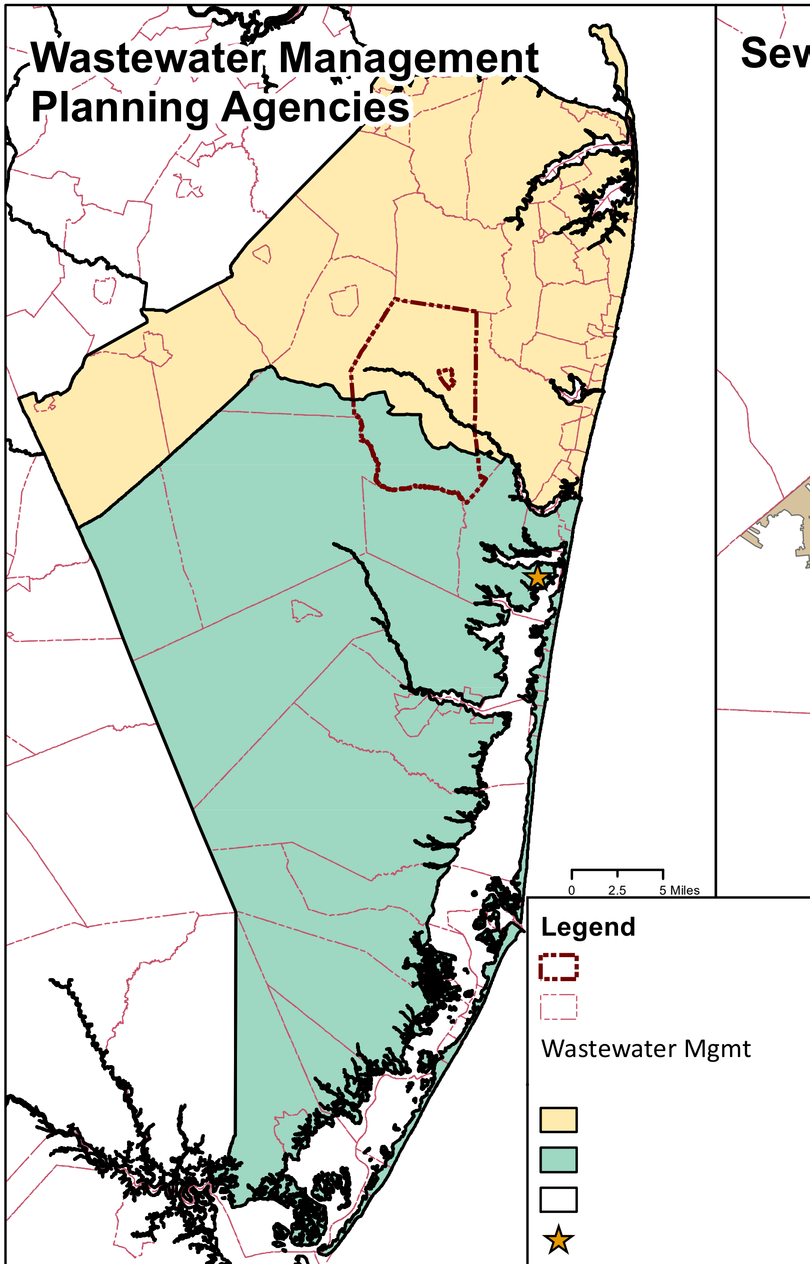
[26] Permit Number NJ 0028142 OCUA STP Mantoloking discharges to surface water (Atlantic Ocean) at Mantoloking Road in Brick Township (Location of discharge: -74° 01” 39’, 40° 01” 55’) (Monmouth County Division of Planning. February 21, 2012).



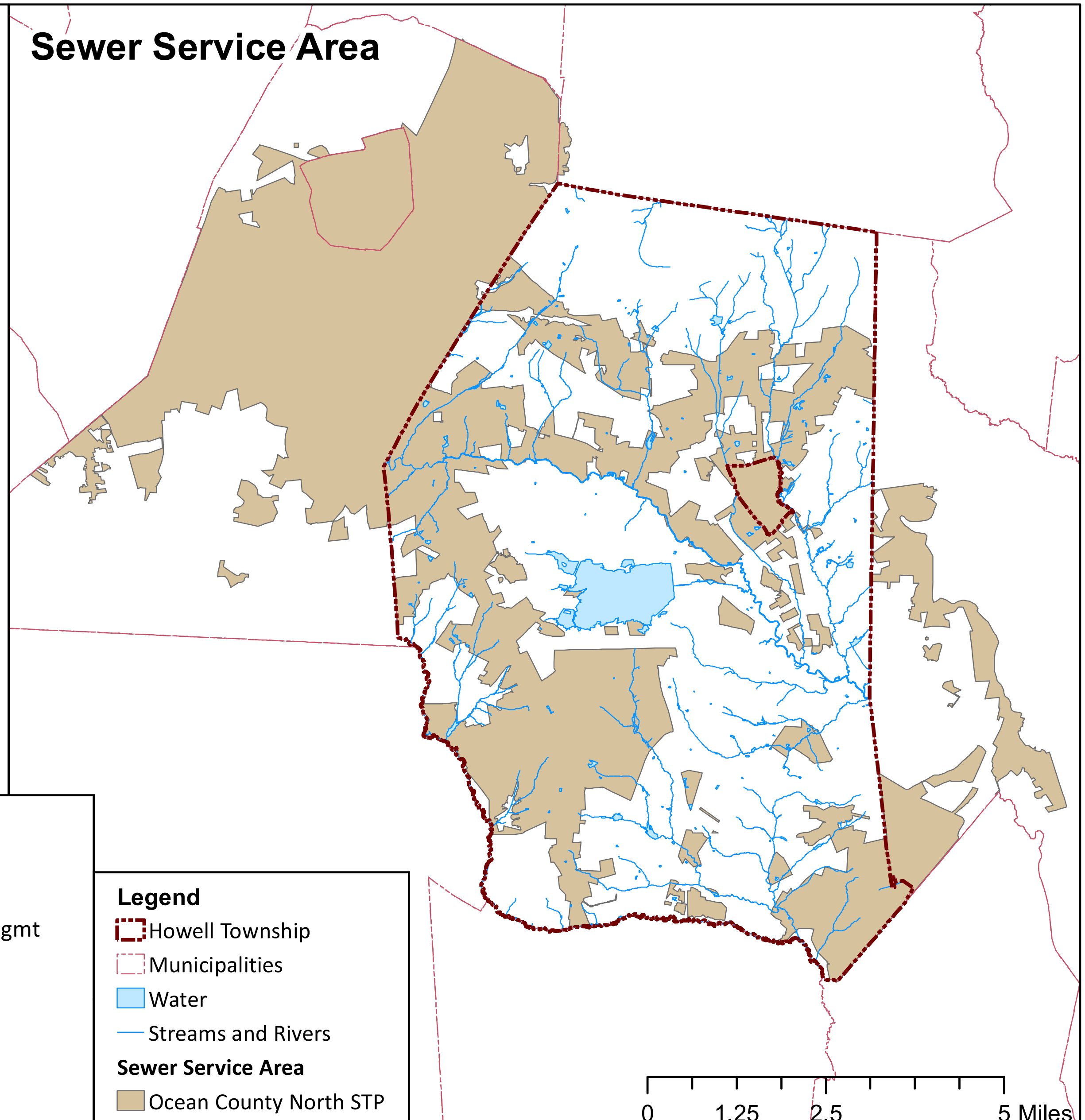


Figure 13.1. Howell Township, Water Quality Management Planning

Data Sources: NJDEP
Disclaimer required for NJDEP Data: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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The Wastewater Management Plan (WMP) for Monmouth County Future Wastewater Service Area (FWSA) Map, including the Sewer Service Area in Howell Township, was adopted in 2013. The only change within Howell Township since then was an April 13, 2015 amendment, entitled “Harms and Pinnacle Sewer Service Area” (east of Route 9 and south of W Farms Road) that expanded the Manasquan River Regional Sewerage Authority MRRSA sewer service area by 84.8 acres to allow for the construction of 57 single family homes and the connection of 3 existing single family homes to the MRRSA (Monmouth County Division of Planning, March 24, 2020; NJDEP, April 17, 2020). The current SSA is shown in **Figure 13.1**)

The 2016 WQMP rules require the designated planning authorities to develop a new WMP based on modeling and analysis for capacity of sewer service areas and septic areas. The public *Sewer Service Area (SSA)* shows the planned method of wastewater disposal for the township. On January 3, 2019, NJDEP extended the statewide deadline for these updated WMP components to June 30, 2019 (NJDEP, April 17, 2020).

Ocean County adopted an amendment to the Ocean County Water Quality Management Plan on March 26, 2020, which the NJDEP determined is compliant with N.J.A.C. 7:15-3.5 and 4. The nitrate dilution analysis included in the amendment revealed that portions of the HUC11 watershed 02040301020, the North Branch Metedeconk River (which includes portions of Lakewood and Millstone Townships, as well as the portion of Howell Township in the Ocean County WMP), are zoned for a greater density of septic development than can be accommodated through dilution. According to the nitrate dilution analysis, this HUC11 would exceed its assimilative capacity by 126.57 future residential equivalent units (Ocean County Department of Planning, December 22, 2017). The WMP presents several possible strategies to mitigate this deficiency, including:

- Identify areas appropriate for expansion of the sewer service area
- Require individual subsurface disposal systems (ISSDS) to reach a higher level of treatment
- Acquire open space (or preserving undeveloped land to restrict areas that are eligible for development)
- Change local zoning to reduce the potential square footage of future development, reduce floor area ratio and/or density, or increase lot size for development served by onsite septic systems (Ocean County Department of Planning, December 22, 2017).

13.6 MANASQUAN RIVER REGIONAL SEWERAGE AUTHORITY

New Jersey's Sewerage Authorities Law (N.J.S.A. 40:14) was enacted on April 23, 1946 in order to reduce pollution and protect public health. The act granted municipalities the power to form regional sewerage authorities to acquire, construct, maintain, operate, or improve works for the collection, treatment, purification, or disposal of sewage or other wastes. The Manasquan River Regional Sewerage Authority was established on December 23, 1974 and serves five municipalities including Howell, Freehold and Wall Townships and Freehold and Farmingdale Boroughs (Howell Township, 1974). The Sewerage Authority consists of two members from each participating municipality, and Howell Township's representatives are appointed by the Township Council (Howell Township, 2020).

13.7 METEDECONK WATERSHED PROTECTION ALLIANCE

The Metedeconk Watershed encompasses about 90 square miles in southern Monmouth and northern Ocean counties. The four Monmouth municipalities in the watershed are Howell, Freehold, Millstone, and Wall Townships. The river is an important source of local drinking water, and the water supply facilities are operated by the Brick Township Municipal Utilities Authority (BTMUA). In January

2010, the BTMUA formed a representative steering committee for the development of the Metedeconk River Watershed Protection and Restoration Plan, which was completed in May 2013. The committee continues to meet as needed (Monmouth County Division of Planning, 2016), and Howell has a single representative who is appointed by the Township Council (Howell Township, 2020).

References: Regional Relationships

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Metedeconk Watershed Protection Alliance

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https://co.monmouth.nj.us/documents/24/MP%20-%20Chapter%203.pdf

Internet Resources: Regional Relationships

Monmouth County
Division of Planning: https://co.monmouth.nj.us/page.aspx?Id=140
2016 Master Plan: http://co.monmouth.nj.us/documents/24/FINAL%20Master%20Plan%20Volume%20I.pdf

NJ Rules and Regulations
Laws & Rules https://www.nj.gov/dep/landuse/lawsregs.html
Notice of Rule Proposals https://www.state.nj.us/dep/rules/notices.html

Table of Contents

Appendix A.1. Terms of Agreement for Use of NJDEP GIS Data

Required by NJDEP Office of Information Management, Bureau of Geographic Information and Analysis.

1. Digital data received from the NJDEP are to be used solely for internal purposes in the conduct of daily affairs.

2. The data are provided, as is, without warranty of any kind and the user is responsible for understanding the accuracy limitations of all digital data layers provided herein, as documented in the accompanying Data Dictionary and Readme files. Any reproduction or manipulation of the above data must ensure that the coordinate reference system remains intact.

3. Digital data received from the NJDEP may not be reproduced or redistributed for use by anyone without first obtaining written permission from the NJDEP. This clause is not intended to restrict distribution of printed mapped information produced from the digital data.

4. Any maps, publications, reports, or other documents produced as a result of this project that utilize NJDEP digital data will credit the NJDEP Geographic Information System (GIS) as the source of the data with the following credit/disclaimer:

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

5. Users shall require any independent contractor, hired to undertake work that will utilize digital data obtained from the NJDEP, to agree not to use, reproduce, or redistribute NJDEP GIS data for any purpose other than the specified contractual work. All copies of NJDEP GIS data utilized by an independent contractor will be required to be returned to the original user at the close of such contractual work. Users hereby agree to abide by the use and reproduction conditions specified above and agree to hold any independent contractor to the same terms. By using data provided herein, the user acknowledges that terms and conditions have been read and that the user is bound by these criteria.

Appendix A.2. Cautions and Restrictions on Use of Natural Heritage Data

Required by NJDEP Division of Parks and Forestry, Natural Lands Management.

CAUTIONS AND RESTRICTIONS ON NATURAL HERITAGE DATA

The quantity and quality of data collected by the Natural Heritage Program is dependent on the research and observations of many individuals and organizations. Not all of this information is the result of comprehensive or site-specific field surveys. Some natural areas in New Jersey have never been thoroughly surveyed. As a result, new locations for plant and animal species are continuously added to the database. Since data acquisition is a dynamic, ongoing process, the Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of New Jersey. Information supplied by the Natural Heritage Program summarizes existing data known to the program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments. The attached data is provided as one source of information to assist others in the preservation of natural diversity.

This office cannot provide a letter of interpretation or a statement addressing the classification of wetlands as defined by the Freshwater Wetlands Act. Requests for such determination should be sent to the DEP Division of Land Use Regulation, P.O. Box 439, Trenton, NJ 08625-0439.

The Landscape Project was developed by the Division of Fish & Wildlife, Endangered and Nongame Species Program in order to map critical habitat for rare animal species. Natural Heritage Database response letters will also list all species (if any) found during a search of the Landscape Project. However, this office cannot answer any inquiries about the Landscape Project. All questions should be directed to the DEP Division of Fish and Wildlife, Endangered and Nongame Species Program, P.O. Box 400, Trenton, NJ 08625-0400.

This cautions and restrictions notice must be included whenever information provided by the Natural Heritage Database is published.

NJ Department of Environmental Protection
Division of Parks and Forestry
Natural Lands Management

APPENDIX B. METADATA FOR GIS DATA LAYERS USED FOR THIS REPORT

Map	Source of Data	Data Title	Date	Scale	Online Link
all	NJDEP BGIS	Municipalities of New Jersey (Clipped to Coast), Edition 20121228 (Govt_admin_mun_coast_bnd)	12/28/2012	1:2,400	http://www.state.nj.us/dep/gis/stateshp.html#MUNCOAST
Most	Monmouth Co	State of New Jersey Composite of Parcels Data, New Jersey State Plane NAD83 and MOD-IV Tax List Search Database	8/6/2019	n/a	https://njogis-newjersey.opendata.arcgis.com/datasets/parcels-and-mod-iv-of-monmouth-county-nj-shp-download
	NJDEP BGIS	National Hydrography Dataset (NHD) Streams 2002	11/1/2010	1:2,400	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/nhdstreams2002shp.zip
	NJDOT	New Jersey Department of Transportation Statewide Public Road Network (1:2400)	12/1/2014	1:2,400	http://www.state.nj.us/transportation/gis/data.shtm
	NJDEP BGIS	NJDEP 2002 Waters of New Jersey (Lakes and Ponds), Version 20080501	5/1/2008	1:2,400	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njwaterbody.zip
2.1 Location	ESRI (1)	World Terrain Reference	na	~1:70,000	http://goto.arcgisonline.com/maps/Reference/World_Reference_Overlay " target="_new
	NJDEP BGIS	Counties of New Jersey, New Jersey State Plane NAD83	3/9/2010	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/county-boundaries-of-nj
2.2 Aerial Photography	ESRI (2)	World Imagery	~ 2015-2017	varies	http://goto.arcgisonline.com/maps/World_Imagery
	ESRI (3)	World Boundaries and Places	8/13/2020	varies	http://goto.arcgisonline.com/maps/Reference/World_Boundaries_and_Places
	ESRI (4)	World Transportation	8/13/2020	varies	http://goto.arcgisonline.com/maps/Reference/World_Transportation
2.3 Land Use Type	NJDEP BGIS	Land Use/Land Cover 2015 Update, Edition 20190128 (Land_lu_2015)	1/28/2019	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::land-use-land-cover-of-new-jersey-2015-download
2.4 Land use change	NJDEP	Land use/Land cover 1995/97 Update for New Jersey (by WMA), Edition 20001201 (Land_lu_1995)	12/1/2000	1:12,000	https://gisdata-njdep.opendata.arcgis.com/datasets/land-use-land-cover-of-new-jersey-1995-1997-download
	NJDEP BGIS	Land Use/Land Cover 2012 Update (Generalized), Edition 20150217 (Land_lu_2012_gen)	2/17/2015	1:2,400	http://www.state.nj.us/dep/gis/lulc12.html
	NJDEP BGIS	Land Use/Land Cover 2012 Update, Edition 20150217 Subbasin 02030104 -Sandy Hook-Staten Island (Land_lu_2012_hu02030104)	2/17/2015	1:2,400	http://www.state.nj.us/dep/gis/lulc12.html
	NJDEP BGIS	Land Use/Land Cover 2012 Update, Edition 20150217 Subbasin 02040301 - Mullica-Toms (Land_lu_2012_hu02040301)	2/17/2015	1:2,400	http://www.state.nj.us/dep/gis/lulc12.html
	NJDEP BGIS	Land Use/Land Cover 2015 Update, Edition 20190128 (Land_lu_2015)	1/28/2019	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::land-use-land-cover-of-new-jersey-2015-download
	NJDEP	NJDEP 2002 Land use/Land cover Update, Barnegat Bay Watershed Management Area, WMA-13, Edition 20080304	3/4/2008	1:2,400	https://www.nj.gov/dep/gis/lulc02cshp.html
	NJDEP	NJDEP 2002 Land use/Land cover Update, Monmouth Watershed Management Area, WMA-12, Edition 20080304	3/4/2008	1:2,400	https://www.nj.gov/dep/gis/lulc02cshp.html

Map	Source of Data	Data Title	Date	Scale	Online Link
	NJDEP	NJDEP 2007 Land use/Land Cover Update, Barnegat Bay Watershed Management Area, WMA13	7/12/2010	1:2,400	https://www.nj.gov/dep/gis/lulc07shp.html
	NJDEP	NJDEP 2007 Land use/Land Cover Update, Monmouth Watershed Management Area, WMA12	7/12/2010	1:2,400	https://www.nj.gov/dep/gis/lulc07shp.html
	ESRI (2)	World Imagery	~ 2015-2017	varies	http://goto.arcgisonline.com/maps/World_Imagery
	ESRI (4)	World Transportation	8/13/2020	varies	http://goto.arcgisonline.com/maps/Reference/World_Transportation
4.1 Geology	NJGS	DGS02-7: Physiographic Provinces of New Jersey	6/30/2002	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs02-7.htm
	NJGS	DGS04-6: Bedrock Geology for New Jersey 1:100,000 Scale	5/10/2007	1:100,000	https://gisdata-njdep.opendata.arcgis.com/datasets/bedrock-geology-of-new-jersey
	NJGS	DGS05-1: Selected Sand, Gravel and Rock Surficial Mining Operations in New Jersey, Series DGS05-1, Edition 20070313 (Geol_sandgravel)	12/12/2006	na	https://gisdata-njdep.opendata.arcgis.com/datasets/quarries-sand-and-gravel-in-new-jersey
	NJDEP	NJDEP Statewide Grid of Quarterquad Boundaries, New Jersey, 1991 (QQ91)	1991 (2016)		https://gisdata-njdep.opendata.arcgis.com/datasets/statewide-grid-of-quarterquad-boundaries-of-new-jersey
4.2 Elevation	Monmouth Co	Monmouth County Contour Database, 2' elevations	8/15/2017		https://gis-monmouthnj.opendata.arcgis.com/datasets/8c7faafbee524234bed84d1591503077_0/data
	Monmouth Co	Monmouth County Contour point elevations	2003		https://gis-monmouthnj.opendata.arcgis.com/pages/open-data
4.3 Shaded Elevation	NJDEP BGIS	NJDEP Digital Elevation Grid for New Jersey (100 meter)	5/1/2002	1:24,000	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/nj100mlat.zip
4.4 Surficial Geology	NJGWS	DGS07-2: Surficial Geology of New Jersey	1/1/2006	1:100,000	https://www.state.nj.us/dep/njgs/geodata/dgs07-2.htm
	NJGWS	DGS07-2: Thickness of Surficial Deposits in New Jersey	10/3/2013	1:100,000	https://www.state.nj.us/dep/njgs/geodata/dgs07-2.htm
	NJGWS	Historic Fill For New Jersey, Series DGS04-7, Edition 20180314 (Geol_soil_historicfill)	3/14/2018	1:100,000	https://gisdata-njdep.opendata.arcgis.com/datasets/historic-fill-in-new-jersey
5.1 to 5.8 Soils	NRCS	Soil Survey Geographic (SSURGO) database for Monmouth County, New Jersey	9/15/2019	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
6.1 Aquifers	NJGS	DGS98-5 Aquifers of New Jersey	5/21/1998	1:100,000	https://gisdata-njdep.opendata.arcgis.com/datasets/bedrock-aquifers-in-new-jersey
	NJGS	DGS98-6 NJDEP Sole-Source Aquifers in New Jersey	4/5/2000	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/sole-source-aquifers-in-new-jersey
6.3 Recharge	NJGS	DGS02-3-New Jersey Ground-Water Recharge, Series DGS02-3, Edition 200605 (Geol_gw_recharge)	5/1/2006	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/ground-water-recharge-areas-in-new-jersey
6.5 Water Supply	NJGS	NJDEP Public-Community Water Supply Wells of NJ (PCWS)	2/18/2010	1:24,000	na
	NJDEP	Public Community Water Purveyor Service Areas, New Jersey, Edition 20190211 (Util_drinkingwater_PSA)	2/11/2019	na	https://gisdata-njdep.opendata.arcgis.com/datasets/00e7ff046ddb4302abe7b49b2ddee07e_13
7.1 Watersheds	NJDEP BGIS	Watershed Management Areas in New Jersey	3/8/2016		https://gisdata-njdep.opendata.arcgis.com/datasets/watershed-management-areas-in-new-jersey

Map	Source of Data	Data Title	Date	Scale	Online Link
7.2 Sub-watersheds	NJDEP BGIS	14 Digit Hydrologic Unit Code Delineations for New Jersey	3/8/2016		https://gisdata-njdep.opendata.arcgis.com/datasets/14-digit-hydrologic-unit-code-delineations-for-new-jersey
7.3 Surface Water Quality Standards (SWQS)	NJDEP	Surface Water Quality Standards of New Jersey, Edition 201012 (Hydr_water_stream_swqs)	12/1/2010	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/surface-water-quality-classification-of-new-jersey/data
7.4 Surface Water Quality and Flow Monitoring	NJDEP BGIS	Ambient Biomonitoring Network (AMNET) of New Jersey	6/5/2017	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/ambient-biomonitoring-network-amnet-of-new-jersey
	NJDEP BGIS	Ambient Stream Quality Monitoring Sites of New Jersey	9/30/2019	1:2,400	https://gisdata-njdep.opendata.arcgis.com/datasets/ambient-stream-quality-monitoring-sites-of-new-jersey
	USGS	USGS Water Quality and Flow Monitoring Sites	2/22/2020	na	na; entered coordinates from USGS data site http://waterdata.usgs.gov/nj/nwis/current/?type=flow
	NWQMC	Water Quality Data Search	3/1/2020	na	waterqualitydata.us
7.5 Surface Water Quality (2014 integrated report)	NJDEP	Integrated List of Waters for New Jersey, 2014 (Integrated List), Edition 20170927 (Envr_mon_water_IR_2014_use)	9/27/2017	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/2014-new-jersey-integrated-list-of-waters-integrated-list-of-new-jersey
		Integrated List of Waters for New Jersey, 2016		not GIS	GIS layer not available yet; created join table
7.6 Floodplains/FEMA Flood Zones	FEMA	FEMA Flood Zones	09/25/2009	1:12,000	https://msc.fema.gov [theoretically here, but could only find for part of twp]
7.7 Wetlands	NJDEP BGIS	Land Use/Land Cover 2015 Update, Edition 20190128 (Land_lu_2015)	1/28/2019	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::land-use-land-cover-of-new-jersey-2015-download
8.1.a Land Cover - forest	NJDEP BGIS	Land Use/Land Cover 2015 Update, Edition 20190128 (Land_lu_2015)	1/28/2019	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::land-use-land-cover-of-new-jersey-2015-download
8.1.b Land Cover - wetland	NJDEP BGIS	Land Use/Land Cover 2015 Update, Edition 20190128 (Land_lu_2015)	1/28/2019	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::land-use-land-cover-of-new-jersey-2015-download
8.2 Natural Heritage Priority	NJDEP ONLM	Natural Heritage Priority Areas	3/1/2007	1:2,400	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::natural-heritage-priority-sites-in-new-jersey
8.3 Wildfire Fuel Hazard	NJDEP NJFFS	2002 NJFFS Wildfire Fuel Hazard for Monmouth County, New Jersey	4/17/2009	1:2,400	https://www.state.nj.us/dep/gis/njfh.html#MON
8.4 Natural Heritage Grid	NJDEP ONLM	Natural Heritage Grid Map for New Jersey, Edition 200911 (Grid_NHP)	11/1/2009	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/natural-heritage-grid-map-for-new-jersey
8.5 Trees and canopy closure	NJDEP BGIS	Land Use/Land Cover 2012 Update, Edition 20150217 Subbasin 02040301 - Mullica-Toms (Land_lu_2012_hu02040301)	2/17/2015	1:2,400	http://www.state.nj.us/dep/gis/lulc12.html
8.7 Important Bird Areas	Audubon	Audubon publicly bound Important Bird Areas Updated 09/15/2015	9/15/2015	1:50,000	https://audubon.maps.arcgis.com/home/item.html?id=2e401b20392449918f6b6b00b7f49074#overview

Map	Source of Data	Data Title	Date	Scale	Online Link
8.8 Vernal Pools - Landscape Project version 3.3	NJDEP DFW ENSP	NJDEP Species Based Habitat, Vernal Habitat, Version 3.3, 20170509 (Envr_hab_ls_v3_3_vernalhabitat)	5/9/2017	1:12,000	http://www.nj.gov/dep/gis/listall.html
	NJDEP DFW ENSP	NJDEP Species Based Habitat, Vernal Pools, Version 3.3, 20170509 (Envr_hab_ls_v3_3_vernalpools)	5/9/2017	1:12,000	http://www.nj.gov/dep/gis/listall.html
8.9 Landscape Project (rare, threatened and endangered animals)	NJDEP DFW ENSP	NJDEP Species Based Habitat, Atlantic Coastal Region, Version 3.3, 20170509 (Envr_hab_ls_v3_3_coastal)	5/9/2017	1:12,000	http://www.nj.gov/dep/gis/listall.html
	NJDEP DFW ENSP	NJDEP Species Based Habitat, Piedmont Plains Region, Version 3.3, 20170509 (Envr_hab_ls_v3_3_piedmont)	5/9/2017	1:12,000	http://www.nj.gov/dep/gis/listall.html
8.10 Wildlife habitat & habitat connectivity "CHANJ"	NJDEP BGIS	Connecting Habitat Across New Jersey (CHANJ) Action Regions for New Jersey	11/1/2018	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::connecting-habitat-across-new-jersey-chanj-action-regions-for-new-jersey
	NJDEP BGIS	NAACC Culvert Inventory of New Jersey [North Atlantic Aquatic Connectivity Collaborative (NAACC) Road-Stream Crossing Assessments in New Jersey, (Envr_CHANJ_pts)]	4/18/2018	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::naacc-culvert-inventory-of-new-jersey
	NJDEP BGIS	NJDEP Terrestrial Wildlife Habitat Core Links in New Jersey, Connecting Habitat Across New Jersey (CHANJ), Edition 20181101 (Envr_CHANJ_core_links)	11/1/2018	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::terrestrial-wildlife-habitat-core-links-in-new-jersey
	NJDEP BGIS	NJDEP Terrestrial Wildlife Habitat Stepping Stones in New Jersey, Edition 20181101 (Envr_CHANJ_stepping_stones)	11/1/2018	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::terrestrial-wildlife-habitat-stepping-stones-in-new-jersey
	NJDEP BGIS	Terrestrial Wildlife Habitat Cores and Corridors in New Jersey, Connecting Habitat Across New Jersey (CHANJ)	11/1/2018	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::terrestrial-wildlife-habitat-cores-and-corridors-in-new-jersey-connecting-habitat-across-new-jersey-chanj
9.1 Open Space - trails	NJDEP	New Jersey State Park Service - Parks and Forests Trail System, Edition 20181127 (Land_use_trails)	11/27/2015	1:1,500	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::parks-and-forests-trail-system-for-new-jersey-state-park-service
	NJDEP	State Protected Open Space Agency Locations in New Jersey, Edition 20190605 (Land_owner_openspace_pt)	6/5/2019	1:24,000	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::state-protected-open-space-agency-locations-in-new-jersey
	NJDEP	State, Local and Nonprofit Open Space of New Jersey, Edition 20190917 (Land_owner_openspace)	9/17/2019	1:24,000	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::state-local-and-nonprofit-open-space-of-new-jersey
9.6 Preserved Farmland	SADC	Monmouth County Farmland		not GIS	https://www.nj.gov/agriculture/sadc/farmpreserve/progress/maps/index.html
	SADC	New Jersey Farmland Preservation Program (njfpp)	7/20/2018	1:12,000	http://www.nj.gov/agriculture/sadc/farmpreserve/resources/njfpp.zip
	SADC	property list (no block and lot)		not GIS	https://www.nj.gov/agriculture/sadc/farmpreserve/progress/stats/preservedfarmslist.pdf
10.1 Historic sites, districts, areas	NJDEP NHR HPO	Archaeological Site Grid of New Jersey, Edition 20190129 (Land_use_HPO_arch_grid)	1/29/2019	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::archaeological-site-grid-of-new-jersey
	NJDEP NHR HPO	Historic Districts of New Jersey, Edition 20190129 (Land_use_HPO_district)	1/29/2019	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::historic-districts-of-new-jersey
	NJDEP NHR HPO	Historic Properties of New Jersey, Edition 20190129 (Land_use_HPO_property)	1/29/2019	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::historic-properties-of-new-jersey

Map	Source of Data	Data Title	Date	Scale	Online Link
	NJDEP NHR HPO	Historic Property Features of New Jersey, Edition 20190129 (Land_use_HPO_property_feature)	1/29/2019	na	https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::historic-property-features-of-new-jersey
11.1 Water Supply	NJGWS	Well Head Protection Areas For Public Community Water Supply Wells In New Jersey, Edition 20180517	5/17/2018	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/well-head-protection-areas-for-public-community-water-supply-wells-in-new-jersey
	NJGWS	Well Head Protection Areas For Public Non-Community Water Supply Wells In New Jersey, Series DGS04-5 , Edition 20150219	2/19/2015	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/well-head-protection-areas-for-public-non-community-water-supply-wells-in-new-jersey
11.2 NJEMS	NJDEP	New Jersey Environmental Management System (NJEMS) Sites (Envr_NJEMS_site)	4/26/2020	1:12,000	https://gisdata-njdep.opendata.arcgis.com/datasets/new-jersey-environmental-management-system-njems-sites
	NJDEP	NJPDES Surface Water Discharges in New Jersey, (1:12,000) Edition 20190807 (Strc_NJPDES_sw_pipe)	20190807	1:12,000	https://gisdata-njdep.opendata.arcgis.com/datasets/njpdes-surface-water-discharges-in-new-jersey-112000
11.3 Percent Impervious Surface & NJPDES (2015)	NJDEP & consultant	Impervious Surfaces of New Jersey, Edition 20180930 (Rast_impervious_surface)	9/30/2018	na	https://gisdata-njdep.opendata.arcgis.com/datasets/monmouth-county-impervious-surface-2015-of-new-jersey
	USDA & others	New Jersey Hydrologic Modeling Database	5/18/2020	na	https://hydro.rutgers.edu/ (downloaded table of Monmouth county stormwater basins, selected those in Howell Township area and imported into ArcGIS)
11.5 Contaminated Sites	NJDEP	Classification Exception Areas-Well Restriction Areas for New Jersey, Edition 20190214 (Envr_mon_gw_CEA)	2/4/2020	1:1,000	https://gisdata-njdep.opendata.arcgis.com/datasets/classification-exception-areas-well-restriction-areas-for-new-jersey
	NJDEP	Deed Notice Extent in New Jersey, Edition 20190214 (Envr_mon_soil_DNA)	2/4/2020	1:24,000	https://gisdata-njdep.opendata.arcgis.com/datasets/deed-notice-extent-in-new-jersey
	NJDEP	Known Contaminated Site List for New Jersey (Envr_NJEMS_KCSL)	5/30/2020	1:1,000	https://gisdata-njdep.opendata.arcgis.com/datasets/known-contaminated-site-list-for-new-jersey-non-homeowner
	NJDEP	Underground Storage Tanks, New Jersey (Envr_NJEMS_site_ust)	5/24/2020	1:12,000	https://gisdata-njdep.opendata.arcgis.com/datasets/underground-storage-tank-facilities-in-new-jersey
12.1 Critical Environmental Areas		[based on a combination of layers]			
13.1 Wastewater Management Planning Areas	NJDEP BGIS	Municipal Boundary Lines of New Jersey, New Jersey State Plane 1983	7/20/2016	1:12,000	https://gisdata-njdep.opendata.arcgis.com/datasets/newjersey::municipal-boundaries-of-nj
	NJDEP BGIS	Statewide Sewer Service Area for New Jersey, Edition 20200302 (Util_wastewater_servicearea)	3/2/2020	na	https://gisdata-njdep.opendata.arcgis.com/datasets/statewide-sewer-service-area-for-new-jersey
	NJDEP BGIS	Water Quality Management Planning Areas (Version 200908)	8/1/2009	1:24,000	https://www.state.nj.us/dep/gis/stateshp.html#WATMAN

Sources:

Abbreviation	Full Name
Audubon	National Audubon Society
ESRI (1)	Esri, Garmin, USGS, NPS

Abbreviation	Full Name
ESRI (2)	Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
ESRI (3)	Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
ESRI (4)	Esri, HERE, Garmin, © OpenStreetMap contributors
FEMA	Federal Emergency Management Agency
Monmouth Co	Monmouth County Division of Planning, NJ Office of Information Technology, Office of GIS (NJOGIS)
NJDEP	NJ Department of Environmental Protection
NJDEP & consultant	NJDEP with consultant, Applied Geographics, Inc.
NJDEP BGIS	NJ Department of Environmental Protection, Bureau of Geographic Information Systems
NJDEP DFW ENSP	NJ Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program
NJDEP NHR HPO	NJ Department of Environmental Protection, Natural and Historic Resources, Historic Preservation Office
NJDEP NJFFS	NJ Department of Environmental Protection
NJDEP ONLM	NJ Department of Environmental Protection, Office of Natural Lands Management
NJDOT	NJ Department of Transportation
NJGS	NJ Department of Environmental Protection, New Jersey Geological and Water Survey (formerly NJGS)
NJGWS	NJ Department of Environmental Protection, New Jersey Geologic Survey (now NJGWS)
NRCS	US Department of Agriculture, Natural Resources Conservation Service
NWQMC	National Water Quality Monitoring Council
SADC	NJ Department of Agriculture, State Agriculture Development Committee
USDA & others	US Department of Agriculture, NJ Department of Agriculture, NJ Department of Environmental Protection, NJ Soil Conservation Districts, Rutgers University Office of Research Analytics
USGS	US Geological Survey

APPENDIX C. SOILS DATA

Selected map unit descriptions for Howell Township, Monmouth County, New Jersey (brief, generated) from:

USDA Natural Resources Conservation Service

Survey Area Version: 13
Survey Area Version Date: 09/16/2019

[Minor map unit components are excluded from this report]

Map unit: AdnA - Adelphia loam, 0 to 2 percent slopes

The Adelphia component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on low interfluves on Noth Atlantic coastal plains. The parent material consists of glauconite bearing eolian deposits and/or glauconite bearing fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches during January, February, March, April. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: AtsA - Atsion sand, 0 to 2 percent slopes, Northern Coastal Plain

The Atsion component makes up 90 percent of the map unit. Slopes are 0 to 2 percent. This component is on coastal plains, flats. The parent material consists of sandy eolian deposits and/or fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is low.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 2 inches (depth from the mineral surface is 0 inches) during March, April. Organic matter content in the surface horizon is about 85 percent. Nonirrigated land capability classification is 5w. This soil meets hydric criteria.
There are no saline horizons within 30 inches of the soil surface.

Map unit: AtsAO - Atsion sand, 0 to 2 percent slopes, Northern Tidewater Area

The Atsion component makes up 90 percent of the map unit. Slopes are 0 to 2 percent. This component is on coastal plains, flats. The parent material consists of sandy eolian deposits and/or fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is low.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 2 inches (depth from the mineral surface is 0 inches) during March, April. Organic matter content in the surface horizon is about 85 percent. Nonirrigated land capability classification is 5w. This soil meets hydric criteria.
There are no saline horizons within 30 inches of the soil surface.

Map unit: BerAt - Berryland sand, 0 to 2 percent slopes, frequently flooded

The Berryland, frequently flooded component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on lowland flats, depressions, North Atlantic coastal plains. The parent material consists of sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is frequently flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, May, June, October, November, December. Organic matter content in the surface horizon is about 6 percent. Nonirrigated land capability classification is 5w. This soil meets hydric criteria. The soil has a very slightly saline horizon within 30 inches of the soil surface.

Map unit: CokC2 - Collington sandy loam, 5 to 10 percent slopes, eroded

The Collington, eroded component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on North Atlantic coastal plains, hillslopes, knobs. The parent material consists of glauconite bearing eolian deposits and/or glauconite bearing fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: DocB - Downer loamy sand, 0 to 5 percent slopes, Northern Coastal Plain

The Downer component makes up 80 percent of the map unit. Slopes are 0 to 5 percent. This component is on low hills on coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: DocBO - Downer loamy sand, 0 to 5 percent slopes, Northern Tidewater Area

The Downer component makes up 80 percent of the map unit. Slopes are 0 to 5 percent. This component is on low hills on coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: DocC - Downer loamy sand, 5 to 10 percent slopes, Northern Coastal Plain

The Downer component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on low hills, coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: DocCO - Downer loamy sand, 5 to 10 percent slopes, Northern Tidewater Area

The Downer component makes up 80 percent of the map unit. Slopes are 5 to 10 percent. This component is on low hills, coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: DoeAO - Downer sandy loam, 0 to 2 percent slopes, Northern Tidewater Area

The Downer component makes up 80 percent of the map unit. Slopes are 0 to 2 percent. This component is on flats on coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate.
Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 1. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: DoeB - Downer sandy loam, 2 to 5 percent slopes, Northern Coastal Plain

The Downer component makes up 80 percent of the map unit. Slopes are 2 to 5 percent. This component is on fluviomarine terraces, coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent.
Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: DoeBO - Downer sandy loam, 2 to 5 percent slopes, Northern Tidewater Area

The Downer component makes up 80 percent of the map unit. Slopes are 2 to 5 percent. This component is on flats, coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: DouB - Downer-Urban land complex, 0 to 5 percent slopes

The Downer component makes up 60 percent of the map unit. Slopes are 0 to 5 percent. This component is on knolls, low hills, coastal plains. The parent material consists of loamy fluviomarine deposits and/or gravelly fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded.
There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria.

Component: Urban land (30%)
Generated brief soil descriptions are created for major soil components. The Urban land is a miscellaneous area.

Map unit: EkaAr - Elkton loam, 0 to 2 percent slopes, rarely flooded

The Elkton component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on marine terraces on coastal plains. The parent material consists of silty eolian deposits over loamy alluvium and/or loamy marine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is low. Available water to a *depth of 60 inches (or restricted depth) is high. Shrink-swell potential is moderate. This soil is rarely flooded. It is rarely ponded. A seasonal zone of water saturation is at 6 inches during January, February, March, April, May, November, December. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 3w. This soil meets hydric criteria.*

Map unit: EveB - Evesboro sand, 0 to 5 percent slopes

The Evesboro component makes up 80 percent of the map unit. Slopes are 0 to 5 percent. This component is on low hills on North Atlantic coastal plains. The parent material consists of sandy eolian deposits and/or sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: EveC - Evesboro sand, 5 to 10 percent slopes

The Evesboro component makes up 95 percent of the map unit. Slopes are 5 to 10 percent. This component is on low hills on coastal plains. The parent material consists of sandy eolian deposits and/or sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent.
Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: EveD - Evesboro sand, 10 to 15 percent slopes

The Evesboro component makes up 95 percent of the map unit. Slopes are 10 to 15 percent. This component is on dunes, low hills, coastal plains. The parent material consists of sandy eolian deposits and/or sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: EveE - Evesboro sand, 15 to 25 percent slopes

The Evesboro component makes up 95 percent of the map unit. Slopes are 15 to 25 percent. This component is on low hills on coastal plains. The parent material consists of sandy eolian deposits and/or sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent.
Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: EvuB - Evesboro-Urban land complex, 0 to 5 percent slopes

The Evesboro component makes up 60 percent of the map unit. Slopes are 0 to 5 percent. This component is on low hills on coastal plains. The parent material consists of sandy eolian deposits and/or sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent.
Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Component: Urban land (30%)
Generated brief soil descriptions are created for major soil components. The Urban land is a miscellaneous area.

Map unit: FapA - Fallsington loams, 0 to 2 percent slopes, Northern Coastal Plain

Component: Fallsington, undrained (38%)
The Fallsington, undrained component makes up 38 percent of the map unit. Slopes are 0 to 2 percent. This component is on flats on coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is occasionally ponded. A seasonal zone of water saturation is at 5 inches (depth from the mineral surface is 3 inches) during January, February, March, April. Organic matter content in the surface horizon is about 68 percent. Nonirrigated land capability classification is 5w. This soil meets hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Component: Fallsington, drained (37%)
The Fallsington, drained component makes up 37 percent of the map unit. It is similar to the undrained component but It is rarely ponded. A seasonal zone of water saturation is at 14 inches during January, February, March, April. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3w. This soil meets hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: FrfB - Freehold loamy sand, 0 to 5 percent slopes

The Freehold component makes up 80 percent of the map unit. Slopes are 0 to 5 percent. This component is on North Atlantic coastal plains, low hills, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface *horizon is about 2 percent. Nonirrigated land capability classification is 2s. This soil does not meet hydric criteria.*

Map unit: FrfC - Freehold loamy sand, 5 to 10 percent slopes

The Freehold component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on North Atlantic coastal plains, low hills, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: FrkB - Freehold sandy loam, 2 to 5 percent slopes

The Freehold component makes up 85 percent of the map unit. Slopes are 2 to 5 percent. This component is on North Atlantic coastal plains, low hills, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: FrkC - Freehold sandy loam, 5 to 10 percent slopes

The Freehold component makes up 90 percent of the map unit. Slopes are 5 to 10 percent. This component is on North Atlantic coastal plains, hillslopes, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: FrkD - Freehold sandy loam, 10 to 15 percent slopes

The Freehold component makes up 90 percent of the map unit. Slopes are 10 to 15 percent. This component is on North Atlantic coastal plains, low hills, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 0 percent. Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: FrkD2 - Freehold sandy loam, 10 to 15 percent slopes, eroded

The Freehold, eroded component makes up 90 percent of the map unit. Slopes are 10 to 15 percent. This component is on North Atlantic coastal plains, hillslopes, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 0 percent. Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: FrkE2 - Freehold sandy loam, 15 to 25 percent slopes, eroded

The Freehold, eroded component makes up 85 percent of the map unit. Slopes are 15 to 25 percent. This component is on North Atlantic coastal plains, hillslopes, knolls. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: FroA - Freehold loam, 0 to 2 percent slopes

The Freehold component makes up 75 percent of the map unit. Slopes are 0 to 2 percent. This component is on Noth Atlantic coastal plains, flats, low hills. The parent material consists of glauconite bearing loamy eolian deposits and/or glauconite bearing loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 1. This soil does not meet hydric criteria.

Map unit: HbmB - Hammonton loamy sand, 0 to 5 percent slopes

The Hammonton component makes up 80 percent of the map unit. Slopes are 0 to 5 percent. This component is on flats, depressions, North Atlantic coastal plains. The parent material consists of coarse-loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches during January, February, March, April. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: HboA - Hammonton sandy loam, 0 to 2 percent slopes

The Hammonton component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on flats, depressions, North

Atlantic coastal plains. The parent material consists of coarse-loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches during January, February, March, April. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: HboB - Hammonton sandy loam, 2 to 5 percent slopes

The Hammonton component makes up 85 percent of the map unit. Slopes are 2 to 5 percent. This component is on flats, depressions, coastal plains. The parent material consists of coarse-loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches during January, February, March, April. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: HocA - Holmdel sandy loam, 0 to 2 percent slopes

The Holmdel component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on flats on North Atlantic coastal plains. The parent material consists of glauconite bearing loamy marine deposits and/or fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 27 inches during January, February, March, April, May, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: HocB - Holmdel sandy loam, 2 to 5 percent slopes

The Holmdel component makes up 85 percent of the map unit. Slopes are 2 to 5 percent. This component is on North Atlantic coastal plains, flats, low hills. The parent material consists of glauconite bearing loamy marine deposits and/or fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high.

Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 27 inches during January, February, March, April, May, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: HumAt - Humaquepts, 0 to 3 percent slopes, frequently flooded

The Humaquepts, frequently flooded component makes up 85 percent of the map unit. Slopes are 0 to 3 percent. This component is on flood plains, river valleys on North Atlantic coastal plains. The parent material consists of loamy alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is moderate. This soil is frequently flooded. It is frequently ponded. A seasonal zone of water saturation is at 6 inches during January, February, March, April, May, June, November, December. Organic matter content in the surface horizon is about 12 percent.

Nonirrigated land capability classification is 5w. This soil meets hydric criteria.

Map unit: KemA - Keyport sandy loam, 0 to 2 percent slopes

The Keyport component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on knolls on North Atlantic coastal plains. The parent material consists of silty and clayey eolian deposits and/or silty and clayey fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during January, February, March, April, May, November, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria.

Map unit: KemB - Keyport sandy loam, 2 to 5 percent slopes

The Keyport component makes up 85 percent of the map unit. Slopes are 2 to 5 percent. This component is on flats on North Atlantic coastal plains, depressions. The parent material consists of silty and clayey eolian deposits and/or silty and clayey fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches during January, February, March, April. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: KemC - Keyport sandy loam, 5 to 10 percent slopes

The Keyport component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on knolls on North Atlantic coastal plains. The parent material consists of silty and clayey eolian deposits and/or silty and clayey fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is low. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during January, February, March, April, May, November, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: KkgB - Klej loamy sand, 0 to 5 percent slopes

The Klej component makes up 90 percent of the map unit. Slopes are 0 to 5 percent. This component is on dunes on North Atlantic coastal plains. The parent material consists of unconsolidated sandy marine deposits. Depth to a root restrictive layer is greater than 60 inches. The *natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 18 inches (depth from the mineral surface is 14 inches) during January, February, March, April, December. Organic matter content in the surface horizon is about 85 percent. Below this thin organic horizon, the organic matter content is about 2 percent. Nonirrigated land capability classification is 3w. This soil does not meet hydric criteria.*

Map unit: KkgkB - Klej loamy sand, clayey substratum, 0 to 5 percent slopes

The Klej, clay substratum component makes up 90 percent of the map unit. Slopes are 0 to 5 percent. This component is on dunes on North Atlantic coastal plains. The parent material consists of unconsolidated sandy marine deposits over clayey estuarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 21 inches (depth from the mineral surface is 17 inches) during January, February, March, April, December. Organic matter content in the surface horizon is about 85 percent. Below this thin organic horizon the organic matter content is about 2 percent. Nonirrigated land capability classification is 3w. This soil does not meet hydric criteria.

Map unit: KrhB - Kresson loam, 2 to 5 percent slopes

The Kresson component makes up 90 percent of the map unit. Slopes are 2 to 5 percent. This component is on depressions, flats on North Atlantic coastal plains. The parent material consists of glauconitic clayey marine deposits and/or glauconitic clayey fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is high. Shrink-swell potential is moderate. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 12 inches during January, February, March, April, May, December. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 3w. This soil does not meet hydric criteria.

Map unit: LakB - Lakehurst sand, 0 to 5 percent slopes

The Lakehurst component makes up 85 percent of the map unit. Slopes are 0 to 5 percent. This component is on flats on North Atlantic coastal plains, dunes. The parent material consists of sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches (depth from the mineral surface is 28 inches) during January, February, March, April. Organic matter content in the surface horizon is about 85 percent. Below this thin organic horizon the organic matter content is about 2 percent. Nonirrigated land capability classification is 4w. This soil does not meet hydric criteria.

Map unit: LasB - Lakewood sand, 0 to 5 percent slopes

The Lakewood component makes up 85 percent of the map unit. Slopes are 0 to 5 percent. This component is on flats on North Atlantic coastal plains, knolls. The parent material consists of sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: LasC - Lakewood sand, 5 to 10 percent slopes

The Lakewood component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on marine terraces on North Atlantic coastal plains. The parent material consists of sandy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is excessively drained.
Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 72 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7s. This soil does not meet hydric criteria.

Map unit: MakAt - Manahawkin muck, 0 to 2 percent slopes, frequently flooded

The Manahawkin, frequently flooded component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on swamps on North Atlantic coastal plains, flood plains. The parent material consists of organic, woody material over sandy alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is very high. Shrink-swell potential is low. This soil is frequently flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April. Organic matter content in the surface horizon is about 55 percent. Nonirrigated land capability classification is 7w. This soil meets hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: PegB - Pemberton loamy sand, 0 to 5 percent slopes

The Pemberton component makes up 85 percent of the map unit. Slopes are 0 to 5 percent. This component is on flats on North Atlantic coastal plains, low hills. The parent material consists of eolian sands over old alluvium and/or glauconitic bearing marine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high.
Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 30 inches during January, February, March, April, May, June, November, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 3w. This soil does not meet hydric criteria.

Map unit: PhbC - Phalanx loamy sand, 5 to 10 percent slopes

The Phalanx component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on hills on North Atlantic coastal plains. The parent material consists of sandy and/or loamy fluviomarine deposits. Depth to a root restrictive layer, petroferric, is 12 to 30 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is very low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 72 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: PHG - Pits, sand and gravel

Generated brief soil descriptions are created for major soil components. The Pits is a miscellaneous area

Map unit: SacB - Sassafras sandy loam, 2 to 5 percent slopes, Northern Coastal Plain

The Sassafras component makes up 80 percent of the map unit. Slopes are 2 to 5 percent. This component is on fluviomarine terraces on uplands coastal plains. The parent material consists of loamy fluviomarine deposits.
Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: SacBO - Sassafras sandy loam, 2 to 5 percent slopes, Northern Tidewater Area

The Sassafras component makes up 80 percent of the map unit. Slopes are 2 to 5 percent. This component is on flats on uplands coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent.
Nonirrigated land capability classification is 2e. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

Map unit: SacC - Sassafras sandy loam, 5 to 10 percent slopes, Northern Coastal Plain

The Sassafras component makes up 80 percent of the map unit. Slopes are 5 to 10 percent. This component is on fluviomarine terraces on uplands coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent.
Nonirrigated land capability classification is 3e. Irrigated land capability classification is 3e. This soil does not meet hydric criteria.

Map unit: SacD - Sassafras sandy loam, 10 to 15 percent slopes

The Sassafras component makes up 85 percent of the map unit. Slopes are 10 to 15 percent. This component is on knolls on coastal plains, hillslopes. The parent material consists of loamy and/or gravelly fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent.
Nonirrigated land capability classification is 4e. This soil does not meet hydric criteria.

Map unit: SacE - Sassafras sandy loam, 15 to 25 percent slope

The Sassafras component makes up 85 percent of the map unit. Slopes are 15 to 25 percent. This component is on knolls on North Atlantic coastal plains, hillslopes. The parent material consists of loamy and/or gravelly fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 72 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

Map unit: SafA - Sassafras loam, 0 to 2 percent slopes

The Sassafras component makes up 80 percent of the map unit. Slopes are 0 to 2 percent. This component is on fluviomarine terraces on uplands coastal plains. The parent material consists of loamy fluviomarine deposits.
Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 1. Irrigated land capability classification is 1 This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: ShrA - Shrewsbury sandy loam, 0 to 2 percent slopes

The Shrewsbury component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. This component is on flats on North Atlantic coastal plains. The parent material consists of fine-loamy marine deposits containing moderate amounts of glauconite. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 6 inches during January, February, March, April, May, June, October, November, December. Organic matter content in the surface horizon is about 4 percent. Nonirrigated land capability classification is 3w. This *soil meets hydric criteria.*

Map unit: ThgB - Tinton loamy sand, 0 to 5 percent slopes

The Tinton component makes up 85 percent of the map unit. Slopes are 0 to 5 percent. This component is on low hills on North Atlantic coastal plains. The parent material consists of sandy eolian deposits over glauconite bearing fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 3s. This soil does not meet hydric criteria.

Map unit: ThgC - Tinton loamy sand, 5 to 10 percent slopes

The Tinton component makes up 85 percent of the map unit. Slopes are 5 to 10 percent. This component is on ridges on North Atlantic coastal plains. The parent material consists of sandy eolian deposits over glauconite bearing fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 4s. This soil does not meet hydric criteria.

Map unit: ThgE - Tinton loamy sand, 10 to 25 percent slopes

The Tinton component makes up 85 percent of the map unit. Slopes are 10 to 25 percent. This component is on ridges on North Atlantic coastal plains, hillslopes. The parent material consists of sandy eolian deposits over glauconite bearing fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 1 percent. Nonirrigated land capability classification is 6e. This soil does not meet hydric criteria.

Map unit: UdaB - Udorthents, 0 to 8 percent slopes

The Udorthents component makes up 100 percent of the map unit. Slopes are 0 to 8 percent. This component is on low hills on uplands, fills, cuts (road, railroad, etc.). The parent material consists of fill and/or disturbed original soil material. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 3w. This soil does not meet hydric criteria.

Map unit: UdauB - Udorthents-Urban land complex, 0 to 8 percent slopes

Component: Udorthents (60%)

The Udorthents component makes up 60 percent of the map unit. Slopes are 0 to 8 percent. This component is on cuts (road, railroad, etc.), fills, low hills on uplands. The parent material consists of fill and/or disturbed original soil material. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately low. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 3 percent. Nonirrigated land capability classification is 3w. This soil does not meet hydric criteria.

Component: Urban land (40%)

Generated brief soil descriptions are created for major soil components. The Urban land is a miscellaneous area.

Map unit: WATER - Water

Generated brief soil descriptions are created for major soil components. The Water is a miscellaneous area.

Map unit: WoeB - Woodstown sandy loam, 2 to 5 percent slopes, Northern Coastal Plain

The Woodstown component makes up 81 percent of the map unit. Slopes are 2 to 5 percent. This component is on flats, coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during February. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Map unit: WogA - Woodstown loam, 0 to 2 percent slopes, Northern Coastal Plain

The Woodstown component makes up 81 percent of the map unit. Slopes are 0 to 2 percent. This component is on flats, coastal plains. The parent material consists of loamy fluviomarine deposits. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches (or restricted depth) is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during February. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2w. This soil does not meet hydric criteria. There are no saline horizons within 30 inches of the soil surface.

Appendix D.1. Rare Plant Species Reporting Form

Form begins on following page.

Natural Heritage Rare Plant Species Reporting Form

This form is used to report a personal field sighting of a rare plant species tracked by the Natural Heritage Database. It may also be used to summarize locational information from a published or unpublished report. Plant species tracked include those appearing on the State Endangered Plant Species List or the Plant Species of Concern List (http://www.nj.gov/dep/parksandforests/natural/heritage/spplant.html). The Office of Natural Lands Management can provide copies of the lists upon request. In order for this form to be processed, the sections preceded by an asterisk (*) must be completed.

Send completed form to: DEP, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, P.O. Box 404, Trenton, NJ 08625-0404.

Today's Date: (date this form is being completed) ____________________

Common Name: ________________________ **Scientific Name:** _____________________________

***Location Map:** _A mapped location of the occurrence must accompany this form._ The ideal format is to locate the site on a photocopied section of a U.S. Geological Survey 7.5 minute topographical map, and to also sketch a second map showing finer details. Be sure to provide the name of the USGS map.

GPS Coordinates (If available please provide the following)**:**

Datum Used:	☐ NAD 1983	☐ NAD 1927	☐ WGS84	☐ Other ______________
Lat/Long (if applicable):	______________ N (Latitude)		______________ W (Longitude)	
UTM (if applicable)	18 N/S: ______________ Northing		______________ Easting	
Accuracy Level:	+/-_____ ☐feet or ☐meters			

***Directions to Site:** Directions to the element occurrence using a readily locatable and relatively permanent landmark on or near the site (such as a road intersection, a prominent hill or cliff) as the starting point. Use clear, complete sentences so that someone who is unfamiliar with the area will be able to relocate the element occurrence using your written directions (e.g., "About 50 ft. N. of small stream draining Brindel Lake, 0.5 mi. SE of Brindeltown and 0.2 mi. WSW of jct. of Range Rd. and Rt. 539, Fort Dix").

***Date(s) of the Observation(s):** ____________________

Identification: How was the species identification made? Name the identification manuals used or the experts consulted. Were there identification problems?

***Number of Individuals Observed:**

☐ 1-10 ☐ 11-50 ☐ 101-1,000 ☐ 1,001-10,000 ☐ >10,000

If possible, provide the exact number of individuals and an estimated percentage of flowering/fruiting individuals. For rhizomatous plants such as grasses and sedges, what was counted as individual – separate culms or entire clumps or patches?

Life Stages Present: Check life stages observed or provide an estimate of the numbers of individuals for each life stage.

☐ vegetative ☐ in bud ☐ flower ☐ seed dispersing ☐ seedling ☐ dormant

Associated Species/Additional Biological Data: List any associated species and/or additional rare species observed at this site. What else was observed? Provide information on the general condition or vigor of the individuals and viability of the population(s).

Habitat Data: Describe the specific area where the occurrence is located. List natural community types, dominant vegetation and information on the physical environment such as substrate type, hydrology, moisture regime, slope and aspect. Also, describe the surrounding landscape.

Threats: Describe any current or potential threats to this occurrence. If invasive species are present, please list.

Ownership: If known, please provide landowner(s) name, address, phone #.

Information Source:

***Name, Address and Phone #** (of person filing report):

Name:	
Address:	
Phone Number:	

*Does this information come directly from ☐ a field visit or ☐ a published or unpublished report?

Citation: For information taken from a published or unpublished report, please provide a copy of the cover page and the pertinent portions of the report. If a copy can not be provided, list below the author, date, title, publisher, and page numbers.

Voucher: Was the observation vouchered with ☐ a photograph? ☐ a video/digital format? ☐ a specimen?
If possible, attach a copy of the photograph or tape. If specimen voucher, please provide the name of the repository:

Confirmation: Would you accompany a biologist to the site if needed? ☐ yes ☐ no.

Additional Comments: (use extra sheets if needed)

Appendix D.2. Additional Rare Plant Species Know from Monmouth County

Source: NJDEP Division of Parks and Forestry, July 2019.

Scientific Name	Common Name	Habitat
Ferns & Allies		
Lygodium palmatum	climbing fern	moist open woods or thickets
Schizaea pusilla	curly grass fern	in sandy, acid soils of white cedar bog edges and hummocks, just above the water line
Graminoids		
Calamagrostis pickeringii	Pickering's reedgrass	bogs and wet shores
Carex cumulata	clustered sedge	dry, rocky or sandy soil
Carex silicea	seabeach sedge	sand or sandy soil near the coast
Carex utriculata	bottle-shaped sedge	wet soil or shallow water
Cyperus lancastriensis	Lancaster flat sedge	woods and fields
Cyperus polystachyos	coast flat sedge	wet soil
Eleocharis halophila	salt-marsh spike-rush	mainly of coastal salt marshes
Juncus greenei	Greene's rush	moist to dry, clay or sandy soil, sometimes on dunes
Leptochloa fascicularis var maritima	long-awn sprangletop	wet soil of watersides, fresh or usually brackish water of marshes
Luzula acuminata var acuminata	hairy wood-rush	moist woods, less often along roadsides or in other open places
Panicum dichotomum var yadkinense	spotted-sheath panic grass	moist soil in a variety of habitats, including rich woods, bottomlands, thickets, swamps
Panicum scabriusculum	sheathed panic grass	wet, low ground of swamps, woods, pondsides
Paspalum dissectum	mudbank crown grass	usually in wet, muddy soil or in shallow water of watersides, also in dried pond bottoms
Puccinellia fasciculata	saltmarsh alkali grass	wet soil or water of salt marsh borders, beaches
Rhynchospora recognita	coarse grass-like beaked-rush	low, wet to moist ground in swamps and bogs, sandy depressions
Schoenoplectus maritimus	saltmarsh bulrush	fresh, saline or alkaline swamps and marshes
Terrestrial Herbs		
Agastache nepetoides	yellow giant-hyssop	open, rich soil of deciduous woods and shaded edges
Amaranthus pumilus	seabeach amaranth	sea-beaches
Arnoglossum atriplicifoliium	pale Indian plantain	dry, open ground of woods and shaded edges
Artemisia campestris ssp caudata	beach wormwood	dunes and other very sandy placer along the coast and irregularly inland
Asclepias lanceolata	smooth orange milkweed	swamps, bogs and brackish marshes on the coastal plain
Asclepias rubra	red milkweed	swamps, bogs and wet woods on or near the coastal plain
Asclepias variegata	white milkweed	upland woods and thickets
Aster concolor	eastern silvery aster	dry sandy places, often among pines

Scientific Name	Common Name	Habitat
Aster radula	low rough aster	bogs, streambanks and other moist places
Atriplex subspicata	saline orache	sea beaches, also commonly inland in saline habitats
Chenopodium berlandieri var macrocalycium	large-calyx goosefoot	mainly coastal or coastal plain, often on sea beaches
Cuphea viscosissima	blue waxweed	dry soil
Desmodium cuspidatum var cuspidatum	toothed tick-trefoil	dry upland woods and thickets
Desmodium humifusum	trailing tick-trefoil	dry sandy woods
Desmodium pauciflorum	few-flower tick-trefoil	rich woods
Desmodium viridiflorum	velvety tick-trefoil	dry woods
Doellingeria infirma	cornel-leaf aster	dry ground of deciduous woods and shaded edges, rocky slopes
Draba reptans	Carolina whitlow-grass	dry, sterile or sandy soil
Epilobium angustifolium ssp circumvagum	narrow-leaf fireweed	many habitats, esp. moist soils rich in humus, often abundant after fires
Eryngium aquaticum var aquaticum	marsh rattlesnake-master	bogs and marshes near the coast
Eupatorium resinosum	Pine Barren boneset	pocosins, bogs and other wet places, often in pine barrens
Gentiana autumnalis	Pine Barren gentian	dry, commonly sandy soil, often in woods
Glaux maritima	sea-milkwort	moist or dry saline soil
Gnaphalium helleri var micradenium	small everlasting	dry, commonly sandy soil, often in woods
Honckenya peploides var robusta	seabeach sandwort	sea beaches and sand dunes
Hydrocotyle verticillata var verticillata	whorled marsh-pennywort	wet or moist ground of bogs, swampy woods, watersides
Lespedeza stuevei	Stueve's downy bush-clover	dry upland woods and barrens
Liatris scariosa var novae-angliae	northern blazing star	prairies, open woods and other dry open places
Limosella australis	awl-leaf mudwort	muddy or sandy shores
Linum intercursum	sandplain flax	dry or moist, sandy, open ground of thin woods and shaded edges
Listera australis	southern twayblade	shaded bogs and wet woods, mainly on the coastal plain
Malaxis unifolia	green adder's-mouth	damp woods and bogs
Melanthium virginicum	Virginia bunchflower	wet woods and meadows
Mertensia virginica	Virginia bluebells	moist or wet woods
Obolaria virginica	Virginia pennywort	rich woods
Oenothera oakesiana	Oakes' evening-primrose	disturbed open places
Onosmodium virginianum	Virginia false-gromwell	well-drained, dry, open sandy ground of thin woods, barrens, rarely pinelands
Phaseolus polystachios var polystachios	wild kidney bean	moist woods and thickets
Phlox divaricata var divaricata	wild blue phlox	rich moist woods
Phlox maculata var maculata	spotted phlox	moist or wet, low ground of streamsides, meadows, floodplains
Plantago maritima var juncoides	seaside plantain	salt or brackish conditions, in water or wet soil of marshes, swamps, beaches, tidal streams, headlands
Platanthera peramoena	purple fringeless orchid	open, swampy or vernally wet places, often in acid soil
Polygala polygama	racemed milkwort	dry, usually sandy soil

Scientific Name	**Common Name**	**Habitat**
Polygonum glaucum	sea-beach knotweed	shallow water and wet ground of alluvial woods and edges, swamps, beaches, watersides
Porteranthus trifoliatus	Indian physic	dry or moist upland woods
Prenanthes autumnalis	Pine Barren rattlesnake-root	sandy, usually moist places, often among pines
Pycnanthemum torrei	Torrey's mountain-mint	dry or moist, open ground of thin woods and shaded edges, swamp edges
Ranunculus cymbalaria	seaside buttercup	in mud, especially in brackish or alkaline places
Rumex hastatulus	Engelmann's sorrel	sandy soil of the coastal plain
Sabatia dodecandra var dodecandra	large marsh-pink	salt or brackish marshes near the coast
Sagittaria australis	southern arrowhead	mostly in circumneutral water of lakes, ponds or swamps
Schwalbea americana	chaffseed	moist to dry, sandy ground of pine-oak woods and shaded edges, marshes
Sesuvium maritimum	seabeach purslane	sea beaches
Sisyrinchium fuscatum	sand plain blue-eyed grass	sandy areas, mainly near the coast
Stachys hyssopifolia	hyssop hedge-nettle	moist, usually sandy soil near the coast
Suaeda calceoliformis	American seablite	saline or alkaline soil
Triglochin maritima	seaside arrow-grass	brackish or fresh marshes and bogs
Trillium grandiflorum	large-flower trillium	forests, talus and rocky slopes
Verbena simplex	narrow-leaf vervain	dry, open, sandy or rocky non-acid ground of thin woods, fields, roadsides
Vicia americana var americana	American purple vetch	moist woods
Zigadenus leimanthoides	death-camus	bogs and wet woods on the coastal plain
Aquatic Herbs		
Ceratophyllum echinatum	spiny coontail	quiet water
Elatine minima	small waterwort	on mud
Eriocaulon parkeri	Parker's pipewort	tidal flats and muddy shores, oft submerged in fresh to slightly brackish water
Hottonia inflata	featherfoil	quiet shallow water or wet soil of swamps, slow streams, ditches
Myriophyllum tenellum	slender water milfoil	submersed in quiet water or rooting on muddy shores
Shrubs, Trees and Woody Vines		
Asimina triloba	pawpaw	rich, moist, alluvial soil of low woods, streamsides, river islands
Crataegus calpodendron	pear hawthorne	usually in dry or rocky ground
Crataegus succulenta	fleshy hawthorne	dry, rocky ground of woods, roadsides, streamsides
Dirca palustris	leatherwood	rich, moist woods
Fraxinus profunda	pumpkin ash	swamps and wet woods
Prunus angustifolia var angustifolia	Chickasaw plum	dry, open sandy or sterile ground of woods and shaded edges, dune sands
Rubus ostryifolius	highbush blackberry	cliffs, balds, or ledges, forest edges, forests, meadows and fields, woodlands
Rubus pervarius	Davis' dewberry	forest edges, meadows and fields, swamps, wetland margins, woodlands
Salix lucida ssp lucida	shining willow	moist, low ground of bogs, swamps, watersides

Scientific Name	**Common Name**	**Habitat**
Smilax pulverulenta	downy carrion-flower	moist soil of open woods, roadsides and thickets

Appendix D.3. Monmouth County Birds

The list shows every bird species reported in the county on E-bird as of October 9, 2019. Species with an asterisk have also been observed at locations in Howell Township, including Manasquan Reservoir (general), Manasquan Reservoir Environmental Center, Manasquan Reservoir Cove Nature Trail, and Chestnut Point Field.

State Status		Common name	*Scientific name*
Ducks, Geese & Swans			
RV		Black-bellied whistling duck	*Dendrocygna autumnalis*
RV		Greater White-fronted Goose	*Anser albifrons*
RV		Pink-footed goose	*Anser brachyrhynchus*
	*	Snow Goose	*Chen caerulescens*
RV		Ross's Goose	*Chen rossii*
	*	Brant	*Branta bernicla*
RV	*	Cackling Goose	*Branta hutchinsii*
	*	Canada Goose	*Branta canadensis*
RV		Barnacle goose	*Branta leucopsis*
int	*	Mute Swan	*Cygnus olor*
RV	*	Trumpeter Swan	*Cygnus buccinator*
	*	Tundra Swan	*Cygnus columbianus*
		Muscovy Duck	*Cairina moschata*
	*	Wood Duck	*Aix sponsa*
	*	Gadwall	*Anas strepera*
		Eurasian Wigeon	*Anas penelope*
	*	American Wigeon	*Anas americana*
	*	American Black Duck	*Anas rubripes*
	*	Mallard	*Anas platyrhynchos*
	*	Blue-winged Teal	*Anas discors*
	*	Northern Shoveler	*Anas clypeata*
	*	Northern Pintail	*Anas acuta*
	*	Green-winged Teal	*Anas crecca*
	*	Canvasback	*Aythya valisineria*
	*	Redhead	*Aythya americana*
	*	Ring-necked Duck	*Aythya collaris*
	*	Greater Scaup	*Aythya marila*
	*	Lesser Scaup	*Aythya affinis*
		Tufted duck	*Aythya fuligula*
		King Eider	*Somateria spectabilis*
		Common Eider	*Somateria mollissima*
		Harlequin Duck	*Histrionicus histrionicus*
	*	Surf Scoter	*Melanitta perspicillata*
	*	White-winged Scoter	*Melanitta fusca*
	*	Black Scoter	*Melanitta americana*
	*	Long-tailed Duck	*Clangula hyemalis*
	*	Bufflehead	*Bucephala albeola*
	*	Common Goldeneye	*Bucephala clangula*
RV		Barrow's Goldeneye	*Bucephala islandica*
	*	Hooded Merganser	*Lophodytes cucullatus*
	*	Common Merganser	*Mergus merganser*
	*	Red-breasted Merganser	*Mergus serrator*

State Status		Common name	*Scientific name*
	*	Ruddy Duck	*Oxyura jamaicensis*
Grouse, Quail & Allies			
WAP-FS		Northern Bobwhite	*Colinus virginianus*
	*	Ring-necked Pheasant	*Phasianus colchicus*
		Ruffed Grouse	*Bonasa umbellus*
	*	Wild Turkey	*Meleagris gallopavo*
Grebes			
Ebr, SCnb	*	Pied-billed Grebe	*Podilymbus podiceps*
	*	Horned Grebe	*Podiceps auritus*
	*	Red-necked Grebe	*Podiceps grisegena*
RV		Eared Grebe	*Podiceps nigricollis*
RV	*	Western Grebe	*Aechmorphorus occidentalis*
Pigeons & Doves			
int	*	Rock Pigeon	*Columba livia*
RV		Eurasian Collared-Dove	*Streptopelia decaocto*
RV		White-winged Dove	*Zenaida asiatica*
	*	Mourning Dove	*Zenaida macroura*
Cuckoos			
-		Groove-billed Ani	*Crotophaga sulcirostris*
	*	Yellow-billed Cuckoo	*Coccyzus americanus*
SCbr		Black-billed Cuckoo	*Coccyzus erythropthalmus*
Nightjars			
SC	*	Common Nighthawk	*Chordeiles minor*
		Chuck-will's-widow	*Antrostomus carolinensis*
SCbr, Unb		Eastern Whip-poor-will	*Antrostomus vociferous*
Swifts & Hummingbirds			
	*	Chimney Swift	*Chaetura pelagica*
	*	Ruby-throated Hummingbird	*Archilochus colubris*
RV		Rufous Hummingbird	*Selasphorus rufus*
RV		Mexican violetear	*Colibri thalassinus*
Cranes & Rails			
		Yellow rail	*Coturnicops noveboracensis*
		Clapper Rail	*Rallus longirostris*
		King Rail	*Rallus elegans*
		Virginia Rail	*Rallus limicola*
	*	Sora	*Porzana carolina*
		Purple gallinule	*Poryphyrula martinica*
		Common Gallinule	*Gallinula galeata*
	*	American Coot	*Fulica americana*
		Sandhill Crane	*Grus canadensis*
Plovers, Sandpipers & Allies			
	*	Black-bellied Plover	*Pluvialis squatarola*
		American Golden-Plover	*Pluvialis dominica*
RV		Wilson's Plover	*Charadrius wilsonia*
	*	Semipalmated Plover	*Charadrius semipalmatus*

State Status		Common name	*Scientific name*
E		Piping Plover	*Charadrius melodus*
	*	Killdeer	*Charadrius vociferus*
SC		American Oystercatcher	*Haematopus palliatus*
		Black-necked Stilt	*Himantopus mexicanus*
		American Avocet	*Recurvirostra americana*
SCbr	*	Spotted Sandpiper	*Actitis macularius*
	*	Solitary Sandpiper	*Tringa solitaria*
	*	Greater Yellowlegs	*Tringa melanoleuca*
	*	Willet	*Tringa semipalmata*
	*	Lesser Yellowlegs	*Tringa flavipes*
E		Upland Sandpiper	*Bartramia longicauda*
SCnb		Whimbrel	*Numenius phaeopus*
		Hudsonian Godwit	*Limosa haemastica*
		Marbled Godwit	*Limosa fedoa*
WAP-FS		Ruddy Turnstone	*Arenaria interpres*
Enb		Red Knot	*Calidris canutus*
SCnb	*	Sanderling	*Calidris alba*
SCnb	*	Semipalmated Sandpiper	*Calidris pusilla*
		Western Sandpiper	*Calidris mauri*
	*	Least Sandpiper	*Calidris minutilla*
	*	White-rumped Sandpiper	*Calidris fuscicollis*
		Baird's Sandpiper	*Calidris bairdii*
	*	Pectoral Sandpiper	*Calidris melanotos*
		Purple Sandpiper	*Calidris maritima*
	*	Dunlin	*Calidris alpina*
		Stilt Sandpiper	*Calidris himantopus*
		Ruff	*Calidris pugnax*
		Buff-breasted Sandpiper	*Tryngites subruficollis*
	*	Short-billed Dowitcher	*Limnodromus griseus*
		Long-billed Dowitcher	*Limnodromus scolopaceus*
	*	Wilson's Snipe	*Gallinago delicata*
WAP-FS	*	American Woodcock	*Scolopax minor*
		Wilson's Phalarope	*Phalaropus tricolor*
		Red-necked Phalarope	*Phalaropus lobatus*
		Red Phalarope	*Phalaropus fulicarius*
		Black-legged Kittiwake	*Rissa tridactyla*
RV		Sabine's Gull	*Xema sabini*
	*	Bonaparte's Gull	*Chroicocephalus philadelphia*
		Black-headed Gull	*Chroicocephalus ridibundus*
		Little Gull	*Hydrocoloeus minutus*
	*	Laughing Gull	*Leucophaeus atricilla*
RV		Franklin's Gull	*Leucophaeus pipixcan*
	*	Ring-billed Gull	*Larus delawarensis*
RV		California Gull	*Larus californicus*
	*	Herring Gull	*Larus argentatus*
	*	Iceland Gull	*Larus glaucoides*
		Lesser Black-backed Gull	*Larus fuscus*
		Glaucous Gull	*Larus hyperboreus*
	*	Great Black-backed Gull	*Larus marinus*
		Bridled Tern	*Onychoprion anaethetus*
RV		Sooty Tern	*Onychoprion fuscatus*
E		Least Tern	*Sternula antillarum*

State Status		Common name	*Scientific name*
SC		Gull-billed Tern	*Gelochelidon nilotica*
SCbr	*	Caspian Tern	*Hydroprogne caspia*
		Black Tern	*Chlidonias niger*
RV		White-winged Tern	*Chlidonias leucopterus*
E		Roseate Tern	*Sterna dougallii*
SCbr	*	Common Tern	*Sterna hirundo*
RV		Arctic Tern	*Sterna paradisaea*
WAP-FS	*	Forster's Tern	*Sterna forsteri*
		Royal Tern	*Thalasseus maximus*
		Sandwich Tern	*Thalasseus sandvicensis*
RV		Elegant Tern	*Thalasseus elegans*
E		Black Skimmer	*Rynchops niger*
RV		Great Skua	*Stercorarius skua*
RV		South Polar Skua	*Stercorarius maccormicki*
		Pomarine Jaeger	*Stercorarius pomarinus*
		Parasitic Jaeger	*Stercorarius parasiticus*
		Long-tailed Jaeger	*Stercorarius longicaudus*
		Dovekie	*Alle alle*
		Common Murre	*Uria aalge*
		Thick-billed murre	*Uria lomvia*
		Razorbill	*Alca torda*
RV		Black Guillemot	*Cepphus grylle*
		Long-billed murrelet	*Brachyramphus perdix*
		Atlantic Puffin	*Fratercula arctica*
Loons			
	*	Red-throated Loon	*Gavia stellata*
	*	Common Loon	*Gavia immer*
RV		Pacific Loon	*Gavia arctica*
Tubenoses			
		Northern Fulmar	*Fulmarus glacialis*
		Cory's Shearwater	*Calonectris diomedea*
		Great Shearwater	*Puffinus gravis*
		Sooty Shearwater	*Puffinus griseus*
		Manx Shearwater	*Puffinus puffinus*
		Audubon's Shearwater	*Puffinus lherminieri*
		Wilson's Storm-Petrel	*Oceanites oceanicus*
RV		White-faced Storm-Petrel	*Pelagodroma marina*
Storks			
RV		Wood Stork	*Mycteria americana*
Frigatebirds, Boobies, Cormorants, Darters & Allies			
RV		Magnificent Frigatebird	*Fregata magnificens*
RV		Brown Booby	*Sula leucogaster*
	*	Northern Gannet	*Morus bassanus*
	*	Double-crested Cormorant	*Phalacrocorax auritus*
	*	Great Cormorant	*Phalacrocorax carbo*
RV		Anhinga	*Anhinga anhinga*
Pelicans, Herons, Ibises & Allies			
		American White Pelican	*Pelecanus erythrorhynchos*

State Status		Common name	*Scientific name*
		Brown Pelican	*Pelecanus occidentalis*
Ebr, SCnb		American Bittern	*Botaurus lentiginosus*
SC	*	Least Bittern	*Ixobrychus exilis*
SCbr	*	Great Blue Heron	*Ardea herodias*
	*	Great Egret	*Ardea alba*
SCbr	*	Snowy Egret	*Egretta thula*
SC	*	Little Blue Heron	*Egretta caerulea*
SC		Tricolored Heron	*Egretta tricolor*
Tbr, SCnb		Cattle Egret	*Bubulcus ibis*
	*	Green Heron	*Butorides virescens*
Tbr, SCnb	*	Black-crowned Night-Heron	*Nycticorax nycticorax*
T		Yellow-crowned Night-Heron	*Nyctanassa violacea*
RV		White Ibis	*Eudocimus albus*
SCbr	*	Glossy Ibis	*Plegadis falcinellus*
New World Vultures			
	*	Black Vulture	*Coragyps atratus*
	*	Turkey Vulture	*Cathartes aura*
Hawks, Kites, Eagles & Allies			
Tbr	*	Osprey	*Pandion haliaetus*
		Swallow-tailed Kite	*Elanoides forficatus*
		Mississippi Kite	*Ictinia mississippiensis*
Ebr, Tnb	*	Bald Eagle	*Haliaeetus leucocephalus*
Ebr, SCnb	*	Northern Harrier	*Circus cyaneus*
SC	*	Sharp-shinned Hawk	*Accipiter striatus*
SCbr	*	Cooper's Hawk	*Accipiter cooperii*
Ebr, SCnb		Northern Goshawk	*Accipiter gentilis*
Ebr, SCnb	*	Red-shouldered Hawk	*Buteo lineatus*
SCbr	*	Broad-winged Hawk	*Buteo platypterus*
	*	Red-tailed Hawk	*Buteo jamaicensis*
		Rough-legged Hawk	*Buteo lagopus*
		Golden Eagle	*Aquila chrysaetos*
Owls			
		Barn Owl	*Tyto alba*
	*	Eastern Screech-Owl	*Megascops asio*
	*	Great Horned Owl	*Bubo virginianus*
		Snowy Owl	*Bubo scandiacus*
T	*	Barred Owl	*Strix varia*
T		Long-eared Owl	*Asio otus*
Ebr, SCnb		Short-eared Owl	*Asio flammeus*
		Northern Saw-whet Owl	*Aegolius acadicus*
Kingfishers & Allies			
	*	Belted Kingfisher	*Megaceryle alcyon*
Woodpeckers			
T	*	Red-headed Woodpecker	*Melanerpes erythrocephalus*
	*	Red-bellied Woodpecker	*Melanerpes carolinus*
	*	Yellow-bellied Sapsucker	*Sphyrapicus varius*
	*	Downy Woodpecker	*Picoides pubescens*

State Status		Common name	Scientific name
	*	Hairy Woodpecker	*Picoides villosus*
	*	Northern Flicker	*Colaptes auratus*
	*	Pileated Woodpecker	*Dryocopus pileatus*
Caracaras & Falcons			
RV		Crested Caracara	*Caracara cheriway*
T	*	American Kestrel	*Falco sparverius*
	*	Merlin	*Falco columbarius*
		Gyrfalcon	*Falco rusticolus*
Ebr, SCnb	*	Peregrine Falcon	*Falco peregrines*
Parrots			
int		Monk Parakeet	*Myiopsitta monachus*
Perching Birds			
	*	Olive-sided Flycatcher	*Contopus cooperi*
	*	Eastern Wood-Pewee	*Contopus virens*
		Yellow-bellied Flycatcher	*Empidonax flaviventris*
		Acadian Flycatcher	*Empidonax virescens*
		Alder Flycatcher	*Empidonax alnorum*
	*	Willow Flycatcher	*Empidonax traillii*
SCbr	*	Least Flycatcher	*Empidonax minimus*
	*	Eastern Phoebe	*Sayornis phoebe*
RV		Say's Phoebe	*Sayornis saya*
RV		Vermilion Flycatcher	*Pyrocephalus rubinus*
RV		Ash-throated Flycatcher	*Myiarchus cinerascens*
	*	Great Crested Flycatcher	*Myiarchus crinitus*
		Western Kingbird	*Tyrannus verticalis*
	*	Eastern Kingbird	*Tyrannus tyrannus*
RV		Scissor-tailed Flycatcher	*Tyrannus forficatus*
RV		Fork-tailed Flycatcher	*Tyrannus savana*
RV		Gray Kingbird	*Tyrannus dominicensis*
		Northern Shrike	*Lanius excubitor*
Enb		Loggerhead shrike	*Lanius ludovicianus*
	*	White-eyed Vireo	*Vireo griseus*
	*	Yellow-throated Vireo	*Vireo flavifrons*
SCbr	*	Blue-headed Vireo	*Vireo solitarius*
	*	Warbling Vireo	*Vireo gilvus*
	*	Philadelphia Vireo	*Vireo philadelphicus*
	*	Red-eyed Vireo	*Vireo olivaceus*
	*	Blue Jay	*Cyanocitta cristata*
	*	American Crow	*Corvus brachyrhynchos*
	*	Fish Crow	*Corvus ossifragus*
	*	Common Raven	*Corvus corax*
Tbr, SCnb		Horned Lark	*Eremophila alpestris*
	*	Purple Martin	*Progne subis*
	*	Tree Swallow	*Tachycineta bicolor*
	*	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
	*	Bank Swallow	*Riparia riparia*
SCbr	*	Cliff Swallow	*Petrochelidon pyrrhonota*
		Cave Swallow	*Petrochelidon fulva*
	*	Barn Swallow	*Hirundo rustica*
	*	Carolina Chickadee	*Poecile carolinensis*

State Status		Common name	*Scientific name*
		Black-capped Chickadee	*Poecile atricapillus*
	*	Tufted Titmouse	*Baeolophus bicolor*
	*	Red-breasted Nuthatch	*Sitta canadensis*
	*	White-breasted Nuthatch	*Sitta carolinensis*
	*	Brown Creeper	*Certhia americana*
	*	House Wren	*Troglodytes aedon*
SCbr	*	Winter Wren	*Troglodytes hiemalis*
E		Sedge Wren	*Cistothorus platensis*
	*	Marsh Wren	*Cistothorus palustris*
	*	Carolina Wren	*Thryothorus ludovicianus*
	*	Blue-gray Gnatcatcher	*Polioptila caerulea*
	*	Golden-crowned Kinglet	*Regulus satrapa*
	*	Ruby-crowned Kinglet	*Regulus calendula*
	*	Eastern Bluebird	*Sialia sialis*
RV		Townsend's Solitaire	*Myadestes townsendi*
SCbr	*	Veery	*Catharus fuscescens*
SCnb		Gray-cheeked Thrush	*Catharus minimus*
		Bicknell's Thrush	*Catharus bicknelli*
	*	Swainson's Thrush	*Catharus ustulatus*
	*	Hermit Thrush	*Catharus guttatus*
SCbr	*	Wood Thrush	*Hylocichla mustelina*
	*	American Robin	*Turdus migratorius*
	*	Gray Catbird	*Dumetella carolinensis*
	*	Northern Mockingbird	*Mimus polyglottos*
		Sage thrasher	*Oreoscoptes montanus*
SCbr	*	Brown Thrasher	*Toxostoma rufum*
int	*	European Starling	*Sturnus vulgaris*
	*	American Pipit	*Anthus rubescens*
RV		Bohemian Waxwing	*Bombycilla garrulus*
	*	Cedar Waxwing	*Bombycilla cedrorum*
		Lapland Longspur	*Calcarius lapponicus*
RV		Chestnut-collared Longspur	*Calcarius ornatus*
	*	Snow Bunting	*Plectrophenax nivalis*
	*	Ovenbird	*Seiurus aurocapilla*
SCbr	*	Worm-eating Warbler	*Helmitheros vermivorum*
	*	Louisiana Waterthrush	*Parkesia motacilla*
	*	Northern Waterthrush	*Parkesia noveboracensis*
Ebr,SCnb	*	Golden-winged Warbler	*Vermivora chrysoptera*
WAP-FS	*	Blue-winged Warbler	*Vermivora cyanoptera*
	*	Black-and-white Warbler	*Mniotilta varia*
WAP-FS	*	Prothonotary Warbler	*Protonotaria citrea*
RV		Swainson's Warbler	*Limnothlypis swainsonii*
		Tennessee Warbler	*Oreothlypis peregrina*
	*	Orange-crowned Warbler	*Oreothlypis celata*
SCbr	*	Nashville Warbler	*Oreothlypis ruficapilla*
	*	Connecticut Warbler	*Oporornis agilis*
RV		MacGillivray's Warbler	*Geothlypis tolmiei*
		Mourning Warbler	*Geothlypis philadelphia*
SC	*	Kentucky Warbler	*Geothlypis formosa*
	*	Common Yellowthroat	*Geothlypis trichas*
SCbr	*	Hooded Warbler	*Setophaga citrina*
	*	American Redstart	*Setophaga ruticilla*

State Status		Common name	*Scientific name*
	*	Cape May Warbler	*Setophaga tigrina*
SCbr		Cerulean Warbler	*Setophaga cerulea*
SCbr	*	Northern Parula	*Setophaga americana*
	*	Magnolia Warbler	*Setophaga magnolia*
	*	Bay-breasted Warbler	*Setophaga castanea*
SCbr	*	Blackburnian Warbler	*Setophaga fusca*
	*	Yellow Warbler	*Setophaga petechia*
	*	Chestnut-sided Warbler	*Setophaga pensylvanica*
	*	Blackpoll Warbler	*Setophaga striata*
SCbr	*	Black-throated Blue Warbler	*Setophaga caerulescens*
	*	Palm Warbler	*Setophaga palmarum*
	*	Pine Warbler	*Setophaga pinus*
	*	Yellow-rumped Warbler	*Setophaga coronata*
	*	Yellow-throated Warbler	*Setophaga dominica*
	*	Prairie Warbler	*Setophaga discolor*
RV		Black-throated Gray Warbler	*Setophaga nigrescens*
RV		Townsend's Warbler	*Setophaga townsendi*
SCbr	*	Black-throated Green Warbler	*Setophaga virens*
SCbr	*	Canada Warbler	*Cardellina canadensis*
	*	Wilson's Warbler	*Cardellina pusilla*
SCbr		Yellow-breasted Chat	*Icteria virens*
	*	Eastern Towhee	*Pipilo erythrophthalmus*
	*	American Tree Sparrow	*Spizella arborea*
	*	Chipping Sparrow	*Spizella passerina*
		Clay-colored Sparrow	*Spizella pallida*
	*	Field Sparrow	*Spizella pusilla*
Ebr, SCnb		Vesper Sparrow	*Pooecetes gramineus*
		Lark Sparrow	*Chondestes grammacus*
RV		Lark Bunting	*Calamospiza malanocorys*
Tbr	*	Savannah Sparrow	*Passerculus sandwichensis*
Tbr, SCnb	*	Grasshopper Sparrow	*Ammodramus savannarum*
E		Henslow's sparrow	*Ammodramus henslowii*
RV		Le Conte's Sparrow	*Ammodramus leconteii*
		Nelson's Sparrow	*Ammodramus nelsoni*
SCbr		Saltmarsh Sparrow	*Ammodramus caudacutus*
		Seaside Sparrow	*Ammodramus maritimus*
	*	Fox Sparrow	*Passerella iliaca*
	*	Song Sparrow	*Melospiza melodia*
	*	Lincoln's Sparrow	*Melospiza lincolnii*
	*	Swamp Sparrow	*Melospiza georgiana*
	*	White-throated Sparrow	*Zonotrichia albicollis*
RV		Harris's Sparrow	*Zonotrichia querula*
	*	White-crowned Sparrow	*Zonotrichia leucophrys*
RV		Golden-crowned Sparrow	*Zonotrichia atricapilla*
	*	Dark-eyed Junco	*Junco hyemalis*
		Summer Tanager	*Piranga rubra*
WAP-FS	*	Scarlet Tanager	*Piranga olivacea*
RV		Western Tanager	*Piranga ludoviciana*
	*	Northern Cardinal	*Cardinalis cardinalis*
	*	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
RV		Black-headed Grosbeak	*Pheucticus melanocephalus*
	*	Blue Grosbeak	*Passerina caerulea*
	*	Indigo Bunting	*Passerina cyanea*

State Status		Common name	*Scientific name*
RV		Painted Bunting	*Passerina ciris*
	*	Dickcissel	*Spiza americana*
Tbr, SCnb	*	Bobolink	*Dolichonyx oryzivorus*
	*	Red-winged Blackbird	*Agelaius phoeniceus*
SCbr	*	Eastern Meadowlark	*Sturnella magna*
		Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
	*	Rusty Blackbird	*Euphagus carolinus*
RV		Brewer's Blackbird	*Euphagus cyanocephalus*
	*	Common Grackle	*Quiscalus quiscula*
	*	Boat-tailed Grackle	*Quiscalus major*
int	*	Brown-headed Cowbird	*Molothrus ater*
	*	Orchard Oriole	*Icterus spurius*
	*	Baltimore Oriole	*Icterus galbula*
	*	Purple Finch	*Haemorhous purpureus*
int	*	House Finch	*Haemorhous mexicanus*
		Red Crossbill	*Loxia curvirostra*
	*	White-winged Crossbill	*Loxia leucoptera*
	*	Common Redpoll	*Acanthis flammea*
RV		European Goldfinch	*Carduelis carduelis*
	*	Pine Siskin	*Spinus pinus*
	*	American Goldfinch	*Spinus tristis*
		Evening Grosbeak	*Coccothraustes vespertinus*
int	*	House Sparrow	*Passer domesticus*

RV indicates a species that is only a rare visitor to NJ.

WAP-FS indicates a species that has not yet been formally listed in NJ but has been identified as a Focal Species for conservation in the state's Wildlife Action Plan (NJDEP, 2017).

Data from Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink, and S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. Biological Conservation 142: 2282-2292. Available online: http://ebird.org/ebird/nj/places. Site Accessed October 2019.

APPENDIX D.4. NEW JERSEY LAND MAMMALS

Mammals have not been inventoried by county.

Status	Common Name	*Scientific Name*
	Opossum	*Didelphis marsupialis*
	Masked shrew	*Sorex cinereus*
	Tuckahoe masked shrew	*Sorex cinereus nigriculus*
	Water shrew	*Sorex palustris*
	Smokey shrew	*Sorex fumeus*
	Long-tailed shrew	*Sorex dispar*
	Short-tailed shrew	*Blarina brevicauda*
	Least shrew	*Cryptotis parva*
	Pygmy shrew	*Sorex hoyii*
	Hairy-tailed mole	*Parascalops breweri*
	Eastern mole	*Scalopus aquaticus*
	Star-nosed mole	*Condylura cristata*
WAP-FS	Little brown bat	*Myotis lucifugus*
E	Indiana bat	*Myotis sodalis*
WAP-FS	Northern myotis	*Myotis septentrionalis*
	Small-footed myotis	*Myotis leibii*
	Silver-haired bat	*Lasionycteris noctivagans*
	Eastern pipistrel	*Pipistrellus subflavus*
	Big brown bat	*Eptesicus fuscus*
	Red bat	*Lasiurus borealis*
peripheral	Northern yellow bat	*Lasiurus intermedius*
	Hoary bat	*Lasiurus cinereus*
	Eastern cottontail	*Sylvilagus floridanus*
	New England cottontail	*Sylvilagus transitionalis*
int	European hare	*Lepus capensis*
int	Black-tailed jackrabbit	*Lepus californicus*
int	White-tailed jackrabbit	*Lepus townsendii*
	Eastern chipmunk	*Tamias striatus*
	Woodchuck	*Marmota monax*
	Gray squirrel	*Sciurus carolinensis*
	Red squirrel	*Tamiasciurus hudsonicus*
	Southern flying squirrel	*Glaucomys volans*
	Northern flying squirrel	*Glaucomys sabrinus*
	Beaver	*Castor canadensis*
int	Nutria	*Myocastor coypus*
	Marsh rice rat	*Oryzomys palustris*
	White-footed mouse	*Peromyscus leucopus*
E	Allegheny woodrat	*Neotoma magister*
	Red-backed mouse	*Clethrionomys gapperi*
	Meadow vole	*Microtus pennsylvanicus*
	Woodland vole	*Microtus pinetorum*
	Muskrat	*Ondatra zibethicus*
	Southern bog lemming	*Synaptomys cooperi*

Status	Common Name	*Scientific Name*
int	Black rat	*Rattus rattus*
int	Brown rat	*Rattus norvegicus*
int	House mouse	*Mus musculus*
	Woodland jumping mouse	*Napaeozapus insignis*
	Meadow jumping mouse	*Zapus hudsonius*
	Porcupine	*Erethizon dorsatum*
	Eastern coyote	*Canis latrans, var*
	Red fox	*Vulpes vulpes*
	Gray fox	*Urocyon cinereoargenteus*
	Black bear	*Ursus americanus*
	Raccoon	*Procyon lotor*
	Ermine	*Mustela erminea*
	Long-tailed weasel	*Mustela frenata*
	Mink	*Mustela vison*
	Striped skunk	*Mephitis mephitis*
	River otter	*Lutra canadensis*
E	Bobcat	*Felis rufus*
	White-tailed deer	*Odocoileus virginianus*
WAP-FS indicates a species that has not yet been formally listed in NJ, but has been		
Source: NJDEP Division of Fish and Wildlife, 2004b.		

APPENDIX D.5. MONMOUTH COUNTY REPTILES

New Jersey reptile species that may occur in Monmouth County.

Status	Common Name	*Scientific Name*
Lizards		
	Common five-lined skink	*Plestiodon fasciatus*
	Eastern fence lizard	*Sceloporus undulatus*
	Ground skink	*Scincella lateralis*
Snakes		
	Eastern wormsnake	*Carphophis a. amoenus*
WAP-FS	Northern black racer	*Coluber c. constrictor*
	Northern ring-necked snake	*Diadophis punctatus edwardsi*
	Southern ring-necked snake *****	*Diadophis p. punctatus*
WAP-FS	Eastern hog-nosed snake	*Heterodon platirhinos*
SC	Eastern kingsnake *****	*Lampropeltis getula*
	Eastern milksnake	*Lampropeltis t. triangulum*
	Coastal plain milksnake *****	*Lampropeltis t. triangulum x L. t. elapsoides*
	Northern watersnake	*Nerodia s. sipedon*
	Rough greensnake *****	*Opheodrys aestivus*
	Eastern ratsnake	*Pantherophis alleghaniensis*
T	Northern pinesnake *****	*Pituophis m. melanoleucus*
	Northern brownsnake	*Storeria d. dekayi*
	Northern red-bellied snake	*Storeria o. occipitomaculata*
	Eastern ribbonsnake	*Thamnophis s. sauritus*
	Eastern gartersnake	*Thamnophis s. sirtalis*
	Eastern smooth earthsnake	*Virginia v. valeriae*
Turtles		
	Snapping turtle	*Chelydra serpentina*
	Eastern painted turtle	*Chrysemys p. picta*
SC	Spotted turtle	*Clemmys guttata*
T	Wood turtle	*Glyptemys insculpta*
E	Bog turtle	*Glyptemys muhlenbergii*
	Southeastern mud turtle	*Kinosternon s. subrubrum*
WAP-FS	Northern diamond-backed terrapin	*Malaclemys t. terrapin*
WAP-FS	Northern red-bellied cooter	*Pseudemys rubiventris*
	Eastern musk turtle	*Sternotherus odoratus*
SC	Woodland box turtle	*Terrapene c. carolina*
int	Red-eared slider	*Trachemys scripta*
***** Range in Monmouth is limited to the southern end of the county.		
WAP-FS indicates a species that has not yet been formally listed in NJ, but has been identified as a		
Source: NJDEP Division of Fish and Wildlife, June 6, 2014.		

Appendix D.6. Monmouth County Amphibians

New Jersey amphibian species that may occur in Monmouth County.

Status	Common Name	Scientific Name
Anurans		
	Eastern cricket frog	*Acris crepitans*
SC	Fowler's toad	*Anaxyrus fowleri*
T	Pine Barrens treefrog*	*Hyla andersonii*
	Northern gray treefrog	*Hyla versicolor*
	Bullfrog	*Lithobates catesbeianus*
	Green frog	*Lithobates clamitans*
	Atlantic coast leopard frog +	*Lithobates kauffeldi*
	Pickerel frog	*Lithobates palustris*
	Southern leopard frog	*Lithobates sphenocephalus*
	Wood frog	*Lithobates sylvaticus*
SC	Carpenter frog	*Lithobates virgatipes*
	Spring peeper	*Pseudacris crucifer*
WAP-FS	New Jersey chorus frog	*Pseudacris kalmi*
WAP-FS	Eastern spadefoot toad	*Scaphiopus h. holbrooki*
Salamanders		
	Spotted salamander	*Ambystoma maculatum*
SC	Marbled salamander	*Ambystoma opacum*
	Northern dusky salamander	*Desmognathus fuscus*
	Northern two-lined salamander	*Eurycea bislineata*
	Four-toed salamander	*Hemidactylium scutatum*
	Red-spotted newt	*Notophthalmus v. viridescens*
	Red-backed salamander	*Plethodon cinereus*
	Northern slimy salamander	*Plethodon glutinosus*
WAP-FS	Northern red salamander	*Pseudotriton r. ruber*
***** Range in Monmouth is limited to the southern end of the county.		
+ Species range still under study.		
WAP-FS indicates a species that has not yet been formally listed in NJ but has been identified as a		
Sources: NJDEP Division of Fish and Wildlife, June 6, 2014; NJENSP November 2014.		

Appendix D.7. New Jersey Freshwater Fish

Fish have not been inventoried by county.

Status	Common Name	***Scientific Name***
Northern Lampreys		
	American Brook Lamprey	*Lampetra appendix*
	Sea Lamprey	*Petromyzon marinus*
Sturgeons		
E	Atlantic Sturgeon	*Acipenser oxyrhynchus*
E	Shortnose Sturgeon	*Acipenser brevirostrum*
Gars		
X	Longnose Gar	*Lepisosteus osseus*
Bowfins		
	Bowfin	*Amia calva*
Freshwater Eels		
	American Eel	*Anguilla rostrata*
Swamp		
int*	Swamp Eel	*Monopterus albus*
Herrings, Shads, Sardines, Menhadens		
WAP-FS	Blueback Herring	*Alosa aestivalis*
	Hickory Shad	*Alosa mediocris*
WAP-FS	Alewife	*Alosa pseudoharengus*
	American Shad	*Alosa sapidissima*
	Gizzard Shad	*Dorosoma cepedianum*
Salmonids		
int	Rainbow Trout	*Oncorhynchus mykiss*
int	Brown Trout	*Salmo trutta*
WAP-FS	Brook Trout	*Salvelinus fontinalis*
int	Lake Trout	*Salvelinus namaycush*
Smelts		
	Rainbow Smelt	*Osmerus mordax*
Mudminnows		
	Eastern Mudminnow	*Umbra pygmaea*
Pikes		
	Redfin Pickerel	*Esox americanus*
int	Northern Pike	*Esox lucius*

Status	Common Name	*Scientific Name*
	Chain Pickerel	*Esox niger*
int	Muskellunge	*Esox masquinongy*
Carps, Minnows		
int	Goldfish	*Carassius auratus*
int*	Grass Carp	*Ctenopharyngodon idella*
	Satinfin Shiner	*Cyprinella analostana*
	Spotfin Shiner	*Cyprinella spiloptera*
int	Common Carp	*Cyprinus carpio*
	Cutlip Minnow	*Exoglossum maxillingua*
	Eastern Silvery Minnow	*Hybognathus regius*
int*	Bighead Carp	*Hypophthalmichthys nobilis*
	Common Shiner	*Luxilis cornutus*
int	Allegheny Pearl Dace	*Margariscus margarita*
	Golden Shiner	*Notemigonus crysoleucas*
WAP-FS	Comely Shiner	*Notropis amoenus*
WAP-FS	Bridle Shiner	*Notropis bifrenatus*
WAP-FS	Ironcolor Shiner	*Notropis chalybaeus*
	Spottail Shiner	*Notropis husdonius*
	Swallowtail Shiner	*Notropis procne*
int	Fathead Minnow	*Pimephales promelas*
int	Bluntnose Minnow	*Pimephales notatus*
	Blacknose Dace	*Rhinichthys atratulus*
	Longnose Dace	*Rhinichthys cataractae*
	Creek Chub	*Semotilus atromaculatus*
	Fallfish	*Semotilus corporalis*
Suckers		
	Quillback	*Carpiodes cyprinus*
	White Sucker	*Catostomus commersoni*
	Creek Chubsucker	*Erimyzon oblongus*
	Northern Hog Sucker	*Hypentelium nigricans*
Freshwater Catfishes		
	White Catfish	*Ameiurus catus*
int	Black Bullhead	*Ameiurus melas*
	Yellow Bullhead	*Ameiurus natalis*
	Brown Bullhead	*Ameiurus nebulosus*
int	Channel Catfish	*Ictalurus punctatus*
	Tadpole Madtom	*Noturus gyrinus*
	Margined Madtom	*Noturus insignis*
int*	Flathead Catfish	*Pylodictis olivarus*
Pirate Perches		
	Pirate Perch	*Aphredoderus sayanus*

Status	Common Name	*Scientific Name*
Killifishes		
	Banded Killifish	*Fundulus diaphanus*
	Mummichog	*Fundulus heteroclitus*
Poeciliids		
	Eastern Mosquitofish	*Gambusia holbrooki*
int	Mosquitofish	*Gambusia affinis*
Gasterosteidae:		
	Fourspine Stickleback	*Apletes quadracus*
int*	Brook Stickleback	*Culaea inconstans*
	Threespoine Stickleback	*Gasterosteus aculeatus*
	Ninespine Stickleback	*Pungitius pungitius*
Moronidae:		
	White Perch	*Morone americana*
	Striped Bass	*Morone saxatilis*
Sticklebacks, Tubesnouts		
WAP-FS	Mud Sunfish	*Acantharchus pomotis*
int	Rock Bass	*Ambloplites rupestris*
WAP-FS	Blackbanded Sunfish	*Enneacanthus chaetodon*
	Bluespotted Sunfish	*Enneacanthus gloriosus*
WAP-FS	Banded Sunfish	*Enneacanthus obesus*
int*	Green Sunfish	*Lepomis cyanellus*
	Pumpkinseed	*Lepomis gibbosus*
int	Bluegill	*Lepomis macrochirus*
	Redbreast Sunfish	*Lepomis auritus*
int*	Warmouth	*Lepomis gulosus*
int	Smallmouth Bass	*Micropterus dolomieu*
int	Largemouth Bass	*Micropterus salmoides*
int	White Crappie	*Pomoxis annularis*
int	Black Crappie	*Pomoxis nigromaculatus*
Perches		
WAP-FS	Swamp Darter	*Etheostoma fusiforme*
	Tessellated Darter	*Etheostoma olmstedi*
	Yellow Perch	*Perca flavescens*
	Shield Darter	*Percina peltata*
int	Walleye	*Sander vitreus*
Sculpins		
	Slimy Sculpin	*Cottus cognatus*
Loaches		
int*	Oriental Weatherfish	*Misgurnus anguillicaudatus*

Status	Common Name	*Scientific Name*
Soles		
	Hogchoker	*Trinectes maculatus*
* indicates species that pose a serious threat to freshwater resources and must be destroyed when encountered. An anticipated addition to this category, the silver carp (*Hypophthalmichthys molitrix*) has not yet been documented in NJ.		
WAP-FS indicates a species that has not yet been formally listed in NJ but has been identified as a Focal Species for conservation in the state's Wildlife Action Plan (NJDEP, 2017).		
Source: NJDEP Division of Fish and Wildlife. 2016.		

APPENDIX D.8. RARE WILDLIFE SIGHTING FORM

Form begins on the following page.

RARE WILDLIFE SIGHTING REPORT FORM

REPORT FORM MUST BE ACCOMPANIED BY AN AERIAL PHOTOGRAPH, SATELLITE IMAGE, OR TOPOGRAPHIC MAP WITH THE LOCATION PRECISELY MARKED. PLEASE PRINT LEGIBLY.
*The inclusion of a map is mandatory, please see other side for further information on obtaining a map.

General Information

Today's Date ____________________
Common Name ____________________ Scientific Name (If known) ____________________

Where did the sighting take place?

Municipality/ Township ____________________ County ____________________

Topographic quad (if known) ____________________ Coordinates in state plane feet (if known) ________ ________

Directions to location with landmarks, which will enable the future relocation of the site where the species was sighted:

____
____
____

Land Owner (name, address and phone number, if known) ____________________
Describe habitat at the point of sighting and habitat in the general area of the sighting location.

____
____

Would you accompany a biologist to the site if needed? ☐ Yes ☐ No
Can you describe any immediate or future plans to develop or disturb the site? ☐ Yes ☐ No
If so, please describe. ____________________

____

Locational Accuracy

1. Is your depiction of the sighting location on the topographic map or aerial photo within 6m (20ft) of the animals actual location on the ground? ☐ Yes ☐ No (if no, answer question 2 below)

2. Your mapping is accurate to within ___ meters ___ feet ___ miles of the actual location.

What was observed?

How was the species identification made? (ex. Sighting, Call, Road Kill, etc.) ____________________

Date and time of this sighting (ex. August 20, 2004, 10:30am) ____________________

How frequently has this species been sighted at this location and over how long a period of time? ____________________

____

Number of individuals sighted: Adult ____ Immature ____ Larva ____ Unknown/Other ____

Describe sighting and activity observed (ex. Nesting, Perched, Flying, Sunning, etc.) ____________________

Describe physical features that identify the sighted animal as the species you are reporting. ____________________

____
____

Were photos taken? ☐ Yes ☐ No Was video recorded? ☐ Yes ☐ No Was audio recorded? ☐ Yes ☐ No
(PHOTOS/VIDEO/AUDIO ARE STRONGLY ENCOURAGED IN ORDER TO VERIFY THE ACCURACY OF A SIGHTING. Items should be identified with the date taken, location, and observer signature. Items will not be returned.)

List manuals used or experts consulted to verify identification. ____________________

Provide a brief background on wildlife knowledge and/or experience, or additional information that would add to the validity of the sighting. ____________________

____

Can this be verified by someone else or can anyone vouch for your identification skills? ☐ Yes ☐ No ____________________

Describe any additional information that may be useful in regards to the condition of the animal or location.

____

____

Your Contact information

Name ____________________
Street ____________________
City ____________________ State ____________________ ZIP ____________
Daytime Phone ( ) - ____________ E-mail ____________________

Preferred method of contact ____________________

Signature ____________________

Conserve Wildlife
N.J. Division of Fish, Game & Wildlife
Endangered & Nongame Species Program

Return to:
Endangered and Nongame Species Program
NJ Division of Fish and Wildlife
PO Box 400
Trenton, NJ 08625-0400
(609) 292-9400

NEW JERSEY DIVISION OF
Fish and Wildlife

Instructions

1. Complete this form for first-hand field observations only.
2. DO NOT COMPLETE THIS FORM if the source of your information is a report, letter, conversation, or other document. Send us the documentation instead.
3. Attach a copy of a map.(**see below*)
4. Only report one species at each location per form and map.

***Mapping**
A map is necessary to help our biologists determine if suitable habitat is present at the location. Once the suitability of the area is determined the map provided aids in the delineation of land to be protected. Ideally the most accurate form of map is an aerial photo, which can be obtained from http://www.state.nj.us/dep/gis/newmapping.htm, if you are comfortable with your ability to identify the location of the sighting accurately on them. In addition, satellite-derived images are available at http://www.maps.google.com. These images can be printed and clearly marked with a pen. An alternative to an aerial photo or satellite image is a topographic map. You may also print copies of topographic maps from the internet at http://www.topozone.com. Please use 1:24,000 scale topographic maps only. Please provide either an image or a topographic map, but NOT both. Thank you.

Refer to the DFW website for further information: http://www.njfishandwildlife.com/ensp/rprtform.htm

Appendix D.9. Habitat Requirements for Rare Wildlife Species Recorded in Howell Township

Habitat notes are generally direct quotes or loosely paraphrased excerpts from the cited sources.

Amphibians and Reptiles:

Pine Barrens Treefrog	*Hyla andersonii*	Threatened
The Pine Barrens treefrog congregates in the acidic waters of swamps and bogs in the Pinelands during the breeding season and disperses into the adjacent terrestrial habitat afterwards (Gessner and Stiles, 2001). The species prefers sites with an open canopy, dense shrub layer and heavy ground cover (Beans and Niles, 2003). As the northern boundary of the Pinelands region passes through Howell Township, the attractive frog is more likely to be encountered in the southern part of the municipality.		
Bog Turtle	*Glyptemys muhlenbergii*	Federally Threatened, State Endangered
Characteristic bog turtle habitat includes fens, bogs, and wet pastures with perennial groundwater seepage, a soft mud substrate, and some open areas for basking and nesting. While the substrate may be deep, the surface water is usually fairly shallow. Although natural habitats are more favorable, the turtles have been known to persist at sites formerly used as pastures or drainage ditches (Beans and Niles, 2003).		
Woodland (Eastern) Box Turtle	*Terrapene c. carolina*	Special Concern
The box turtle is one of our terrestrial turtles and is primarily a species of open woods and pastures. During hot, dry weather the turtles remain concealed beneath logs or rotting vegetation (Conant, 1975). Box turtles may also utilize shallow pools as a means of thermoregulation during the hottest weather (Ernst et al., 1994).		
Wood Turtle	*Glyptemys insculpta*	Threatened
Wood turtles need a combination of aquatic and terrestrial habitats. Freshwaters streams, brooks or creeks are needed during mating and hibernation periods, while uplands are required for basking, egg laying and foraging during the balance of the year. The turtles favor sites with few roads and limited human activity (Beans and Niles, 2003).		

Birds:

American Kestrel	*Falco sparverius*	Threatened, breeding and non-breeding
American Kestrels favor open areas with short ground vegetation and sparse trees. They may be found in meadows, grasslands, deserts, parks, farm fields, cities, and suburbs. When breeding, kestrels need access to at least a few trees or structures that provide appropriate nesting cavities. Kestrels are attracted to many habitats modified by humans, including pastures and parkland, and are often found near areas of human activity including golf courses, towns and cities (Cornell Lab of Ornithology, 2015-a; Elphick et al., 2001).		
American Woodcock	*Scolopax minor*	Wildlife Action Plan Focal Species
The American woodcock may be found in moist woodlands, mixed forests, wet meadows and thickets along boggy streams, abandoned fields and conifer plantations. Courtship diplays in early spring may be seen over fields, meadows or clearings, and nests are built on the ground beneath brush or shrubs or in the hollows of rocks or tree roots (Ehrlich et al., 1988).		
Bald Eagle	*Haliaeetus leucocephalus*	Endangered breeding, Threatened non-breeding
Bald eagles live near rivers, lakes, and marshes where they can find fish, their staple food. The eagles will also feed on waterfowl, turtles, rabbits, snakes, and other small animals and carrion. Bald eagles require a good food base, perching areas, and nesting sites. Their habitat includes estuaries, large lakes, reservoirs, rivers, and some seacoasts. In winter, the birds congregate near open water in tall trees for spotting prey and night roosts for sheltering (USFWS, 2015).		
Barred Owl	*Strix varia*	Threatened
Barred owls typically inhabit wooded wetlands, preferring large tracts of old-growth forest that are buffered from human disturbance. Large trees with cavities are required for nesting. The owls may also nest in habitat adjacent to their swampy hunting grounds if suitable trees are not present in the wetlands (Beans and Niles, 2003).		
Blackburnian Warbler	*Setophaga fusca*	Special Concern breeding, Stable non-breeding

This warbler requires mature coniferous forests for its nesting sites (Ehrlich et al., 1988). In New Jersey, it is only known to breed in the northwestern part of the state (Walsh et al., 1999).		
Black-crowned Night Heron	*Nycticorax nycticorax*	Threatened breeding, Special Concern non-breeding
Forests, scrub/shrubland, marshes and ponds serve as nesting, roosting and foraging habitats for black-crowned night herons. The birds nest colonially, sometimes in mixed-species colonies, in wooded swamps, coastal dune forests, vegetated dredge spoil islands, scrub thickets or marshes. The herons forage in marshes, along the edges of ponds and creeks, and in saline habitats including shallow tide pools, tidal channels and mudflats (Beans and Niles, 2003).		
Black-Throated Blue Warbler	*Setophaga caerulescens*	Special Concern breeding, Stable non-breeding
The black-throated blue warbler nests in mixed deciduous woodlands with a dense understory of laurel or rhododendron. Breeding records in New Jersey are limited to the northwestern part of the state, although there is an unconfirmed report from Mercer County (Walsh et al., 1999).		
Black-throated Green Warbler	*Setophaga virens*	Special Concern breeding, Stable non-breeding
Breeding records for this warbler are widely distributed across the state. The species prefers coniferous and mixed woodlands, often near spruce or hemlock groves but also in cedar swamps (Walsh et al., 1999).		
Blue-headed Vireo	*Vireo solitarius*	Special Concern breeding, Stable non-breeding
The blue-headed vireo nests in hemlock forests as well as other semi-open coniferous or mixed woods. Although most of the state breeding records for this species come from the northwestern counties, there is a confirmed record from Monmouth County (Walsh et al., 1999).		
Blue-winged Warbler	*Vermivora cyanoptera*	Wildlife Action Plan Focal Species
Blue-winged warblers may be found breeding in any county in New Jersey. Their preferred nesting habitat is open second-growth woodlands and along woodland edges. During the past century, the species has declined in urban areas but expanded its presence in less developed parts of the state (Walsh et al., 1999).		
Bobolink	*Dolichonyx oryzivorus*	Threatened breeding, Special Concern non-breeding
Meadows, fallow fields and low intensity agricultural habitats such as pastures and hay fields are utilized by boblinks during the breeding season. Habitat patches larger than 10 acres in size are preferred (Beans and Niles, 2003). Adjustment of mowing times in selected agricultural fields is an increasingly popular method of managing habitat to favor boblinks and other grassland birds (USDA Natural Resources Conservation Service, 2010).		
Broad-winged Hawk	*Buteo platypterus*	Special Concern breeding, Stable non-breeding
Breeding habitat for the broad-winged hawk is characterized by dense deciduous and mixed forest cover, although they occasionally utilize more open woodlands. The hawks often select nesting sites near water (Ehrlich et al., 1988).		
Brown Thrasher	*Toxostoma rufum*	Special Concern breeding, Stable non-breeding
In eastern North America, brown thrashers nest in thickets, hedgerows, forest edges, and overgrown clearings in deciduous forest. They're often found in woodlands with cottonwood, willow, dogwood, American plum, saltcedar, hawthorn, pitch pine, or scrub oak. On rare occasions they breed in backyards and gardens, although they are more likely to breed in suburban settings in the western part of their range (Cornell Lab of Ornithology, 2015-b; Ehrlich et al., 1988).		
Canada Warbler	*Cardellina canadensis*	Special Concern breeding, Stable non-breeding
Moist or wet woodlands with a dense understory typify the preferred breeding habitat of the Canada warbler. Although the majority of the species' breeding records in New Jersey are limited to the northern part of the state, there is an unconfirmed record from Monmouth County as well as two probable records from Burlington and southern Hunterdon Counties (Walsh et al., 1999).		
Caspian Tern	*Hydroprogne caspia*	Special Concern breeding, Stable non-breeding
The Caspian tern breeds in small colonies or rarely in solitary pairs. Habitats utilized include flat sand or gravel beaches, shell banks, and occasionally marshes (Ehrlich et al., 1988). New Jersey breeding sites are typically located on barrier or salt marsh islands (Walsh et al., 1999).		
Cliff Swallow	*Petrochelidon pyrrhonota*	Special Concern breeding, Stable non-breeding
Formerly restricted to canyons, foothills, and river valleys with natural cliff faces and overhangs, cliff swallows have spread into a wide variety of habitats by nesting on buildings, bridges, and other human-made structures. They now live in grasslands, towns, broken forest, and river edges, but avoid heavy forest and deserts. In the south-central and northeastern states, they are rare and localized breeders. Most colony sites are close to a water source, open fields or pastures for foraging, and a source of mud for nest building. Cliff Swallows spend		

the winter in grasslands, farmland, marshes, and the outskirts of towns in southern South America (Cornell Lab of Ornithology, 2015-c).		
Common Nighthawk	*Chordeiles minor*	Special Concern, breeding and non-breeding
The booming sound made by the common nighthawk during its aerial displays may be heard over a variety of open and semi-open habitats including savannas, grasslands, fields, cities and towns. The species does not make a nest but lays its eggs on sandy or gravelly surfaces, stumps, or old robins' nests (Ehrlich et al., 1988).		
Common Tern	*Sterna hirundo*	Special Concern breeding, Stable non-breeding
Common terns utilize a variety of coastal habitats, including sand and shell beaches, grassy uplands, or rocky island shores. In some areas, the birds have resorted to nesting on spoil banks. Availability of suitable nesting sites for this colonial species is a limiting factor to its success in the eastern United States (Harrison, 1975).		
Cooper's Hawk	*Accipiter cooperii*	Special Concern breeding, Stable non-breeding
During the breeding season, Cooper's hawks may be found in a variety of deciduous and coniferous forest types. They often choose nesting sites in or adjacent to wetlands, preferring forests with a closed canopy, moderate to heavy shrub cover and trees at least 30 years old. Wintering hawks may hunt for smaller birds at backyard feeders, sheltering in dense stands of evergreens during harsh weather (Beans and Niles, 2003).		
Eastern Meadowlark	*Sturnella magna*	Special Concern breeding, Stable non-breeding
Eastern meadowlarks may use a variety of open habitats for breeding, including grassy or weedy fields, meadows, or the upper zones of salt marshes (Walsh et al., 1999). Ehrlich et al. (1988) noted that their nests are often destroyed by the mowing of cultivated fields, so the species may benefit from practices such as adjusting cutting dates for hay fields (USDA Natural Resources Conservation Service, 2010).		
Forster's Tern	*Sterna forsteri*	Wildlife Action Plan Focal Species
Forster's tern may breed in freshwater or saltwater marshes, or along the marshy borders of ponds and lakes (Ehrlich et al., 1988). In New Jersey, they mainly breed on salt marsh islands and migrate in the fall, although they have been known to winter over in the state (Walsh et al., 1999).		
Glossy Ibis	*Plegadis falcinellus*	Special Concern breeding, Stable non-breeding
The glossy ibis is a colonial wetland breeder, favoring habitats such as marshes and swamps (Ehrlich et al., 1988). The birds may be found along the coast, nesting near water in trees or shrubs or occasionally on the ground. Nesting sites may be shared with other herons or egrets (Walsh et al., 1999).		
Golden-winged Warbler	*Vermivora chrysoptera*	Endangered breeding, Special Concern non-breeding
Ehrlich et al. (1988) refer to the golden-winged warbler as a habitat specialist, citing the species' preference for early successional habitats in old fields. Although shrubby or brushy openings with scattered trees may be found around the state, confirmed New Jersey breeding records for the golden-winged warbler are limited to the northern part of the state (Walsh et al., 1999).		
Grasshopper Sparrow	*Ammodramus savannarum*	Threatened breeding, Special Concern non-breeding
Breeding habitats for grasshopper sparrows include early successional fields, meadows, pastures, grasslands and hay fields. Optimal habitat includes some patches of bare ground and small shrubs, although more uniform grassy habitats may also be utilized. Large tracts (100+ acres) are preferred (Beans and Niles, 2003). Like other grassland birds, bobolinks may benefit from the adjustment of mowing times when nesting in agricultural fields (USDA Natural Resources Conservation Service, 2010).		
Great Blue Heron	*Ardea herodias*	Special Concern breeding, Stable non-breeding
Great blue herons forage widely in both freshwater and saltwater habitats, and also in grasslands and agricultural fields, where they stalk frogs and mammals. Most breeding colonies are located within 2 to 4 miles of feeding areas, often in isolated swamps or on islands, and near lakes and ponds bordered by forests (Cornell Lab of Ornithology, 2015-d).		
Hooded Warbler	*Setophaga citrina*	Special Concern breeding, Stable non-breeding
Nesting records for the hooded warbler span the full length of New Jersey. The species nests in the dense understory of moist or wet deciduous woodlands, particularly favoring a laurel-dominated shrub layer (Walsh et al., 1999).		
Kentucky Warbler	*Geothlypis formosa*	Special Concern, breeding and non-breeding
Swamps and other woodlands with a dense, damp undergrowth are the preferred breeding sites of the Kentucky warbler (Ehrlich et al., 1988). Although not abundant, the species is known to breed throughout New Jersey so the warblers could make a home in any moist, deciduous forest with a dense understory (Walsh et al., 1999).		
Least Bittern	*Ixobrychus exilis*	Special Concern, breeding and non-breeding

<table>
<tr><td colspan="3">The least bittern spends most of its time in densely vegetated marshes, both during breeding and migration. The species only rarely winters in New Jersey. The elusive bird nests on the ground or in low shrubs, primarily in freshwater wetlands or occasionally in brackish marshes (Ehrlich et al. 1988, Walsh et al. 1999).</td></tr>
<tr><td>Least Flycatcher</td><td>Empidonax minimus</td><td>Special Concern breeding, Stable non-breeding</td></tr>
<tr><td colspan="3">The least flycatcher may be found nesting in open deciduous woodlands, along forest edges or in clearings. The majority of breeding records for this species in New Jersey are from the northern counties. However, there are two confirmed records from southern Hunterdon County, and a smattering of unconfirmed records from other locations around the state including two in Monmouth County (Walsh et al., 1999).</td></tr>
<tr><td>Little Blue Heron</td><td>Egretta caerulea</td><td>Special Concern, breeding and non-breeding</td></tr>
<tr><td colspan="3">During the breeding season, the little blue heron may be found around marshes, ponds, lakes, meadows, and streams (Ehrlich et al., 1988). In New Jersey, most of the habitat utilized is located along the coast, where the species nests colonially with other herons and egrets. The little blue heron rarely winters in the state (Walsh et al., 1999).</td></tr>
<tr><td>Nashville Warbler</td><td>Oreothlypis ruficapilla</td><td>(Special Concern breeding, Stable non-breeding</td></tr>
<tr><td colspan="3">The Nashville warbler nests in riparian woodlands, brushy bogs, and open second-growth woodlands. There are a limited number of breeding records for this species in New Jersey, and all of those are limited to the northwestern part of the state (Walsh et al., 1999).</td></tr>
<tr><td>Northern Harrier</td><td>Circus cyaneus</td><td>Endangered breeding, Special Concern non-breeding</td></tr>
<tr><td colspan="3">Harriers may be seen flying low over the landscape in a variety of open habitats including marshes, meadows, grasslands, agricultural fields, and airports. Vegetation in their foraging habitats is usually under two meters in height. The raptors nest on the ground in both salt and freshwater marshes, and also occasionally in agricultural fields with low levels of disturbance (Beans and Niles, 2003).</td></tr>
<tr><td>Northern Parula</td><td>Setophaga americana</td><td>Special Concern breeding, Stable non-breeding</td></tr>
<tr><td colspan="3">The northern parula utilizes a variety of habitats for nesting, including deciduous or mixed woodlands and spruce plantations. Although widely distributed in the state, the species is most likely to be found in the northwestern areas and in the Pine Barrens (Walsh et al., 1999).</td></tr>
<tr><td>Osprey</td><td>Pandion haliaetus</td><td>Threatened breeding, Stable non-breeding</td></tr>
<tr><td colspan="3">As a piscivorous species, the osprey is strictly associated with bodies of water that support adequate fish populations. Consequently, ospreys inhabit coastal rivers, marshes, bays and inlets as well as inland rivers, lakes and reservoirs. Ospreys nest on live or dead trees, artificial nesting platforms, light poles, channel markers, abandoned duck blinds, or other artificial structures that are in close proximity to fishing areas and offer an unobstructed view of the surrounding landscape. Territories typically contain poles, snags, or structures near the nest on which the ospreys perch (Beans and Niles, 2003).</td></tr>
<tr><td>Peregrine Falcon</td><td>Falco peregrines</td><td>Endangered breeding, Special Concern non-breeding</td></tr>
<tr><td colspan="3">The natural nesting habitat of this large falcon is cliffs and large rock outcrops, but the species has adapted to human presence and will now utilize tall buildings or bridges. The birds also nest on large platforms that were constructed in coastal marshes to help the species recover following a severe population decline. Marshes, beaches and open water are favored as hunting grounds (Beans and Niles, 2003).</td></tr>
<tr><td>Pied-billed Grebe</td><td>Podilymbus podiceps</td><td>Endangered breeding, Special Concern non-breeding</td></tr>
<tr><td colspan="3">During the breeding season, pied-billed grebes primarily inhabit freshwater marshes associated with slow-moving rivers or open water such as ponds, lakes or reservoirs that offer a robust mixture of emergent and aquatic plants. A wider variety of open water habitats, both fresh and saline, may also be utilized during the winter months (Beans and Niles, 2003).</td></tr>
<tr><td>Prothonotary Warbler</td><td>Protonotaria citrea</td><td>Wildlife Action Plan Focal Species</td></tr>
<tr><td colspan="3">The prothonotary warbler inhabits swamps and forested floodplains, where it nests in the understory. A variety of natural cavities may be used, often located over water. The species has also been known to utilize nest boxes (Ehrlich et al. 1988, Walsh et al. 1999).</td></tr>
<tr><td>Red-headed Woodpecker</td><td>Melanerpes erythrocephalus</td><td>Threatened, breeding and non-breeding</td></tr>
<tr><td colspan="3">The red-headed woodpecker is considered a habitat specialist, favoring deciduous forests with an open understory and plenty of large, dead trees or snags (Audubon Minnesota, 2014). Cavity nests are excavated in the snags, or occasionally in dead stubs on live trees (Ehrlich et al., 1988). Snags are also utilized for roosting and foraging (Audubon Minnesota, 2014), and clusters of snags are preferred over scattered ones (Kreitinger and Staffen, 2013).</td></tr>
</table>

Red-shouldered Hawk	*Buteo lineatus*	Endangered breeding, Special Concern non-breeding
Mature wet woods such as hardwood swamps and riparian forests typify red-shouldered hawk breeding habitat. Nesting territories, which occur in deciduous, coniferous, or mixed woodlands, are typically located within remote and extensive old growth forests containing standing water. Red-shouldered hawks select large deciduous and, to a lesser extent, coniferous trees for nesting. Forest characteristics include a closed canopy of tall trees, an open subcanopy, and variable amounts of understory cover. An area sensitive species, the red-shouldered hawk typically nests away from residences, roads, and development. During the non-breeding season, red-shouldered hawks are less restrictive in their habitat use. They inhabit the traditional wetland forests occupied during the breeding season as well as uplands, fragmented woods, smaller forests, open areas, and edges (NJENSP, undated).		
Sanderling	*Calidris alba*	Special Concern non-breeding
Sanderlings may be seen in New Jersey year-round, although they head further north to breed during the summer. The species is scarce inland and is most often seen running along the high tide line on sandy beaches probing the sand for small invertebrates (Ehrlich et al. 1988, Walsh et al. 1999).		
Savannah Sparrow	*Passerculus sandwichensis*	Threatened breeding, Stable non-breeding
Savannah sparrows breed in both open and early-successional habitats including grasslands, upland meadows, agricultural fields, pastures, airports and vegetated landfills. Suitable nesting locations offer a mixture of short and tall grasses, a thick litter layer, dense ground cover and scattered shrubs or forbs (Beans and Niles, 2003).		
Scarlet Tanager	*Piranga olivacea*	Wildlife Action Plan Focal Species
Scarlet tanagers breed in mature deciduous and mixed deciduous-coniferous forests. Breeding tanagers prefer large forest tracts with large trees. During spring and fall migration they use similar forest habitats as well as open spaces such as parks and gardens (Cornell Lab of Ornithology, 2015-e).		
Semipalmated Sandpiper	*Calidris pusilla*	Special Concern non-breeding
New Jersey is an important stop for the semipalmated sandpiper during its spring and fall migration periods, but the species is seldom seen at other times of year. Although the sandpipers spend most of their time along the coast, they can be fairly common further inland as well (Walsh et al., 1999).		
Sharp-shinned Hawk	*Accipiter striatus*	Special Concern, breeding and non-breeding
Sharp-shinned hawks are birds of the forest and forest edge and are only found where trees are scarce during migration. They require dense forest, ideally with a closed canopy, for breeding. In the winter season they may also be found in somewhat more open habitats, including forest edges and suburban areas with bird feeders where they hunt for smaller birds (Cornell Lab of Ornithology, 2015-f).		
Snowy Egret	*Egretta thula*	Special Concern breeding, Stable non-breeding
Marshes, lakes, ponds and shallow coastal habitats are the preferred haunts of the snowy egret (Ehrlich et al., 1988). Like other herons, the species nest colonially. While snowy egret breeding sites in the state are mainly along the Atlantic coast, the species has also been known to nest along the Delaware River (Walsh et al., 1999).		
Spotted Sandpiper	*Actitis macularius*	Special Concern breeding, Stable non-breeding
The spotted sandpiper breeds in a wide variety of habitats (Erlich et al., 1988). The birds typically nest near fresh water including lakes, ponds, rivers and streams. The species breeds throughout New Jersey but is less common in the southern part of the state (Walsh et al., 1999).		
Tricolored Heron	*Egretta tricolor*	Special Concern, breeding and non-breeding
The tricolored heron is associated with marshes, ponds and rivers. The species usually breeds near saltwater but may also utilize inland freshwater habitats (Ehrlich et al., 1988). The species was not known to breed in New Jersey prior to the mid-1900s but may now be found in mixed-species colonies along the coast. Tricolored herons may remain in New Jersey during mild winters (Walsh et al., 1999).		
Veery	*Catharus fuscescens*	Special Concern breeding, Stable non-breeding
The spiraling musical song of the veery may be heard in moist deciduous woodlands and forested swamps during their breeding season. Veeries are most commonly encountered in the northern and central part of the state but are generally absent in highly developed areas (Walsh et al., 1999).		
Winter Wren	*Troglodytes hiemalis*	Special Concern breeding, Stable non-breeding
Breeding habitat favored by the winter wren is typified by moist coniferous woodlands with a thick understory, often located on talus slopes. New Jersey nesting records for the species are somewhat sparse and mainly limited to the northern counties. The southernmost breeding location documented in the state is in Somerset County (Walsh et al., 1999).		
Wood Thrush	*Hylocichla mustelina*	Special Concern breeding, Stable non-breeding

Wood thrushes breed throughout mature deciduous and mixed forests in eastern North America. They nest somewhat less successfully in fragmented forests and even suburban parks where there are enough large trees for a territory. Ideal habitat includes trees over 50 feet tall, a moderate understory of saplings and shrubs, an open floor with moist soil and decaying leaf litter, and water nearby. In their winter range, they are most abundant in the interior of mature, shady, broad-leaved and palm tropical forests in lowlands. As in their temperate range, they will also inhabit forest edges and the denser understory of second-growth forests (Cornell Lab of Ornithology, 2015-g).		
Worm-eating Warbler	*Helmitheros vermivorum*	Special Concern breeding, Stable non-breeding
There are breeding records for the worm-eating warbler throughout New Jersey, although the majority are from the northern part of the state where it may be found in the undergrowth in forested ravines and on other wooded slopes. Further to the south, the warbler nests in damp or wet deciduous wetlands (Walsh et al., 1999).		

Mammals:

Bobcat	*Felis rufus*	Endangered
Bobcats are able to live in a diverse assortment of environments. In the northeast, these include forests, mixed forest and agriculture, and even rural areas near small cities and towns. The cats prefer a patchy landscape with a mixture of early and late successional stages. Dense shrub and/or briar thickets that provide cover from weather and predators are used for resting and safety (Beans and Niles, 2013).		

Insects:

Pine Barrens Bluet	*Enallagma recurvatum*	(Special Concern)
The Pine Barrens bluet is a small damselfly of the eastern coastal plain. It may be found in shallow, acidic ponds with muddy substrates and ample vegetation, or along the edges of larger lakes where habitat conditions are similar (Barlow et al., 2009).		

Although moths and beetles are not yet included on New Jersey's lists of endangered, threatened and special concern species, these three species appear on a list of the state's rare invertebrates (NJDEP, 2001) and are tracked by New Jersey's Endangered and Nongame Species Program:		
Coastal Bog Metarranthis	*Metarranthis pilosaria*	n.a.
As its name suggests, the species inhabits bogs, boggy wetlands and acid swamps, often in the Pine Barrens. Habitats are characterized by larval foodplants such as cranberry (*Vaccinium macrocarpon*) and leatherleaf (*Chamaedaphne calyculata*) (NatureServe, 2019).		
Placentia Tiger Moth	*Grammia placentia*	n.a.
The placentia tiger moth is a southern species with some northern records from New Jersey, including one from Monmouth County. In its larval form, the moth feeds on plantain leaves (*Plantago sp*.) (BugGuide 2019, NatureServe 2019).		
New Jersey Pine Barrens Tiger Beetle	*Cicindela d. dorsalis*	n.a.
The New Jersey subspecies of the north barrens tiger beetle is generally found in the core of the Pine Barrens. The insect occupies oak-pine woodland or scrub habitat that offers both open patches of bare sand with exposed pebbles for breeding and shady areas where adults may escape the heat (Nature Serve, 2019).		

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Appendix D.10. Additional Bird Species Reported on eBird from Sites in Monmouth County Outside of Howell Township

State Status	Common name	Scientific name
E	Black Skimmer	*Rynchops niger*
E	Henslow's sparrow	*Ammodramus henslowii*
E	Least Tern	*Sternula antillarum*
E	Piping Plover	*Charadrius melodus*
E	Roseate Tern	*Sterna dougallii*
E	Sedge Wren	*Cistothorus platensis*
E	Upland Sandpiper	*Bartramia longicauda*
Ebr, SCnb	American Bittern	*Botaurus lentiginosus*
Ebr, SCnb	Northern Goshawk	*Accipiter gentilis*
Ebr, SCnb	Short-eared Owl	*Asio flammeus*
Ebr, SCnb	Vesper Sparrow	*Pooecetes gramineus*
Enb	Loggerhead shrike	*Lanius ludovicianus*
Enb	Red Knot	*Calidris canutus*
T	Long-eared Owl	*Asio otus*
T	Yellow-crowned Night-Heron	*Nyctanassa violacea*
Tbr, SCnb	Cattle Egret	*Bubulcus ibis*
Tbr, SCnb	Horned Lark	*Eremophila alpestris*
SC	American Oystercatcher	*Haematopus palliatus*
SC	Gull-billed Tern	*Gelochelidon nilotica*
SC	Tricolored Heron	*Egretta tricolor*
SCbr	Black-billed Cuckoo	*Coccyzus erythropthalmus*
SCbr	Cerulean Warbler	*Setophaga cerulea*
SCbr	Saltmarsh Sparrow	*Ammodramus caudacutus*
SCbr	Yellow-breasted Chat	*Icteria virens*
SCbr, Unb	Eastern Whip-poor-will	*Antrostomus vociferous*
SCnb	Gray-cheeked Thrush	*Catharus minimus*
SCnb	Whimbrel	*Numenius phaeopus*
WAP-FS	Northern Bobwhite	*Colinus virginianus*
WAP-FS	Ruddy Turnstone	*Arenaria interpres*
WAP-FS indicates a species that has not yet been formally listed in NJ but has been identified		
Source: Sullivan et.al., 2009. Site accessed October 9, 2019.		

APPENDIX E. OPEN SPACE INVENTORY

Municipal

Note: Always confirm accuracy of parcel ownership and preservation status with the Community Development office before relying on same.

Owner	Managed by	Property Name	Block	Lot	GIS acres
Howell Township	Howell Township	Aldrich Lake	93	9.01	21.21
Howell Township	Howell Township	Aldrich Lake	93	9.02	14.72
Howell Township	Howell Township	Aldrich Lake	93	13	34.05
Howell Township	Howell Township	Aldrich Lake	93	13.01	13.76
Howell Township	Howell Township	Aldrich Lake	93	16	3.18
Howell Township	Howell Township	Aldrich Lake	93	22	8.09
Howell Township	Howell Township	Aldrich Lake	93	23.02	9.49
Howell Township	Howell Township	Aldrich Lake	93	25	0.66
Howell Township	Howell Township	Aldrich Lake	105	5	2.88
Howell Township	Howell Township	Aldrich Lake	105	7	4.13
Howell Township	Howell Township	Alfred E. Sauer Park at Echo Lake	28	2	9.97
Howell Township	Howell Township	Alfred E. Sauer Park at Echo Lake	28	3	7.62
Howell Township	Howell Township	Alfred E. Sauer Park at Echo Lake	28	25	4.29
Howell Township	Howell Township	Ardena Acres Park	178.02	49	15.84
Howell Township	Howell Township	Ardena School House & Arboretum	67	2	13.05
Howell Township	Howell Township	Bear Swamp Natural Area (Soldier Memorial Park takes up 52.11 acres of this parcel)	46	28	178.05
Howell Township	Howell Township	Bear Swamp Natural Area	51	12	23.12
Howell Township	Howell Township	Bear Swamp Natural Area	51	24	24.15
Howell Township	Howell Township	Bear Swamp Natural Area	51	36.04	9.97
Howell Township	Howell Township	Bear Swamp Natural Area	51	36.05	7.14
Howell Township	Howell Township	Bear Swamp Natural Area	51	41.01	42.73
Howell Township	Howell Township	Bear Swamp Natural Area	51	42	22.47
Howell Township	Howell Township	Bear Swamp Natural Area	51	42.02	9.83
Howell Township	Howell Township	Bear Swamp Natural Area	51	66	38.37
Howell Township	Howell Township	Bear Swamp Natural Area	51	67	11.19
Howell Township	Howell Township	Bear Swamp Natural Area	51	68	8.76
Howell Township	Howell Township	Bear Swamp Natural Area	51	69	27.20
Howell Township	Howell Township	Bear Swamp Natural Area	51	70	5.19
Howell Township	Howell Township	Bear Swamp Natural Area	66	24	39.43
Howell Township	Howell Township	Bear Swamp Natural Area	66	25	39.46
Howell Township	Howell Township	Country Meadows Park	165	6.12	2.01
Howell Township	Howell Township	Deerwood Park	42	79.67	45.71
Howell Township	Howell Township	Diamond Lane Park	35.02	183	18.49
Howell Township	Howell Township	Edgewood Park	92	2	13.97
Howell Township	Howell Township	Freedom Field	169	106	15.10
Howell Township	Howell Township	Freewood Acres Park	110	170.65	22.37
Howell Township	Howell Township	Heathermeade Park	147	22	1.55
Howell Township	Howell Township	Hoffman Fields	152	68	8.56
Howell Township	Howell Township	Lake Louise	29	16	39.18
Howell Township	Howell Township	Lake Louise	29	31	11.75
Howell Township	Howell Township	Lake Louise	29	36	0.12
Howell Township	Howell Township	Lake Louise	29	37	0.12
Howell Township	Howell Township	Lake Louise	29	38	0.13
Howell Township	Howell Township	Lake Louise	29	39	0.14
Howell Township	Howell Township	Lake Louise	29	40	0.16
Howell Township	Howell Township	Lake Louise	29	41	0.15
Howell Township	Howell Township	Lake Louise	29	42	0.14
Howell Township	Howell Township	Lake Louise	29	43	0.15

Owner	Managed by	Property Name	Block	Lot	GIS acres
Howell Township	Howell Township	Lake Louise	29	44	0.15
Howell Township	Howell Township	Lake Louise	29	45	0.14
Howell Township	Howell Township	Lake Louise	29	46	0.15
Howell Township	Howell Township	Lake Louise	29	47	0.17
Howell Township	Howell Township	Lake Louise	29	48	0.16
Howell Township	Howell Township	Lake Louise	29	49	0.15
Howell Township	Howell Township	Lake Louise	29	50	0.15
Howell Township	Howell Township	Lake Louise	29	51	0.14
Howell Township	Howell Township	Lake Louise	29	52	0.14
Howell Township	Howell Township	Lake Louise	29	53	1.93
Howell Township	Howell Township	Lake Louise	29	54	0.23
Howell Township	Howell Township	Lake Louise	29	55	0.23
Howell Township	Howell Township	Lake Louise	29	56	0.23
Howell Township	Howell Township	Lake Louise	29	57	0.19
Howell Township	Howell Township	Lake Louise	29	60	0.53
Howell Township	Howell Township	Lake Louise	30	4	0.20
Howell Township	Howell Township	Lake Louise	30	5	0.23
Howell Township	Howell Township	Lake Louise	30	6	0.25
Howell Township	Howell Township	Lake Louise	30	7	0.06
Howell Township	Howell Township	Lake Louise	30	8	0.30
Howell Township	Howell Township	Lake Louise	30	9	0.34
Howell Township	Howell Township	Lake Louise	30	10	0.26
Howell Township	Howell Township	Lake Louise	30	11	0.20
Howell Township	Howell Township	Lake Louise	30	12	0.23
Howell Township	Howell Township	Lake Louise	30	13	0.21
Howell Township	Howell Township	Lake Louise	30	14	0.23
Howell Township	Howell Township	Long Brook/Manasquan River Greenway	141	20.51	3.24
Howell Township	Howell Township	Long Brook/Manasquan River Greenway	141	21	8.18
Howell Township	Howell Township	Long Brook/Manasquan River Greenway	141.01	1	0.74
Howell Township	Howell Township	Manasquan Reservoir	130	11	2.49
Howell Township	Howell Township	Manasquan Reservoir	130	65	1.62
Howell Township	Howell Township	Manasquan Reservoir	130	67	0.66
Howell Township	Howell Township	Manasquan Reservoir	130	71.01	4.34
Howell Township	Howell Township	Manasquan Reservoir	130	100	6.29
Howell Township	Howell Township	Manasquan Reservoir	130	101	1.49
Howell Township	Howell Township	Manasquan Reservoir	130	102	4.24
Howell Township	Howell Township	Manasquan Reservoir	130	105	35.89
Howell Township	Howell Township	Manasquan Reservoir	130	107	0.09
Howell Township	Howell Township	Metedeconk/Palomino Court	92	3.15	4.28
Howell Township	Howell Township	Monmouth Ridings Park	35.7	168	1.14
Howell Township	Howell Township	Mun Open Space/Metedeconk	2.15	33	4.12
Howell Township	Howell Township	Mun Open Space/Metedeconk	5	15	1.52
Howell Township	Howell Township	Mun Open Space/Metedeconk	5	17	1.21
Howell Township	Howell Township	Mun Open Space/Metedeconk	5	19	3.96
Howell Township	Howell Township	Mun Open Space/Metedeconk	69	11.01	0.17
Howell Township	Howell Township	Mun Open Space/Metedeconk	69	14.01	0.13
Howell Township	Howell Township	Mun Open Space/Metedeconk	69	15.01	0.01
Howell Township	Howell Township	Mun Open Space/Metedeconk	69	24	2.18
Howell Township	Howell Township	Mun Open Space/Metedeconk	69	25	0.83
Howell Township	Howell Township	Mun Open Space/Metedeconk	69	26	1.20
Howell Township	Howell Township	Municipal Open Space	1.08	5	5.62
Howell Township	Howell Township	Municipal Open Space	1.19	9	3.20
Howell Township	Howell Township	Municipal Open Space	1.19	31	2.66
Howell Township	Howell Township	Municipal Open Space	2	4.10	1.71
Howell Township	Howell Township	Municipal Open Space	2	8.03	3.85
Howell Township	Howell Township	Municipal Open Space	2	11	15.82
Howell Township	Howell Township	Municipal Open Space	2	101	10.33

Owner	Managed by	Property Name	Block	Lot	GIS acres
Howell Township	Howell Township	Municipal Open Space	2	113	3.68
Howell Township	Howell Township	Municipal Open Space	2.25	25	3.37
Howell Township	Howell Township	Municipal Open Space	3	15.55	7.94
Howell Township	Howell Township	Municipal Open Space	28	1.04	16.48
Howell Township	Howell Township	Municipal Open Space	35	3	14.33
Howell Township	Howell Township	Municipal Open Space	35	104	12.01
Howell Township	Howell Township	Municipal Open Space	35.02	117	33.02
Howell Township	Howell Township	Municipal Open Space	35.47	29	35.58
Howell Township	Howell Township	Municipal Open Space	35.47	79	0.53
Howell Township	Howell Township	Municipal Open Space	35.47	124	96.93
Howell Township	Howell Township	Municipal Open Space	35.58	18	12.52
Howell Township	Howell Township	Municipal Open Space	35.59	41	3.35
Howell Township	Howell Township	Municipal Open Space	35.70	89	19.15
Howell Township	Howell Township	Municipal Open Space	35.70	169	15.79
Howell Township	Howell Township	Municipal Open Space	35.78	7	0.80
Howell Township	Howell Township	Municipal Open Space	42	41	105.83
Howell Township	Howell Township	Municipal Open Space	42	41.01	33.49
Howell Township	Howell Township	Municipal Open Space	42	58.58	129.27
Howell Township	Howell Township	Municipal Open Space	42	79.69	88.61
Howell Township	Howell Township	Municipal Open Space	42.01	32	4.84
Howell Township	Howell Township	Municipal Open Space	42.05	25	2.81
Howell Township	Howell Township	Municipal Open Space	46	11.05	4.39
Howell Township	Howell Township	Municipal Open Space	65	16.32	3.79
Howell Township	Howell Township	Municipal Open Space	70	4	2.65
Howell Township	Howell Township	Municipal Open Space	78	9	45.81
Howell Township	Howell Township	Municipal Open Space	78	180	3.45
Howell Township	Howell Township	Municipal Open Space	78.06	18	3.08
Howell Township	Howell Township	Municipal Open Space	78.06	33	4.12
Howell Township	Howell Township	Municipal Open Space	78.07	12	0.58
Howell Township	Howell Township	Municipal Open Space	79	63.03	0.99
Howell Township	Howell Township	Municipal Open Space	79	63.16	1.83
Howell Township	Howell Township	Municipal Open Space	79	63.23	0.34
Howell Township	Howell Township	Municipal Open Space	79	67.35	3.19
Howell Township	Howell Township	Municipal Open Space	79	67.36	3.11
Howell Township	Howell Township	Municipal Open Space	79	67.37	1.25
Howell Township	Howell Township	Municipal Open Space	79	81	5.35
Howell Township	Howell Township	Municipal Open Space	79	81.01	8.02
Howell Township	Howell Township	Municipal Open Space	79.05	18	2.18
Howell Township	Howell Township	Municipal Open Space	79.07	10	3.55
Howell Township	Howell Township	Municipal Open Space	84.19	7	0.73
Howell Township	Howell Township	Municipal Open Space	84.20	11	0.86
Howell Township	Howell Township	Municipal Open Space	84.20	35	2.35
Howell Township	Howell Township	Municipal Open Space	84.21	13	3.77
Howell Township	Howell Township	Municipal Open Space	110	178.01	35.09
Howell Township	Howell Township	Manasquan River Greenway	139	1.01	19.70
Howell Township	Howell Township	Manasquan River Greenway	152	1	6.10
Howell Township	Howell Township	Manasquan River Greenway	152	15.10	4.63
Howell Township	Howell Township	Manasquan River Greenway	152	34.01	20.10
Howell Township	Howell Township	Manasquan River Greenway	152	34.24	20.08
Howell Township	Howell Township	Municipal Open Space	165	6.20	5.16
Howell Township	Howell Township	Howell Organic Community Garden	177	97.08	15.65
Howell Township	Howell Township	Municipal Open Space	178.04	17	9.26
Howell Township	Howell Township	Municipal Open Space	178.04	18	1.72
Howell Township	Howell Township	Oak Glen Park	50	44.03	2.61
Howell Township	Howell Township	Oak Glen Park	50	44.04	1.97
Howell Township	Howell Township	Oak Glen Park	50	44.04	16.65
Howell Township	Howell Township	Oak Glen Park	50	44.04	4.30

Owner	Managed by	Property Name	Block	Lot	GIS acres
Howell Township	Howell Township	Oak Glen Park	51.01	16	7.78
Howell Township	Howell Township	Oak Glen Park	51.01	16.01	5.19
Howell Township	Howell Township	Oak Glen Park	51.01	18	33.24
Howell Township	Howell Township	Oak Glen Park	66.01	28	3.15
Howell Township	Howell Township	Oak Glen Park	66.01	29	13.71
Howell Township	Howell Township	Oak Glen Park	66.01	30	0.29
Howell Township	Howell Township	Oak Glen Park	67	2	13.05
Howell Township	Howell Township	Oak Glen Park	68	6	16.80
Howell Township	Howell Township	Pearl Drive Park	129	51	0.34
Howell Township	Howell Township	Pride Park	165	9.07	15.99
Howell Township	Howell Township	Priscilla Lane Park	84.17	22	1.26
Howell Township	Howell Township	Ramtown Manor Park	1.13	1	10.26
Howell Township	Howell Township	Stanford Brook Park	2.15	56	21.72
Howell Township	Howell Township	Tioga Park	78.06	105	2.94
Howell Township	Howell Township	West Farms Park	155	18.39	73.02
Howell Township	Howell Township	Winston Park	93	37	20.29

Municipal "Newspaper Parcels" in Bear Swamp Natural Area Parcels

The following blocks encompass 4,909 lots owned by Howell Township, each less than one acre in size (ranging from 12 sq. ft. to 0.2 acres), and averaging 1,996 sq. ft. and totaling 224.9 acres.

Block	Block	Block	Block	Block	Block	Block	Block	Block	Block	Block
51.07	51.10	51.20	51.40	51.50	51.60	51.71	51.80	66	66.21	66.30
51.08	51.11	51.21	51.41	51.51	51.61	51.72	51.81	66.06	66.22	66.31
51.09	51.12	51.39	51.42	51.52	51.62	51.73	51.82	66.17	66.23	66.32
	51.13		51.43	51.53	51.63	51.74	51.83		66.24	66.33
	51.14		51.44	51.55	51.64	51.75	51.84		66.25	66.34
	51.15		51.45	51.56	51.65	51.76	51.85		66.26	66.35
	51.16		51.46	51.57		51.77	51.86		66.27	66.36
	51.17		51.47	51.58		51.78	51.87		66.28	66.37
	51.18		51.48	51.59		51.79			66.29	66.38
	51.19		51.49							

County

Owner	Managed by	Property Name	Block	Lot	GIS acres
Monmouth County	Monmouth County	Howell Park (Golf Course)	50	42	78.52
Monmouth County	Monmouth County	Howell Park (Golf Course)	50	45	45.46
Monmouth County	Monmouth County	Howell Park (Golf Course)	50	46	4.02
Monmouth County	Monmouth County	Howell Park (Golf Course)	68	7	59.75
Monmouth County	Monmouth County	Howell Park (Golf Course)	68	12	92.14
Monmouth County	Monmouth County	Howell Park (Golf Course)	155	15	22.42
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	24	15.60
Monmouth County	Monmouth County	in progress (201 MAIN ST ALLENHURST)	66.01	26	61.61
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	31	57.10
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	32	11.15
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	33	18.05
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	34	10.58
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	34.01	0.25
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36	34.97
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.01	0.10
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.02	0.15
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.03	0.27
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.04	0.23
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.05	0.14
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.07	0.23

Owner	Managed by	Property Name	Block	Lot	GIS acres
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.13	0.11
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.14	0.26
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.17	0.34
Monmouth County	Monmouth County	Manasquan Reservoir	66.01	36.18	0.48
Monmouth County	Monmouth County	Pinnacle Tract	129	100	0.33
Monmouth County	Monmouth County	Pinnacle Tract	130	14	7.26
Monmouth County	Monmouth County	Pinnacle Tract	130	15	7.38
Monmouth County	Monmouth County	Pinnacle Tract	130	17	6.17
Monmouth County	Monmouth County	Pinnacle Tract	130	20	3.46
Monmouth County	Monmouth County	Pinnacle Tract	130	21	3.73
Monmouth County	Monmouth County	Pinnacle Tract	130	22	4.02
Monmouth County	Monmouth County	Pinnacle Tract	130	57	1.87
Monmouth County	Monmouth County	Pinnacle Tract	130	58	15.68
Monmouth County	Monmouth County	Pinnacle Tract	130	59	76.61
Monmouth County	Monmouth County	Pinnacle Tract	130	60	7.99
Monmouth County	Monmouth County	Pinnacle Tract	130	61	6.97
NJ WSA	Monmouth County	Manasquan Reservoir	130	9	8.22
NJ WSA	Monmouth County	Manasquan Reservoir	130	10	7.66
NJ WSA	Monmouth County	Manasquan Reservoir	130	73.02	1.76
NJ WSA	Monmouth County	Manasquan Reservoir	130	74.02	2.73
NJ WSA	Monmouth County	Manasquan Reservoir	130	76	8.52
NJ WSA	Monmouth County	Manasquan Reservoir	130	86	3.23
NJ WSA	Monmouth County	Manasquan Reservoir	130	87	0.59
NJ WSA	Monmouth County	Manasquan Reservoir	130	88	0.43
NJ WSA	Monmouth County	Manasquan Reservoir	130	89	0.40
NJ WSA	Monmouth County	Manasquan Reservoir	130	90	0.75
NJ WSA	Monmouth County	Manasquan Reservoir	130	91	0.35
NJ WSA	Monmouth County	Manasquan Reservoir	130	91.01	0.33
NJ WSA	Monmouth County	Manasquan Reservoir	130	92	0.12
NJ WSA	Monmouth County	Manasquan Reservoir	130	93	0.90
NJ WSA	Monmouth County	Manasquan Reservoir	130	94	0.91
NJ WSA	Monmouth County	Manasquan Reservoir	130	95	5.00
NJ WSA	Monmouth County	Manasquan Reservoir	130	96	13.71
NJ WSA	Monmouth County	Manasquan Reservoir	130	97	8.32
NJ WSA	Monmouth County	Manasquan Reservoir	130	98	6.28
NJ WSA	Monmouth County	Manasquan Reservoir	130	99	13.56
NJ WSA	Monmouth County	Manasquan Reservoir	130	100.01	3.03
NJ WSA	Monmouth County	Manasquan Reservoir	130	101.01	1.15
NJ WSA	Monmouth County	Manasquan Reservoir	130	103	4.57
NJ WSA	Monmouth County	Manasquan Reservoir	130	104	4.67
NJ WSA	Monmouth County	Manasquan Reservoir	130	104	5.28
NJ WSA	Monmouth County	Manasquan Reservoir	130	106	1.53
NJ WSA	Monmouth County	Manasquan Reservoir	130	108	0.28
NJ WSA	Monmouth County	Manasquan Reservoir	130	109	0.50
NJ WSA	Monmouth County	Manasquan Reservoir	130	110	0.50
NJ WSA	Monmouth County	Manasquan Reservoir	130	111	0.50
NJ WSA	Monmouth County	Manasquan Reservoir	130	112	0.50
NJ WSA	Monmouth County	Manasquan Reservoir	131	7	3.07
NJ WSA	Monmouth County	Manasquan Reservoir	131	8	1.73
NJ WSA	Monmouth County	Manasquan Reservoir	131	9	1.98
NJ WSA	Monmouth County	Manasquan Reservoir	131	10	0.19
NJ WSA	Monmouth County	Manasquan Reservoir	131	11	0.32
NJ WSA	Monmouth County	Manasquan Reservoir	131	12	0.41
NJ WSA	Monmouth County	Manasquan Reservoir	131	13	4.64
NJ WSA	Monmouth County	Manasquan Reservoir	131	14.01	1.50
NJ WSA	Monmouth County	Manasquan Reservoir	131	15.01	5.70
NJ WSA	Monmouth County	Manasquan Reservoir	131	16.01	0.35

Owner	Managed by	Property Name	Block	Lot	GIS acres
NJ WSA	Monmouth County	Manasquan Reservoir	131	17.02	11.08
NJ WSA	Monmouth County	Manasquan Reservoir	131	18	0.58
NJ WSA	Monmouth County	Manasquan Reservoir	131	19	0.42
NJ WSA	Monmouth County	Manasquan Reservoir	131	19.01	0.30
NJ WSA	Monmouth County	Manasquan Reservoir	131	20	0.24
NJ WSA	Monmouth County	Manasquan Reservoir	131	21	0.14
NJ WSA	Monmouth County	Manasquan Reservoir	131	22	15.22
NJ WSA	Monmouth County	Manasquan Reservoir	131	23	0.30
NJ WSA	Monmouth County	Manasquan Reservoir	131	24	0.24
NJ WSA	Monmouth County	Manasquan Reservoir	131	25	0.57
NJ WSA	Monmouth County	Manasquan Reservoir	131	26	1.57
NJ WSA	Monmouth County	Manasquan Reservoir	131	27	0.11
NJ WSA	Monmouth County	Manasquan Reservoir	131	28	0.97
NJ WSA	Monmouth County	Manasquan Reservoir	131	29	1.32
NJ WSA	Monmouth County	Manasquan Reservoir	131	30	9.66
NJ WSA	Monmouth County	Manasquan Reservoir	131	31	11.90
NJ WSA	Monmouth County	Manasquan Reservoir	131	31.01	9.68
NJ WSA	Monmouth County	Manasquan Reservoir	131	31.02	10.09
NJ WSA	Monmouth County	Manasquan Reservoir	131	32	46.41
NJ WSA	Monmouth County	Manasquan Reservoir	131	34	15.67
NJ WSA	Monmouth County	Manasquan Reservoir	131	34.01	1.01
NJ WSA	Monmouth County	Manasquan Reservoir	131	34.02	1.01
NJ WSA	Monmouth County	Manasquan Reservoir	131	34.03	0.95
NJ WSA	Monmouth County	Manasquan Reservoir	131	35	6.69
NJ WSA	Monmouth County	Manasquan Reservoir	131	35.01	0.10
NJ WSA	Monmouth County	Manasquan Reservoir	131	35.02	0.14
NJ WSA	Monmouth County	Manasquan Reservoir	131	36	0.26
NJ WSA	Monmouth County	Manasquan Reservoir	131	36.01	0.26
NJ WSA	Monmouth County	Manasquan Reservoir	131	37	1.21
NJ WSA	Monmouth County	Manasquan Reservoir	131	37.01	0.10
NJ WSA	Monmouth County	Manasquan Reservoir	131	38	0.57
NJ WSA	Monmouth County	Manasquan Reservoir	131	39	0.37
NJ WSA	Monmouth County	Manasquan Reservoir	131	40	0.21
NJ WSA	Monmouth County	Manasquan Reservoir	131	41	27.60
NJ WSA	Monmouth County	Manasquan Reservoir	131	42	12.34
NJ WSA	Monmouth County	Manasquan Reservoir	131	43	22.77
NJ WSA	Monmouth County	Manasquan Reservoir	131	44	1.82
NJ WSA	Monmouth County	Manasquan Reservoir	131	45	5.56
NJ WSA	Monmouth County	Manasquan Reservoir	131	45.01	2.80
NJ WSA	Monmouth County	Manasquan Reservoir	131	45.02	9.70
NJ WSA	Monmouth County	Manasquan Reservoir	131	45.03	2.77
NJ WSA	Monmouth County	Manasquan Reservoir	131	45.04	3.95
NJ WSA	Monmouth County	Manasquan Reservoir	131	46	8.44
NJ WSA	Monmouth County	Manasquan Reservoir	131	48	32.40
NJ WSA	Monmouth County	Manasquan Reservoir	131	49	24.17
NJ WSA	Monmouth County	Manasquan Reservoir	131	50	11.32
NJ WSA	Monmouth County	Manasquan Reservoir	131	51	12.33
NJ WSA	Monmouth County	Manasquan Reservoir	131	52	21.28
NJ WSA	Monmouth County	Manasquan Reservoir	131	53	30.79
NJ WSA	Monmouth County	Manasquan Reservoir	131	54	21.28
NJ WSA	Monmouth County	Manasquan Reservoir	131	55	2.59
NJ WSA	Monmouth County	Manasquan Reservoir	131	56	0.21
NJ WSA	Monmouth County	Manasquan Reservoir	131	57	0.28
NJ WSA	Monmouth County	Manasquan Reservoir	131	58	0.29
NJ WSA	Monmouth County	Manasquan Reservoir	131	59	0.56
NJ WSA	Monmouth County	Manasquan Reservoir	131	60	0.29
NJ WSA	Monmouth County	Manasquan Reservoir	131	61	0.47

Owner	Managed by	Property Name	Block	Lot	GIS acres
NJ WSA	Monmouth County	Manasquan Reservoir	131	62	0.45
NJ WSA	Monmouth County	Manasquan Reservoir	131	63	0.14
NJ WSA	Monmouth County	Manasquan Reservoir	131	63.01	0.22
NJ WSA	Monmouth County	Manasquan Reservoir	131	63.02	0.21
NJ WSA	Monmouth County	Manasquan Reservoir	131	64	19.23
NJ WSA	Monmouth County	Manasquan Reservoir	131	64.01	6.60
NJ WSA	Monmouth County	Manasquan Reservoir	131	65	6.36
NJ WSA	Monmouth County	Manasquan Reservoir	131	66	85.98
NJ WSA	Monmouth County	Manasquan Reservoir	131	67	38.14
NJ WSA	Monmouth County	Manasquan Reservoir	131	68	25.23
NJ WSA	Monmouth County	Manasquan Reservoir	131	68.01	2.88
NJ WSA	Monmouth County	Manasquan Reservoir	131	69	39.74
NJ WSA	Monmouth County	Manasquan Reservoir	131	70	6.54
NJ WSA	Monmouth County	Manasquan Reservoir	131	71	70.05
NJ WSA	Monmouth County	Manasquan Reservoir	131	72	6.63
NJ WSA	Monmouth County	Manasquan Reservoir	131	72.01	0.98
NJ WSA	Monmouth County	Manasquan Reservoir	131	72.02	1.00
NJ WSA	Monmouth County	Manasquan Reservoir	131	72.03	7.73
NJ WSA	Monmouth County	Manasquan Reservoir	131	72.04	1.25
NJ WSA	Monmouth County	Manasquan Reservoir	131	72.05	1.06
NJ WSA	Monmouth County	Manasquan Reservoir	131	72.06	1.01
NJ WSA	Monmouth County	Manasquan Reservoir	131	73	13.50
NJ WSA	Monmouth County	Manasquan Reservoir	131	74	21.56
NJ WSA	Monmouth County	Manasquan Reservoir	131	74.01	4.61
NJ WSA	Monmouth County	Manasquan Reservoir	131	75	10.92
NJ WSA	Monmouth County	Manasquan Reservoir	131	76	15.27
NJ WSA	Monmouth County	Manasquan Reservoir	131	77	0.28
NJ WSA	Monmouth County	Manasquan Reservoir	131	78	1.91
NJ WSA	Monmouth County	Manasquan Reservoir	131	79	12.33
NJ WSA	Monmouth County	Manasquan Reservoir	131	80	10.08
NJ WSA	Monmouth County	Manasquan Reservoir	131	81	10.60
NJ WSA	Monmouth County	Manasquan Reservoir	131	82	11.38
NJ WSA	Monmouth County	Manasquan Reservoir	131	83	14.83
NJ WSA	Monmouth County	Manasquan Reservoir	131	84	12.47
NJ WSA	Monmouth County	Manasquan Reservoir	131	85	161.49
NJ WSA	Monmouth County	Manasquan Reservoir	131	86	2.67
NJ WSA	Monmouth County	Manasquan Reservoir	131	87	2.86
NJ WSA	Monmouth County	Manasquan Reservoir	131	87.01	6.31
NJ WSA	Monmouth County	Manasquan Reservoir	131	87.02	2.67
NJ WSA	Monmouth County	Manasquan Reservoir	131	88	5.71
NJ WSA	Monmouth County	Manasquan Reservoir	131	89	5.82
NJ WSA	Monmouth County	Manasquan Reservoir	131	90	22.26
NJ WSA	Monmouth County	Manasquan Reservoir	131	91	0.62
NJ WSA	Monmouth County	Manasquan Reservoir	131	92	1.57
NJ WSA	Monmouth County	Manasquan Reservoir	131	92.01	3.00
NJ WSA	Monmouth County	Manasquan Reservoir	131	93	1.23
NJ WSA	Monmouth County	Manasquan Reservoir	131	94	2.27
NJ WSA	Monmouth County	Manasquan Reservoir	131	95	13.60
NJ WSA	Monmouth County	Manasquan Reservoir	131	96	1.88
NJ WSA	Monmouth County	Manasquan Reservoir	131	97	11.60
NJ WSA	Monmouth County	Manasquan Reservoir	131	97.01	1.23
NJ WSA	Monmouth County	Manasquan Reservoir	131	98	3.25
Monmouth County	Monmouth County	Manasquan River Greenway	68	5	2.07
Monmouth County	Monmouth County	Manasquan River Greenway	68	8	1.05
Monmouth County	Monmouth County	Manasquan River Greenway	68	9	2.24
Monmouth County	Monmouth County	Manasquan River Greenway	68	11	7.14
Monmouth County	Monmouth County	Manasquan River Greenway	139	1.01	19.70

Owner	Managed by	Property Name	Block	Lot	GIS acres
Monmouth County	Monmouth County	Manasquan River Greenway	139	4	0.65
Monmouth County	Monmouth County	Manasquan River Greenway	139	5	0.41
Monmouth County	Monmouth County	Manasquan River Greenway	139	6	2.11
Monmouth County	Monmouth County	Manasquan River Greenway	139	16.02	1.51
Monmouth County	Monmouth County	Manasquan River Greenway	139	16.03	1.67
Monmouth County	Monmouth County	Manasquan River Greenway	143	2	9.51
Monmouth County	Monmouth County	Manasquan River Greenway	143	14	2.60
Monmouth County	Monmouth County	Manasquan River Greenway	143	18	1.13
Monmouth County	Monmouth County	Manasquan River Greenway	143	32	35.70
Monmouth County	Monmouth County	Manasquan River Greenway	152	1.13	5.00
Monmouth County	Monmouth County	Manasquan River Greenway	152	4.03	4.29
Monmouth County	Monmouth County	Manasquan River Greenway	152	22	4.82
Monmouth County	Monmouth County	Manasquan River Greenway	152	40.13	18.07
Monmouth County	Monmouth County	Manasquan River Greenway	152	64	2.36
Monmouth County	Monmouth County	Manasquan River Greenway	155	9	7.10
Monmouth County	Monmouth County	Manasquan River Greenway	155	10	7.39
Monmouth County	Monmouth County	Manasquan River Greenway	155	11	33.87
Monmouth County	Monmouth County	Manasquan River Greenway	155	14	6.78
Monmouth County	Monmouth County	Manasquan River Greenway	155	16	25.64
Monmouth County	Monmouth County	Manasquan River Greenway	155	17	1.40
Monmouth County	Monmouth County	Manasquan River Greenway	155	32.01	18.00
Monmouth County	Monmouth County	Manasquan River Greenway	156	7.04	10.10
Monmouth County	Monmouth County	Manasquan River Greenway	156	7.05	4.59
Monmouth County	Monmouth County	Manasquan River Greenway	156	10	19.45
Monmouth County	Monmouth County	Manasquan River Greenway	156	13	3.59
Monmouth County	Monmouth County	Manasquan River Greenway	156	14	0.75
Monmouth County	Monmouth County	Manasquan River Greenway	156	17.04	11.71
Monmouth County	Monmouth County	Manasquan River Greenway	156	23	18.76
Monmouth County	Monmouth County	Manasquan River Greenway	185	55	0.24
Monmouth County	Monmouth County	Manasquan River Greenway	185	57	0.72
Monmouth County	Monmouth County	Manasquan River Greenway	185	58	1.56
Monmouth County	Monmouth County	Manasquan River Greenway	185	59	0.23
Monmouth County	Monmouth County	Manasquan River Greenway	185	60	1.06
Monmouth County	Monmouth County	Manasquan River Greenway	185	61	0.14
Monmouth County	Monmouth County	Manasquan River Greenway	185	62	0.87
Monmouth County	Monmouth County	Manasquan River Greenway	185	63	0.83
Monmouth County	Monmouth County	Manasquan River Greenway	185	64	0.57
Monmouth County	Monmouth County	Manasquan River Greenway	185	64.01	0.29
Monmouth County	Monmouth County	Manasquan River Greenway	185	78	0.34
Monmouth County	Monmouth County	Manasquan River Greenway	185	79	7.46
Monmouth County	Monmouth County	Manasquan River Greenway	185	80	3.96
Monmouth County	Monmouth County	Manasquan River Greenway	185	84	0.92
Monmouth County	Monmouth County	Manasquan River Greenway	192	2.03	2.06
Monmouth County	Monmouth County	Metedeconk River Greenway	5	2.01	2.44
Monmouth County	Monmouth County	Metedeconk River Greenway	38	9	27.68
Monmouth County	Monmouth County	Metedeconk River Greenway	84.18	2.01	0.76
Monmouth County	Monmouth County	Metedeconk River Greenway	84.18	6.01	15.76
Monmouth County	Monmouth County	Metedeconk River Greenway	109	16	10.57
Monmouth County	Monmouth County	Metedeconk River Greenway	109	23.02	6.79
Monmouth County	Monmouth County	Metedeconk River Greenway	109	23.02	1.76
Monmouth County	Monmouth County	Metedeconk River Greenway	109	46	2.97
Monmouth County	Monmouth County	Metedeconk River Greenway	109	46.01	8.07
Monmouth County	Monmouth County	Yellow Brook Tract	177	13	7.88
Monmouth County	Monmouth County	Yellow Brook Tract	177	14	8.09
Monmouth County	Monmouth County	Yellow Brook Tract	177	15.01	49.42
Monmouth County	Monmouth County	Yellow Brook Tract	177	33	0.71
Monmouth County	Monmouth County	Yellow Brook Tract	177	34	0.19

Owner	Managed by	Property Name	Block	Lot	GIS acres
Monmouth County	Monmouth County	Yellow Brook Tract	177	36	5.88
Monmouth County	Monmouth County	Yellow Brook Tract	177	37	1.73
Monmouth County	Monmouth County	Yellow Brook Tract (Gombosi Tract)	177	48.01	0.19
Monmouth County	Monmouth County	Yellow Brook Tract (Gombosi Tract)	177	50	1.33
Monmouth County	Monmouth County	Yellow Brook Tract	177	119	0.49
Monmouth County	Monmouth County	Yellow Brook Tract	177	122	3.55
Monmouth County	Monmouth County	Yellow Brook Tract	177	124	0.09
Monmouth County	Monmouth County	Yellow Brook Tract	177	124	27.43
Monmouth County	Monmouth County	Yellow Brook Tract	177	125	0.28
Monmouth County	Monmouth County	Yellow Brook Tract	177	126	2.35
Monmouth County	Monmouth County	Yellow Brook Tract	177	135	45.28
Monmouth County	Monmouth County	Yellow Brook Tract	177	136	48.10
Monmouth County	Monmouth County	Yellow Brook Tract	177	139	53.24
Monmouth County	Monmouth County	Yellow Brook Tract	177	140	9.31
Monmouth County	Monmouth County	Yellow Brook Tract	177	141	6.04
Monmouth County	Monmouth County	Yellow Brook Tract	177	142	36.99
Monmouth County	Monmouth County	Yellow Brook Tract	177	143	31.32
Monmouth County	Monmouth County	Yellow Brook Tract	177	143.01	0.10
Monmouth County	Monmouth County	Yellow Brook Tract	177	145	30.32

State

Owner	Managed by	Property Name	Block	Lot	GIS acres
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	1	167.56
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	2	28.32
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	3	2.49
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	4	3.02
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	5	1.10
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	6	30.37
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	7	14.16
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	8	91.67
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	9	30.01
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	10	11.16
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	10.01	4.88
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	11	1.01
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	12	2.97
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	13	33.43
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	14	3.82
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	23.01	4.96
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	24	0.45
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	25	33.61
NJ DEP	NJ Parks & Forestry	Allaire State Park	47	27	66.81
NJ DEP	NJ Parks & Forestry	Allaire State Park	47.02	25	16.82
NJ DEP	NJ Parks & Forestry	Allaire State Park	47.02	27	16.98
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	4	3.85
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	5.01	3.86
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	6.01	0.58
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	7.02	2.19
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	8	29.56
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	9	64.33
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	10	215.03
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	11	7.89
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	12	24.49
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	13	33.11
NJ DEP	NJ Parks & Forestry	Allaire State Park	48	14	81.65
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	3	6.67
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	5.01	5.03

Owner	Managed by	Property Name	Block	Lot	GIS acres
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	11	1.07
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	12	1.01
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	13	0.61
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	14.01	26.90
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	15.01	2.56
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	16.01	4.46
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	17.01	8.31
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	18.02	4.54
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	18.03	6.19
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	18	3.56
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	19.01	2.38
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	19.02	2.58
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	20.01	8.20
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	21	13.16
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	22	12.35
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	48	39.37
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	49.01	7.32
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	50.01	13.43
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	51.01	5.89
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	53	0.72
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	53.01	3.15
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	54.01	0.11
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	55.01	0.49
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	56.01	2.09
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	57.02	2.25
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	57.03	4.93
NJ DEP	NJ Parks & Forestry	Allaire State Park	50	58	1.63
NJ DEP	NJ Parks & Forestry	Allaire State Park	50.01	1	7.83
NJ DEP	NJ Parks & Forestry	Allaire State Park	50.01	64.01	4.67
NJ DEP	NJ Parks & Forestry	Allaire State Park	50.01	65.01	0.60
NJ DEP	NJ Parks & Forestry	Allaire State Park	50.01	66	11.94
NJ DEP	NJ Parks & Forestry	Allaire State Park	50.01	70.03	3.14
NJ DEP	NJ Parks & Forestry	Allaire State Park	50.01	70.04	0.89
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	3	22.03
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	4	3.40
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	5	20.84
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	6	189.50
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	6.02	24.21
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	9	3.80
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	10	18.90
NJ DEP	NJ Parks & Forestry	Allaire State Park	223	11	19.05
NJ DEP	NJ Parks & Forestry	Allaire State Park	224	1.02	15.90
NJ DEP	NJ Parks & Forestry	Allaire State Park	970	17	0.77
NJ DEP	NJ Parks & Forestry	Allaire State Park	970	6	1.22
NJWSA = New Jersey water Supply Authority; NJDEP = New Jersey Department of Environmental Protection					
Sources: NJDA SADC, July 20, 2018; and NJ Geo-Web, 2020 Elizabeth Naskiewicz, Personal Communication, November 2020 Joan H. Osborne, Personal Communication, November 2020					

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Appendix F. Drinking Water Quality Report

Report begins on the next page.

2019 Annual

Water Quality Report

Coastal North System
PWS ID: NJ1345001

NEW JERSEY AMERICAN WATER

A Message from the New Jersey American Water President

To Our Valued Customers:

New Jersey American Water is proud to be your local water service provider, and we are committed to providing you with the highest quality water and service possible. As you read through our Annual Water Quality Report, you will see that we continue to supply water that meets or surpasses all state and federal water quality standards, with one notable exception. You may recall we notified customers in your area that water samples taken at our Jumping Brook Treatment Plant on September 2, 2019, showed an increased amount of turbidity, which was above the levels permitted by the DEP, in one portion of the treatment process for a short period of time. This turbidity exceedance was not an emergency, and none of our testing revealed contamination in the drinking water during this time.

While this error is disappointing, the good news is that our expert professionals acted quickly to stop the flow of water and remove the cause – a faulty sensor in the system. Thanks to the quick response, we were able to efficiently and effectively restore our system to normal.

We never forget that at the end of every water pipe there's a family depending on us to provide one of life's critical resources. New Jersey American Water has the expertise of more than 800 experienced professionals, the right technologies in use, and a demonstrated commitment to replacing and upgrading our infrastructure so that you can be assured that your drinking water is clean, safe and reliable.

Our team of experts monitors, maintains and upgrades our facilities so that they operate efficiently and meet all regulatory standards. This requires investing millions of dollars each year in our infrastructure, including treatment plants, tanks, pump stations, pipes, fire hydrants and metering equipment. We do this because we care about our customers as much as we care about water. Statewide, we invested more than $375 million in 2019 alone to improve our water treatment and delivery systems.

Additionally, in 2020, during the COVID-19 public health emergency, New Jersey American Water activated business continuity plans to strengthen our ability to provide reliable, high-quality service to our customers, continue to deliver water and wastewater services and protect our employees and customers. According to the U.S. Environmental Protection Agency (EPA) based on current research, the risk to water supplies is low. The U.S. EPA has also relayed that Americans can continue to use and drink water from their tap as usual.

New Jersey American Water remains committed to the delivery of safe, reliable water. That includes continued operation of drinking water treatment barriers, which provide an added layer of protection that includes filtration and disinfection of our surface water supplies (*e.g.*, those from lakes, reservoirs or rivers) and disinfection of our groundwater sources (*e.g.*, underground wells).

We have an exceptional track record when it comes to water quality and drinking water regulatory compliance. In fact, we take water quality so seriously that five of our surface water treatment plants have been nationally recognized with Directors Awards from the EPA's Partnership for Safe Water program for surpassing federal and state drinking water standards.

Please take the time to review this report. It provides details about the source and quality of your drinking water, using the data from water quality testing conducted for your local system between January and December 2019. If you have any questions, I encourage you to visit the Water Quality page of our website at www.newjerseyamwater.com, or call our Customer Service Center at 800-272-1325.

Sincerely,

Cheryl D. Norton

Cheryl Norton
President, New Jersey American Water

This report contains important information about your drinking water. If you do not understand it, please have someone translate it for you.

Este informe contiene información muy importante sobre su agua potable. Tradúzcalo o hable con alguien que lo entienda bien.

આ અહેવાલ માં તમારા પીવાના પાણી વિશે
અગત્ય ની માહિતી આપવા માં આવી છે.
એનો અનુવાદ કરો અથવા જેને સમજણ પડતી
હોય તેની સાથે વાત કરો

本报告与您的饮用水有关。
如果您不了解其内容，应请别人为您翻译解说。

이 보고서에는 귀하께서 사용하고 계시는 식수에 관한 정보가 들어있습니다.
만약에 이해를 못하시면 누군가에게 번역을 의뢰하십시오.

Share This Report:

Landlords, businesses, schools, hospitals and other groups are encouraged to share this important water quality information with water users at their location who are not customers. Additional copies of this report are available by contacting customer service at 1-800-272-1325.

Partnership for Safe Drinking Water Program

New Jersey American Water is a member of the Environmental Protection Agency (EPA) Partnership for Safe Water Program (an association of water utilities and government) which is committed to voluntarily providing drinking water of a quality far better than required by federal regulations. The Partnership recognized New Jersey American Water for our commitment to provide the best water quality by presenting the prestigious "Director's Award" for our surface water treatment plant in Tinton Falls (Monmouth County) and in Neptune (Monmouth County). These plants once again earned the "Director's Award" in 2018 under the Partnership for Safe Water program administered by the U.S. EPA, New Jersey Department of Environmental Protection, and other water related organizations. The award honors water utilities for achieving operational excellence, by voluntarily optimizing their treatment facility operations and adopting more stringent performance goals than those required by federal and state drinking water standards.

About New Jersey American Water

New Jersey American Water, a subsidiary of American Water Works Company (NYSE: AWK), is the largest investor-owned water utility in the state, providing high- quality and reliable water and/or wastewater services to approximately 2.7 million people. For more information, visit www.newjerseyamwater.com and follow New Jersey American Water on Twitter and Facebook.

About American Water

With a history dating back to 1886, American Water is the largest and most geographically diverse U.S. publicly traded water and wastewater utility company. The company employs more than 7,100 dedicated professionals who provide regulated and market-based drinking water, wastewater and other related services to an estimated 13 million people in 46 states and Ontario, Canada. American Water provides safe, clean, affordable and reliable water services to our customers to help keep their lives flowing. For more information, visit amwater.com *and follow American Water on* Twitter, Facebook *and* LinkedIn

Our Commitment to Quality

Once again, we proudly present our annual water quality report, which details the results of water quality testing completed from January to December, 2019. The purpose of this report is to raise your understanding of drinking water and awareness of the need to protect our drinking water sources. Included in this report are details about where your water comes from, what it contains, and how our water quality results compare to federal and state standards.

We are committed to delivering high quality drinking water. To that end, we remain vigilant in meeting the challenges of source water protection, water conservation, and community education while continuing to serve the needs of our water users.

We want you to be informed about your drinking water.

How to Contact Us

Thank you for allowing us to continue to provide your family with quality drinking water this year. We ask that all our customers protect our water sources. Please call our Customer Call Center toll-free at 1-800-272-1325 if you have questions:

New Jersey American Water
1 Water Street
Camden, NJ 08102
www.amwater.com/njaw

Water Information Sources

New Jersey Department of Environmental Protection,

Bureau of Safe Drinking Water:
(609) 292-5550 • www.state.nj.us/dep

New Jersey Board of Public Utilities:
(973) 648-2350 • Two Gateway Center,
Newark, NJ 07102

Division of Customer Relations:
1-800-624-0241 • www.state.nj.us/bpu

US Environmental Protection Agency:
www.epa.gov/safewater

Safe Drinking Water Hotline: 1-800-426-4791

American Water Works Association: www.awwa.org

Centers for Disease Control and Prevention: www.cdc.gov

Public Participation

How You Can Get Involved

Customers can participate in decisions that may affect the quality of water by:

- Reading the information provided in bill inserts and special mailings
- Contacting the company directly with questions or to discuss issues
- Responding to company requests for participation in focus groups and roundtables
- Attending open houses conducted by the company
- Responding to survey requests

Where Your Water Comes From

Your drinking water comes from a blend of sources that may include:

Coastal North System – PWSID # NJ1345001
Shrewsbury area of system-Groundwater from the Potomac-Raritan-Magothy Aquifer (PRM) and surface water from the Glendola Reservoir, the Manasquan River/Reservoir, the Shark River, and the Swimming River/Reservoir.

Lakewood/Howell area of system-14 wells, 1 surface water supply. This system's source water comes from the Englishtown aquifer, Kirkwood-Cohansey aquifer, Mount Laurel-Wenonah aquifer, Potomac-Raritan-Magothy aquifer, upper Potomac-Raritan-Magothy aquifer, and Vincentown aquifer.

Ocean County area of system-5 wells and 1 purchased ground water source. This system's source water comes from the Englishtown aquifer system, Potomac-Raritan-Magothy aquifer, and upper Potomac-Raritan-Magothy aquifer. Also, bulk transfer of surface water from Jumping Brook Treatment Plant.

Ortley Beach/Pelican Island area of the system- This system can purchase water from the Lavallette Water Dept., and Seaside Heights Water Department. Also, bulk transfer of surface water from Jumping Brook Treatment Plant.

Protecting Your Water Source

What is S.W.A.P.

The Source Water Assessment Program (SWAP) is a program of the New Jersey Department of Environmental Protection (NJDEP) to study existing and potential threats to the quality of public drinking water sources throughout the state. Sources are rated depending upon their contaminant susceptibility.

Susceptibility Ratings for New Jersey American Water — Coastal North

The table below illustrates the susceptibility ratings for the seven contaminant categories (and radon) for each source in the system. The table provides the number of wells and intakes that rated high (H), medium (M), or low (L) for each contaminant category. For susceptibility ratings of purchased water, refer to the specific water system's source water assessment report. Source Water Assessment Reports and Summaries are available for public water systems at www.state.nj.us/dep/swap/ or by contacting the NJDEP's Bureau of Safe Drinking Water at (609) 292-5550.

Contaminant Categories
The NJDEP considered all surface water highly susceptible to pathogens, therefore all intakes received a high rating for the pathogen category. For the purpose of the SWAP, radionuclides are more of a concern for ground water than surface water. As a result, surface water intakes' susceptibility to radionuclides was not determined and a low rating was assigned.

If a system is rated highly susceptible for a contaminant category, it does not mean a customer is or will be consuming contaminated drinking water. The rating reflects the potential for contamination of source water, not the existence of contamination. Public water systems are required to monitor for regulated contaminants and to install treatment if any contaminants are detected at frequencies and concentrations above allowable levels.

As a result of the assessments, NJDEP may customize (change existing) monitoring schedules based on the susceptibility ratings.

Source water protection is a long-term dedication to clean and safe drinking water. It is more cost effective to prevent contamination than to address contamination after the fact. Every member of the community has an important role in source water protection. NJDEP recommends controlling activities and development around drinking water sources whether it is through land acquisition, conservation easements or hazardous waste collection programs. We will continue to keep you informed of SWAP's progress and developments.

Susceptibility Chart Definitions

- **Pathogens:** Disease-causing organisms such as bacteria and viruses. Common sources are animal and human fecal wastes.
- **Nutrients:** Compounds, minerals and elements that aid growth, that are both naturally occurring and man-made. Examples include nitrogen and phosphorus.
- **Volatile Organic Compounds:** Man-made chemicals used as solvents, degreasers, and gasoline components. Examples include benzene, methyl tertiary butyl ether (MTBE), and vinyl chloride.
- **Pesticides:** Man-made chemicals used to control pests, weeds and fungus. Common sources include land application and manufacturing centers of pesticides. Examples include herbicides such as atrazine, and insecticides such as chlordane.
- **Inorganics:** Mineral-based compounds that are both naturally occurring and man-made. Examples include arsenic, asbestos, copper, lead, and nitrate.
- **Radionuclides:** Radioactive substances that are both naturally occurring and man-made. Examples include radium and uranium.
- **Radon:** Colorless, odorless, cancer-causing gas that occurs naturally in the environment. For more information go to http://www.nj.gov/dep/rpp/radon/index.htm or call (800) 648-0394.

- **Disinfection By-product Precursors:** A common source is naturally occurring organic matter in surface water. Disinfection by-products are formed when the disinfectants (usually chlorine) used to kill pathogens react with dissolved organic material (for example leaves) present in surface water.

		Pathogens			Nutrients			Pesticides			Volatile Organic Compounds			Inorganics			Radionuclides			Radon			Disinfection By-product Precursors		
	Sources	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Shrewsbury Area	Wells - 10			10			10			10			10		8	2		9	1			10		8	2
	GUDI - 0																								
	Surface water intakes - 5	5			1	4			2	3		5		3	2				5			5	5		
Lakewood Area	Wells - 14		1	13	4		10			14	4		10	4	6	4	1	6	7		5	9	1	13	
	GUDI- 0																								
	Surface water intakes - 1	1				1			1			1			1				1			1	1		
Ocean County	Wells - 5			5			5			5			5		4	1		3	2			5		5	
	GUDI - 0																								
	Surface water intakes - 0																								

Special Informational Statement for Lead

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. New Jersey American Water is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. We take steps to reduce the potential for lead to leach from your pipes into the water. This is accomplished by adding a corrosion inhibitor to the water leaving our treatment facilities. There are steps that you can take to reduce your household's exposure to lead in drinking water. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. For more information, please review our Lead and Drinking Water Fact Sheet https://amwater.com/njaw/water-quality/lead-and-drinking-water. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Unregulated Contaminant Monitoring Rule 4 (UCMR4)

New Jersey American Water participated in the Unregulated Contaminant Monitoring Rule. Unregulated contaminants are those for which the EPA has not established drinking water standards. The purpose of unregulated contaminant monitoring is to assist the EPA and NJDEP in determining the occurrence of unregulated contaminants in drinking water and whether regulation is warranted. Our results are available upon request. For testing conducted within our service area, the following substances were found.

What's in the Source Water Before We Treat It?

In general, the sources of drinking water (both tap and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and can pick up substances resulting from the presence of animals or from human activities.

Substances That May Be Present in Source Water Include:

Microbiological Contaminants: such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations or wildlife.

Inorganic Contaminants: such as salts and metals which can be naturally occurring or may result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.

Pesticides and Herbicides: which may come from a variety of sources such as agriculture, urban stormwater runoff and residential uses.

Organic Chemical Contaminants: including synthetic and volatile organic chemicals which are by-products of industrial processes and petroleum production, and may also come from gas stations, urban stormwater runoff and septic systems.

Radioactive Contaminants: which can be naturally occurring or may be the result of oil and gas production and mining activities.

For more information about contaminants and potential health effects, call the EPA's Safe Drinking Water Hotline at 1-800-426-4791.

What is Radon?

Radon is a radioactive gas that occurs naturally in some groundwater. It may pose a health risk when the gas is released from water into air, as occurs while showering, washing dishes and performing other household activities. Radon can move up through the ground and into a home through cracks in the foundation. Compared to radon entering the home through soil, radon entering through tap water is, in most cases, a small source of radon in indoor air. Inhalation of radon gas has been linked to lung cancer; however, the effects of radon ingested in drinking water are not yet clear. If you are concerned about radon in your home, tests are available to determine the total exposure level.

The EPA is developing regulations to reduce radon in drinking water. Radon in the air is inexpensive to test and easy to correct. For additional information, call the EPA's Radon Hotline at 1-800-SOS-RADON.

Do I Need to Take Special Precautions?

To ensure that tap water is safe to drink, the EPA prescribes regulations limiting the amount of certain contaminants in water provided by public water systems. U.S. Food and Drug Administration regulations establish limits for contaminants in bottled water, which must provide the same protection for public health.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline at 1-800-426-4791.

How Do I Read the Table of Detected Contaminants?

First, determine which table you should read by finding your town in the Towns Served by this System. Starting with the **Contaminant**, read across from left to right. A "**Yes**" under **Compliance Achieved** means the amount of the substance met government requirements. The column marked **MCLG, Maximum Contaminant Level Goal**, is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety. The shaded column marked **MCL**, **Maximum Contaminant Level**, is the highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology. The column marked **Range Detected** shows the highest and lowest test results for the year. The column marked **Highest Level Detected** shows the highest test results during the year. **Typical Source** shows where this substance usually originates. Compare the Range Detected values with the MCL column. To be in compliance, the Highest Level Detected must be lower than the MCL.

As you can see from the table, our system had no MCL violations again this year. The footnotes and the definitions below will help you interpret the data presented in the Table of Detected Contaminants.

Table Definitions

90th Percentile Value: Of the samples taken, 90 percent of the values of the results were below the level indicated in the table.

Action Level: The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

MRDL (Maximum Residual Disinfectant Level): The highest level of disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

MRDLG (Maximum Residual Disinfectant Level Goal): The level of drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.

NA: not applicable

NTU (Nephelometric Turbidity Units): Measurement of the clarity, or turbidity, of the water.

ND (None Detected): Laboratory analysis indicates that the constituent is not present.

ppb (parts per billion): Corresponds to one part substance in one billion parts of water.

ppm (parts per million): Corresponds to one part substance in one million parts of water.

pCi/L (picoCuries per Liter): A measure of the radioactivity in water.

RUL: Recommended Upper Limit

TT (Treatment Technique): A required process intended to reduce the level of a contaminant in drinking water.

Water Quality Statement

The data presented in the Table of Detected Contaminants is the same data collected to comply with EPA and New Jersey state monitoring and testing requirements. We have learned through our testing that some contaminants have been detected, however, these contaminants were detected well below the levels set by the EPA to protect public health. To assure high quality water, individual water samples are taken each year for chemical, physical and microbiological tests. Tests are done on water taken at the source, from the distribution system after treatment and, for lead and copper monitoring, from the customer's tap. Testing can pinpoint a potential problem so that preventative action may be taken. The Safe Drinking Water Act regulations allow monitoring waivers to reduce or eliminate the monitoring requirements for asbestos, volatile organic chemicals, and synthetic organic chemicals. Our system has received monitoring waivers for synthetic organic chemicals

Vulnerable Populations Statement

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/CDC (Center for Disease Control and Prevention) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial pathogens are available from the Safe Drinking Water Hotline (1-800-426-4791).

Coastal North System – PWS ID# NJ1345001
Table of Detected Contaminants – 2019

Towns Served by this system: Shrewsbury area of system-Aberdeen | Allenhurst | Asbury Park | Bradley Beach | Colts Neck in part | Deal | Eatontown | Elberon | Fair Haven | Highlands Borough | Holmdel | Interlaken | Little Silver | Loch Arbor | Long Branch | Middletown | Monmouth Beach | Neptune | Neptune City | Ocean Grove | Oceanport | Ocean Township | Red Bank | Rumson | Sea Bright | Shrewsbury Borough | Shrewsbury Township | Tinton Falls | Wanamassa | West Long Branch | Lakewood/Howell area of system-Freehold in part | Howell Township | Lakewood | Ocean County area of system-Bay Head | Brick Township in part | Dover in part | Lavallette in part | Mantoloking | Ortley Beach | Pelican Island

Those substances not listed in this table were not found in the treated water supply.

Regulated Substances [1]

Contaminant	Units	MCL	MCLG	Range Detected	Highest Level Detected	Compliance Achieved	Typical Source
Inorganic Chemicals							
Total Coliform	cfu	Coliform detected no more than 5% of monthly samples	0	NA	0.05 % [14]	Yes	Naturally present in environment
Fluoride [2]	ppm	2	2	ND to 0.71	0.71	Yes	Erosion of natural deposits; Water additive which promotes strong teeth
Nitrate	ppm	10	10	ND to 1.52	1.52	Yes	Runoff from fertilizer use; Industrial or domestic wastewater discharges; Erosion of natural deposits
Treatment By-Products Stage-2							
Contaminant	Units	MCL	MCLG	Range Detected	LRAA[3]	Compliance Achieved	Typical Source
Total Trihalomethanes [TTHMs Site DBP2-1	ppb	80	NA	20.8 to 84.3	48.25	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-2	ppb	80	NA	21.0 to 76.5	45.95	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-3	ppb	80	NA	32 to 84.4	54.90	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-4	ppb	80	NA	36.0 to 81	54.70	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-5	ppb	80	NA	22.0 to 68.4	45.50	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-6	ppb	80	NA	17.0 to 73.8	39.7	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-7	ppb	80	NA	21 to 82.1	47.38	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-8	ppb	80	NA	4.0 to 76.0	40.15	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-9	ppb	80	NA	35.5 to 81.2	54.28	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-10	ppb	80	NA	24.0 to 60.2	44.15	Yes	By-product of drinking water disinfection

Total Trihalomethanes [TTHMs] Site DBP2-11	ppb	80	NA	18.0 to 74.8	43.28	Yes	By-product of drinking water disinfection
Total Trihalomethanes [TTHMs] Site DBP2-12	ppb	80	NA	20.0 to 74.7	43.48	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-1	ppb	60	NA	9.0 to 10.8	9.63	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-2	ppb	60	NA	6.5 to 10.9	8.7	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-3	ppb	60	NA	5.0 to 8.1	5.33	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-4	ppb	60	NA	6.4 to 10	8.13	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-5	ppb	60	NA	10.4 to 48	22.38	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-6	ppb	60	NA	6.3 to 10.0	7.03	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-7	ppb	60	NA	7.3 to 13.4	10.4	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-8	ppb	60	NA	0 to 25.4	13.0	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-9	ppb	60	NA	5.8 to 9.7	8.05	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-10	ppb	60	NA	9.6 to 42.4	19.38	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-11	ppb	60	NA	7.2 to 10.0	8.53	Yes	By-product of drinking water disinfection
Total Haloacetic Acids [THAA5] Site DBP2-12	ppb	60	NA	6.6 to 10.8	8.85	Yes	By-product of drinking water disinfection
Contaminant	**Units**	**MCL**	**MCLG**	**Range Detected**	**Highest Level Detected**	**Compliance Achieved**	**Typical Source**
Turbidity [12]							
Turbidity 2019[18]	ntu	TT = 1 NTU	NA	0.01 to 2.0	2	Yes	Soil runoff
		TT = percent of Samples <0.3 ntu	NA	99.9%	NA		
Treatment By-products Precursor Removal							
Total Organic Carbon	%	TT > 35% to 45% Removal	NA	27.8 to 65.1	65.1	Yes	Naturally present in the environment
Ratio of actual / Required TOC removal	Ratio	TT: Running Annual Average > 1.0	NA	0.79 to 1.86	1.86	Yes	Naturally present in the environment
Disinfectants							
Chloramines	ppm	MRDL = 4	MRDLG = 4	0.15 to 2.89	1.48[4]	Yes	Water additive used to control microbes
Chlorite [10]	ppm	1	0.8	ND to 0.69	0.69	Yes	By-product of drinking water disinfection
Chlorine Dioxide [11]	ppb	MRDL = 800	MRDLG = 800	20 to 430	430	Yes	Water additive used to control microbes
Radiological Substances (2014-2019)							
Alpha Emitters [9]	pCi/L	15	0	ND to 14.9	14.9	Yes	Erosion of natural deposits
Combined Radium 226 and 228	pCi/L	5[5]	0	ND to 4.18	4.18	Yes	Erosion of natural deposits
Organics							
Carbon Tetrachloride[17] 2019	ppb	0	5	ND to 0.6	0.6	Yes	Discharge from chemical plants and Other industrial activities
Xylene-2018 [15]	ppm	10	N/A	ND to 0.0007	0.0007	Yes	Discharge from chemical plants and Other industrial activities
Styrene-2018[16]	ppb	100	0	ND to 0.5	0.5	Yes	Discharge from rubber plastic factory, leaching from landfills.
Tap water samples were collected for lead and copper analysis from homes in the service area							
Contaminant	**Units**	**Action Level**	**MCLG**	**Amount Detected (90^{th} %tile)**	**Homes Above Action Level**	**Compliance Achieved**	**Typical Source**
Copper 2019	ppm	1.3	1.3	0.14	none	Yes	Corrosion of household plumbing systems
Lead 2019	ppb	15	0	6	3	Yes	Corrosion of household plumbing systems

Secondary Contaminants (2017-2019)

Contaminant	Units	RUL	Amount Detected
Iron[6]	ppm	0.3	ND to 0.33[13]
Manganese[7]	ppm	0.05	ND to 0.045[13]
Sodium[8]	ppm	50	3.8 to 74.9[13]
Hardness	ppm	250	52 to 120[13]
Aluminum	ppm	0.05	ND to 0.15[13]

Unregulated Contaminant Monitoring[13]

Contaminant	Units	Range Detected	Highest Level Detected	Use or Environmental Source
Chlorate	ppb	ND to 760	760	Agricultural defoliant or desiccant; disinfection byproduct; and used in production of chlorine dioxide.
Hexavalant Chromium	ppb	ND to 0.53	0.53	Major sources of Hexavalent Chromium (Chromium-6) in drinking water are discharges from steel and pulp mills, and erosion of natural deposits of chromium-3. Hexavalent Chromium is not currently regulated as an individual substance. NJ American Water voluntarily performed this monitoring based on recommendations from USEPA. For more information on Hexavalent Chromium (Chromium-6), please visit our web site.
Total Chromium	ppb	ND to 1.4	1.4	Naturally - occurring element; used in making steel and other alloys; chromium -3 or -6 forms are used for chrome plating, dyes and pigments, leather tanning and wood preservation
Strontium	ppb	37.6 to 508.5	508.5	Naturally occurring element; commercial use of strontium has been in the faceplate glass of cathode-ray tube televisions to block x-ray emissions.
1,4-Dioxane	ppb	ND to 0.50	0.50	Used as a solvent in manufacturing and processing of paper, cotton, textile products, automotive coolant, cosmetics and shampoos.

Unregulated Contaminant Monitoring Rule 2018-2019					
New Jersey American Water participated in the Unregulated Contaminant Monitoring Rule. Unregulated contaminants are those for which the EPA has not established drinking water standards. The purpose of unregulated contaminant monitoring is to assist the EPA in determining the occurrence of unregulated contaminants in drinking water and whether regulation is warranted. For testing conducted in the Coastal North System, the following substances were found.[1]					
Contaminant	Unit	MRL	Highest Level Detected	Range Detected	Use or Environmental Source
Metals - List AM1					
Manganese	ppb	N/A	73	ND to 73	Naturally present in the environment; used in steel production, fertilizer, batteries and fireworks; drinking water and wastewater treatment chemical
Germanium	ppb	N/A	0.32	ND to 0.32	
Brominated Haloacetic Acid (HAA) Group – List AM 2					
HAA6Br Group					By-product of drinking water disinfection
Bromochloroacetic Acid	ppb	N/A	4.1	0.4 to 4.1	
Bromodichloroacetic Acid	ppb	N/A	3.6	ND to 3.6	
Dibromoacetic Acid	ppb	N/A	0.95	ND to 0.95	
Monobromoacetic Acid	ppb	N/A	0.55	ND to 0.55	
Tribromoacetic Acid	ppb	N/A	ND	ND	
Chlorodibromoacetic Acid	ppb	N/A	2.5	ND to 2.5	
HAA9 Group					By-product of drinking water disinfection

Bromochloroacetic Acid	ppb	N/A	4.1	0.4 to 4.1	
Bromodichloroacetic Acid	ppb	N/A	3.6	ND to 3.6	
Dibromoacetic Acid	ppb	N/A	0.95	ND to 0.95	
Monobromoacetic Acid	ppb	N/A	0.55	ND to 0.55	
Tribromoacetic Acid	ppb	N/A	ND	ND	
Chlorodibromoacetic Acid	ppb	N/A	2.5	ND to 2.5	
Dichloroacetic Acid	ppb	N/A	20	0.64 to 20	
Monochloroacetic Acid	ppb	N/A	ND	ND	
Trichloroacetic Acid	ppb	N/A	14	ND to 14	

Per- and Polyfluoroalkyl Substances

Per- or polyfluoroalkyl substances (PFAS) are man-made substances used in a variety of products, such as: stain resistant fabric, non-stick coatings, firefighting foam, paints, waxes, and cleaning products. They are also components in some industrial processes like electronics manufacturing and oil recovery. The New Jersey Department of Environmental Protection (NJDEP) has begun regulating some of these compounds, establishing a Maximum Contaminant Level for perfluorononanoic acid (PFNA) in 2019. While all other PFAS are not regulated, New Jersey American Water recognizes the importance of testing for these contaminants. Compounds detected are tabulated below, along with typical sources.

Perfulorinated Compounds 2020				
Parameter	Unit	Highest Level Detected	Range Detected	Typical Source
Perfluorooctanoic acid (PFOA)*	ppt	6.8	ND to 6.8	Used for its emulsifier and surfactant properties in or as fluoropolymers (such as Teflon) fire fighting foams, cleaners, cosmetics, lubricants, paints, polishes, adhesives and photographic films
*PFOA has a proposed MCL of 14 ppt				
Perfluorohexanoic Acid (PFHxA)	ppt	3.3	ND to 3.3	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluoropentanoic Acid (PFOS)**	ppt	3.7	ND to 3.7	Manmade chemical; used in products for stain, grease, heat and water resistance
**PFOS has a proposed MCL of 13 ppt				
Perfluorodecanoic Acid (PFDA)	ppt	ND	ND	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluorononanoic Acid (PFNA)	ppt	1.9	ND to 1.9	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluorododecanoic Acid (PFDoA)	ppt	ND	ND	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluorotetradecanoic Acid (PFTA)	ppt	ND	ND	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluorotridecanoic Acid (PFTrDA)	ppt	ND	ND	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluoroundecanoic Acid (PFUnA)	ppt	ND	ND	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluorohexanesulfonic Acid (PFHxS)	ppt	1.5	ND to 1.5	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluoroheptanoic Acid (PFHpA)	ppt	3.0	ND to 3.0	Manmade chemical; used in products for stain, grease, heat and water resistance
Perfluorobutanesulfonic Acid (PFBS)	ppt	10.1	ND to 10.1	Manmade chemical; used in products for stain, grease, heat and water resistance

[1] Under a waiver granted by the State of New Jersey Department of Environmental Protection, our system does not have to monitor for synthetic organic chemicals/pesticides because several years of testing have indicated that these substances do not occur in our source water. The SDWA regulations allow monitoring waivers to reduce or eliminate the monitoring requirements for volatile organic chemicals and synthetic organic chemicals. Our system received monitoring waivers for synthetic organic chemicals.

[2] Fluoride is added to the water (Shrewsbury and Ocean County areas of Coastal North System).

[3] Compliance is based on the Locational Running Annual Average (LRAA). Results in the table show the average of the 4 quarters of 2019.

[4] This level represents the highest annual quarterly Average calculated from the data collected.

[5] Radium 226 and Radium 228 have a combined MCL of 5 pCi/L.

[6] The recommended upper limit for iron is based on unpleasant taste of the water and staining of laundry. Iron is an essential nutrient, but some people who drink water with iron levels well above the recommended upper limit could develop deposits of iron in a number of organs of the body.

[7] The recommended upper limit for manganese is based on staining of laundry. Manganese is an essential nutrient, and toxicity is not expected from high levels which would be encountered in drinking water.

[8] For healthy individuals, the sodium intake from water is not important, because a much greater intake of sodium takes place from salt in the diet. However, sodium levels above the recommended upper limit may be of concern to individuals on a sodium restricted diet.

[9] Certain minerals are radioactive and may emit a form of radiation known as alpha radiation. Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.

[10] Some infants and young children who drink water containing chlorite in excess of the MRDL could experience nervous system effects. Similar effects may occur in fetuses of pregnant women who drink water containing chlorite in excess of the MCL. Some people may experience anemia.

[11] Some infants and young children who drink water containing chlorine dioxide in excess of the MRDL could experience nervous system effects. Similar effects may occur in fetuses of pregnant women who drink water containing chlorine dioxide in excess of the MRDL. Some people may experience anemia.

[12] Turbidity is a measure of the cloudiness of the water. 100% of the turbidity readings were below the treatment technique requirement of 0.3 ntu. We monitor it because it is a good indicator of the effectiveness of our filtration system.

[13] The state of New Jersey allows us to monitor for some substances less than once per year because the concentrations of these substances do not change frequently. Some of our data, though representative, is more than one year old.

[14] Maximum percentage of positive samples collected in any one month.

[15] Some people who drink water containing xylenes in excess of the MCL over many years could experience damage to their nervous system indicator of the effectiveness of our filtration system.

[16] Some people who drink water containing styrene in excess of the MCL over many years could have problems with their liver, kidneys, or circulatory system.

[17] Some people who drink water containing carbon tetrachloride in excess of the MCL over many years could experience problems with their liver and may have an increased risk of getting cancer.

[18] New Jersey American Water routinely monitors your water for turbidity (cloudiness). This tells us whether we are effectively filtering the water supply. Our water system did not comply with the filtration requirements, specifically, our turbidity exceeded 1 Nephelometric Turbidity Units (NTU) in representative samples of the Combined Filter Effluent (CFE) Water. The CFE is the water leaving all of the filters in the treatment plant. Normal turbidity levels at the Jumping Brook Treatment Plant are less than 0.3 turbidity units (NTU). Water samples taken on September 2, 2019 showed a turbidity level of 2.0 NTU from a portion of the water delivered from the plant. This was above the standard of 1 NTU. Because of these high levels of turbidity, there is an increased chance that the water may have contained disease-causing organisms.

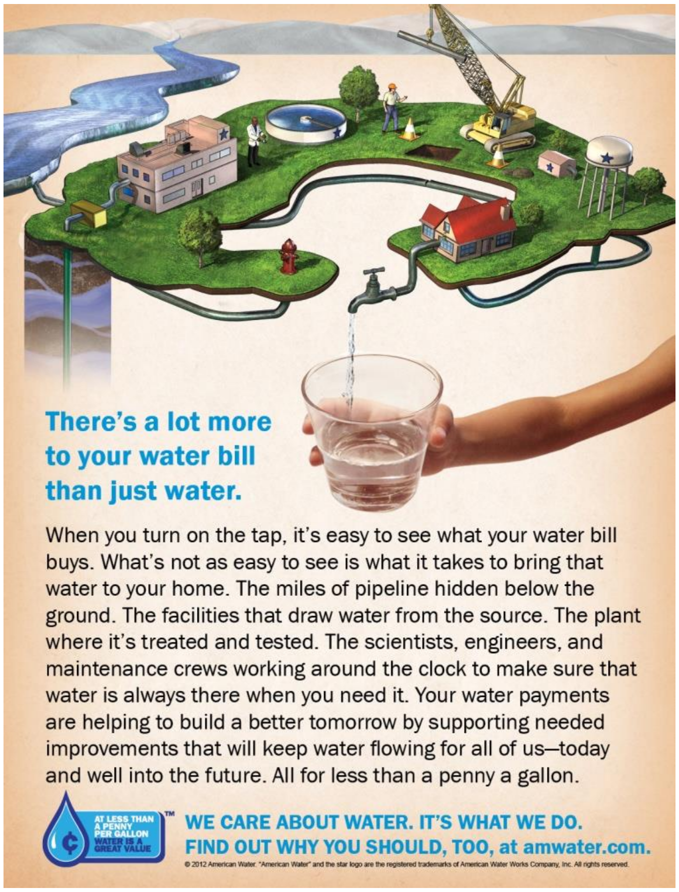
Our Water Research Efforts

Cryptosporidium is a protozoan found in surface water throughout the U.S. Although filtration removes *Cryptosporidium*, the most commonly used filtration methods cannot guarantee 100 percent removal. Ingestion of *Cryptosporidium* may cause cryptosporidiosis, an abdominal infection. Symptoms of infection include nausea, diarrhea, and abdominal cramps. Most healthy individuals can overcome the disease within a few weeks. However, people with severely weakened immune systems have a risk of developing a life threatening illness. We encourage such people to consult their doctors regarding appropriate precautions to take to avoid infection. *Cryptosporidium* must be ingested to cause disease. It can also be spread through means other than drinking water. For additional information regarding cryptosporidiosis and how it may impact those with weakened immune systems, please contact your personal health care provider.

The U.S. EPA issued a rule in January 2006 that requires systems with higher *Cryptosporidium* levels in their source water to provide additional treatment. To comply with this rule, New Jersey American Water once again began conducting 24 consecutive months of monitoring for *Cryptosporidium* in our raw water sources starting in in 2015. The monitoring to date indicates the presence of these organisms in the source water. The samples were collected from the source before the water was processed through our treatment plants. We continued monitoring until April 2017. The data collected is presented in the Source Water Monitoring table below.

Source Water Monitoring

Contaminant	Swimming River source water	Jumping Brook source water	Oak Glen source Water	
Cryptosporidium, Oocysts/L	ND – 0.100	ND	ND	Microbial pathogens found in surface waters throughout the United States.
Giardia, Cysts/L	0 – 0.558	0 – 0.089	0 – 0.558	



NJDEP Water Conservation Message…Because Remember, Every Drop Counts

6 SIMPLE STEPS TO SAVE WATER…BECAUSE REMEMBER, EVERY DROP COUNTS

Due to much lower than normal rainfall, New Jersey's water supply is dwindling. You can do your part to help avoid a drought emergency by taking these six simple steps to save water.

1. Don't let faucets run when brushing your teeth, shaving, or washing the dishes. Just turning off the water while you brush can save 200 gallons a month.
2. Run washing machines and dishwashers only when they are full, or select the properly sized wash cycle for the current laundry load.
3. Install water-saving showerheads and faucet aerators in the bathroom and kitchen (available at most home improvement stores and some supermarkets.)
4. Fix any leaking faucets –one drop every 2 seconds from a leaky faucet wastes 2 gallons of water every day – that's water – and money – down the drain.
5. Don't wash your car at home – a car wash uses much less water and recycles it, too.
6. With the end of the growing season, be sure to turn off automatic lawn and garden sprinkler systems.

EVERY DROP COUNTS

For more detailed information on how you can conserve water in and outside your home, visit njdrought.org.

Remember…every drop counts.