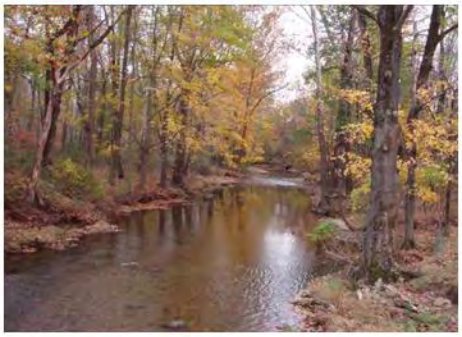
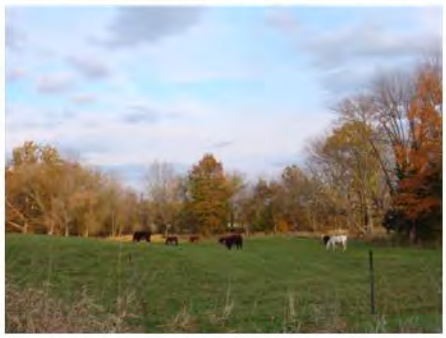
November 2009











Environmental Resource Inventory

for

Tewksbury Township

Hunterdon County, NJ

This plan was prepared with the assistance of a Smart Growth Planning Grant from the Association of New Jersey Environmental Commissions

Prepared for:
Tewksbury Township
Environmental Commission

Written by:
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"We should act like this is the only planet we have because it is." (Honachevsky, 2000)

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ENVIRONMENTAL RESOURCE INVENTORY

The Township of Tewksbury

Hunterdon County

New Jersey

Prepared By

Deborah J. Kratzer, Kratzer Environmental Services

For

The Tewksbury Township Environmental Commission

November 2009

This plan was prepared with the assistance of a Smart Growth Planning Grant from the Association of New Jersey Environmental Commissions anjec

ACKNOWLEDGMENTS

This report was authored by Deborah J. Kratzer. Funding for this report was provided by a grant from the Association of New Jersey Environmental Commissions and Tewksbury Township.

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6	89	Rockaway Creek at Potterstown Road	Deborah J. Kratzer
	94	A wetland in Tewksbury	Christopher J. Teasdale
7	114	A forest in Tewksbury	Christopher J. Teasdale
	119	Pileated woodpeckers in Tewksbury	Christopher J. Teasdale
	121	Eastern milk snake in Tewksbury	Christopher J. Teasdale
	121	White-tailed deer	Deborah J. Kratzer
	122	Black Bear in Tewksbury	Susan Prey
	123	Grey treefrog	Deborah J. Kratzer
	123	A vernal pool in Tewksbury	Christopher J. Teasdale
	137	Invasive barberry in Tewksbury	Christopher J. Teasdale
	137-140	Various invasive plants	Jan Samanek, Britton and Brown, Steve Dewey. Deborah J. Kratzer, James H. Miller, USDA PLANTS Database, Chuck Bargeron, Tom Heutte, Mohlenbrock , John D. Byrd, Jil M. Swearingen
8	146, 148, 154	Scenes of Tewksbury Open Space	Deborah J. Kratzer
9	159-160	Scenes of historic resources	Christopher J. Teasdale

Table of Contents

List of Figures

PREFACE

This Environmental Resource Inventory is a snapshot in time of the known and mapped elements of Tewksbury Township's environment in the first decade of the 21st Century. As both the environment and patterns of human habitation are dynamic, this snapshot represents a moment in time. Yet, it is also a living document. As you will see from the extensive resources at the end of each section, users of this information can go directly to the source material for the latest update at any time.

The Township's Environmental Commission members hope that this comprehensive document will serve several immediate purposes. First, we hope it will provide a massive and updated data set for the upcoming (and periodic) Master Plan revision. Second, we hope the Township officials will use the data to make informed decisions about whether our town will "opt in" the Planning Area of the township (as defined by the Highlands Water Protection and Planning Act, "Highlands Act", N.J.S.A. 13:20-1 et sec.) to be covered by the strong environmental aegis that applies to the resources in the Preservation Zone (which is 2/3rds of our town). Finally, we hope this document will help guide land use decisions by our town's boards and committees now and for the foreseeable future.

We hope you will agree that this is an extraordinary document. Let us know if you find it useful, and let us know what you would like to see added in future updates.

Christopher J. Teasdale
Chair, Tewksbury Township Environmental Commission

1: INTRODUCTION

A. Ecologically Based Planning

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 Tewksbury Township, both affecting and being affected by many physical and biological factors. Even in Tewksbury, with a relatively low human density of 180 people per square mile (Hunterdon County website, 2002 population estimate), the cumulative effects of many individual decisions have the potential to alter the environment in ways that cause harm directly to human health, and indirectly through complex environmental functions.

William Honachefsky, in his book Ecologically Based Municipal Land Use Planning, states,

> "The scientific community needs to articulate more clearly for local decision makers the underlying ecological processes and the consequences resulting from interference or truncation of those processes." (Honachefsky, 2000, p. 32)

Assembling an inventory of the township's ecological 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 land planners create an ecologically healthy community.

B. Goal of the Environmental Resource Inventory

The goal of the *Environmental Resource Inventory (ERI)* is to provide a reference and planning tool containing resource information, data and maps that can be used as part of the Master Plan, as a reference when reviewing development proposals, and as a guide in other township activities in order to better protect the township's natural resources and the overall health and welfare of the community.

The Municipal Land Use Law requires municipalities' Master Plans to have a land use plan including, but not necessarily limited to, topography, soil conditions, water supply, flood plains, wetlands, and woodlands (Municipal Land Use Law, 2002).

The Environmental Commission Enabling Legislation gives environmental commissions the authority to conduct such research for inclusion in the Master Plan, and then to use this information to help evaluate development applications.

The Association of New Jersey Environmental Commissions (ANJEC) defines "Environmental Resource Inventory" in its Resource Paper, The Environmental Resource Inventory: ERI, as follows:

> "The Environmental Resource Inventory (ERI), also called Natural Resource Inventory (NRI), or Index of Natural Resources, is a compilation of text and visual information about the natural resource characteristics and environmental features of an area. An ERI is an unbiased report of integrated data. It provides baseline documentation for measuring and evaluating resource protection issues. The ERI is an objective listing, rather than an interpretation or recommendation. Identifying significant environmental resources is the first step in their protection and preservation." (ANJEC, no date)

The ERI will principally be used by the Land Use Board and Environmental Commission, but will provide valuable information to anyone interested in the natural resources of Tewksbury Township. Ideally, landowners considering subdivision and development will become familiar with the environmental concerns specific to their property, and thereby have the ability to make resource-sensitive development decisions. Even when subdivision is not an issue, residents may learn to appreciate and maintain our valuable natural resources. Areas of specific concern may emerge which require additional protection strategies, such as further research and monitoring, public outreach and education, habitat restoration, easements, volunteer projects, and/or revised or new ordinances.

C. Methods

Funding for this project was obtained through a grant from the Association of New Jersey Environmental Commissions (ANJEC), with 50% cost share provided by Tewksbury Township.

An inventory of what is currently known about the physical and biotic environment and the human influence on the environment of Tewksbury Township has been compiled for this document. Information sources include the 2003 Master Plan, the 2003 Groundwater Resources Study and others. The most current GIS data has been obtained from the New Jersey Department of Environmental Protection GIS Data Web Site and other sources (see **Appendix A** and **Appendix B)**.

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 Tewksbury Township Environmental Commission. The public can also use GIS data by using either the New Jersey Department of Environmental Protection's i-MapNJ website or obtain relevant data layers (most are free on the internet), and download the free software, ArcExplorer (see **Internet Resources**, at end of section) to view the data.

A Geographic Information System (GIS) is computerized mapping which combines layers of information about a place to provide a better understanding of that place.

When viewing the digital document (as opposed to a printed copy) maps in PDF[1], 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[2].

References and related Internet resources 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 the first part of the address. If that works, you may be able to search for the type of information you want. For example, if you click on http://www.state.nj.us/dep/gis/downloadintra.html and the site no longer exists, try http://www.state.nj.us/dep/gis/; if that doesn't work, try http://www.state.nj.us/dep/.

[1] PDF stands for "Portable Document Format," a digital format which allows the document to appear the same to everyone, requiring only the download of the free Adobe® Reader® at http://www.adobe.com/products/acrobat/readstep2.html.

[2] A few maps are so large in this format that they are included as a simple graphic in the report, but are available separately in PDF.

D. Limitations of the ERI

It should be noted that the ERI is not intended to produce original research and is not meant to replace the primary data sources upon which it is based. Details about each data layer, including the date, scale and methods of developing the data, are 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 1:60,000 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 $\pm$ 40 feet). Data mapped at 1:100,000, such as the geology data layer, have an accuracy of $\pm$ 166.7 feet (Garie, 1998).

Sometimes mapped features don't line up exactly, 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 from NJDEP and Hunterdon County are used with permission (see the Terms of Agreement in **Appendix A**), with the required "disclaimer" printed on each map which uses their data: "This map was developed using [NJDEP and/or Hunterdon County] GIS digital data, but this secondary product has not been verified by [NJDEP or Hunterdon County] and is not [NJDEP- or county-] authorized."

Some components of the environment may have been studied or presented in detail, while other important factors may have been minimally addressed. When new or updated information becomes available, or new issues emerge, *updates should be appended to the ERI*.

Following the guidelines provided by ANJEC, management recommendations are not included in the ERI.

E. General Description of Tewksbury Township

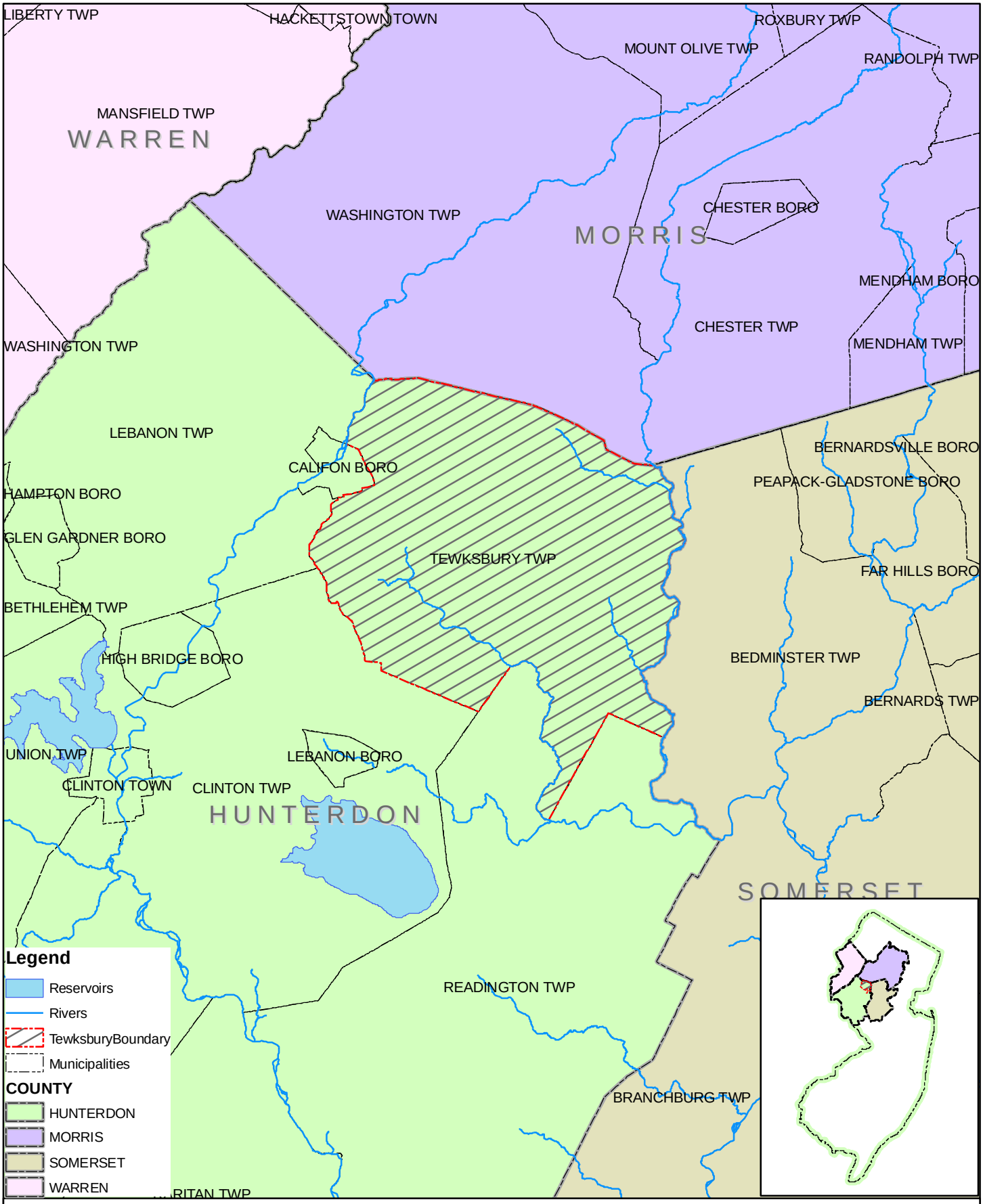
Tewksbury Township is located in the northeastern corner of Hunterdon County, NJ (see **Figure 1a**) and borders on both Morris and Somerset Counties. It was established from a portion of Lebanon Township in 1755 (Hunterdon County website, 2007). Tewksbury Township encompasses 31.8 square miles (20,352 acres) with a population of 5,541 living in 2,052 housing units (2000 census).

Tewksbury contains a wealth of natural and historic resources and has preserved some farmland and open space, funded by a portion of the local tax assessment and other sources.

The township is predominantly a rural municipality (see **Table 1**), relying largely on individual water supply wells and on-site septic systems, with some areas served by public water and sewer. **Figure 1b**

Table 1: Land Use Type Relative Area in Tewksbury

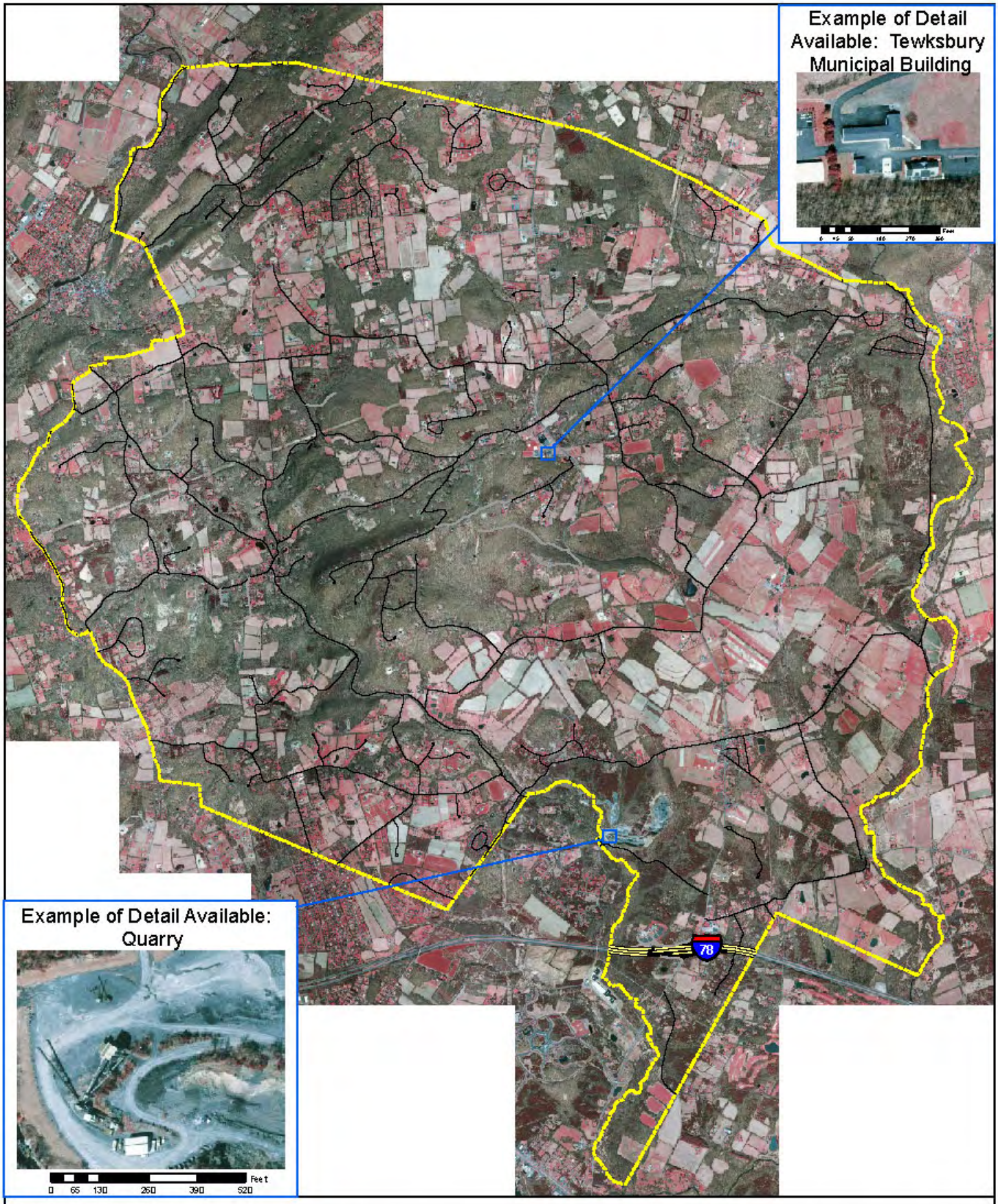
Land Use Type	2002 Percentage
Agriculture	27
Barren Land	Less than 1
Forest	50
Residential/Urban	19
Water	Less than 1
Wetlands	4
Source: NJDEP, 2007 (GIS data 2002 Land use/Land Cover); see USGS 2007 for definitions of land uses	



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 1a: Location of Tewksbury Township

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 1b: 2002 Aerial Photos

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

shows aerial photographs of Tewksbury and the surrounding areas taken in 2002[3]. To provide an overview of the township, **Figure 1c** displays named places, roads and tax parcels, while **Figure 1d** shows parcels grouped by block.

NJDEP used aerial photographs taken in 2002 to determine land use, shown in **Figure 1e**. The map does not show changes that have occurred since the aerial photos were taken in 2002, nor does it reflect any anticipated changes due to approved subdivisions. Detailed categories of land use/land cover are shown in **Section 7 (Figures 7a and 7b)** of this report.

Despite the township's pastoral atmosphere, it is influenced by the same variety of environmental issues confronting the region as a whole. Suburban sprawl results in ecological impacts such as further loss of farmland, forests, wetlands, habitat and an increase in impervious surfaces, erosion, pollution, human/wildlife conflicts, light pollution and the local eradication of species. For example, when fields are allowed to lay fallow, aggressive exotic vegetation, such as multiflora rose, and excessive browsing by deer prevent the normal succession to forest growth. Tewksbury Township also contains several point sources of pollution, such as the Cleveland Industrial Site and potential nonpoint sources of pollution, such as storm drains, farms and lawns. In addition, Tewksbury's geology supports a limited water supply that is vulnerable to quantity and quality degradation. These environmental concerns are addressed in detail in the following chapters.

[3] For the aerial photography, much more detail can be seen when the data is viewed at a larger scale than that used in this report (the 2002 data has pixels of 1 square foot; the 1995 data, in contrast, has pixels of 1 square meter). Inset pictures show examples of what level of detail is available.

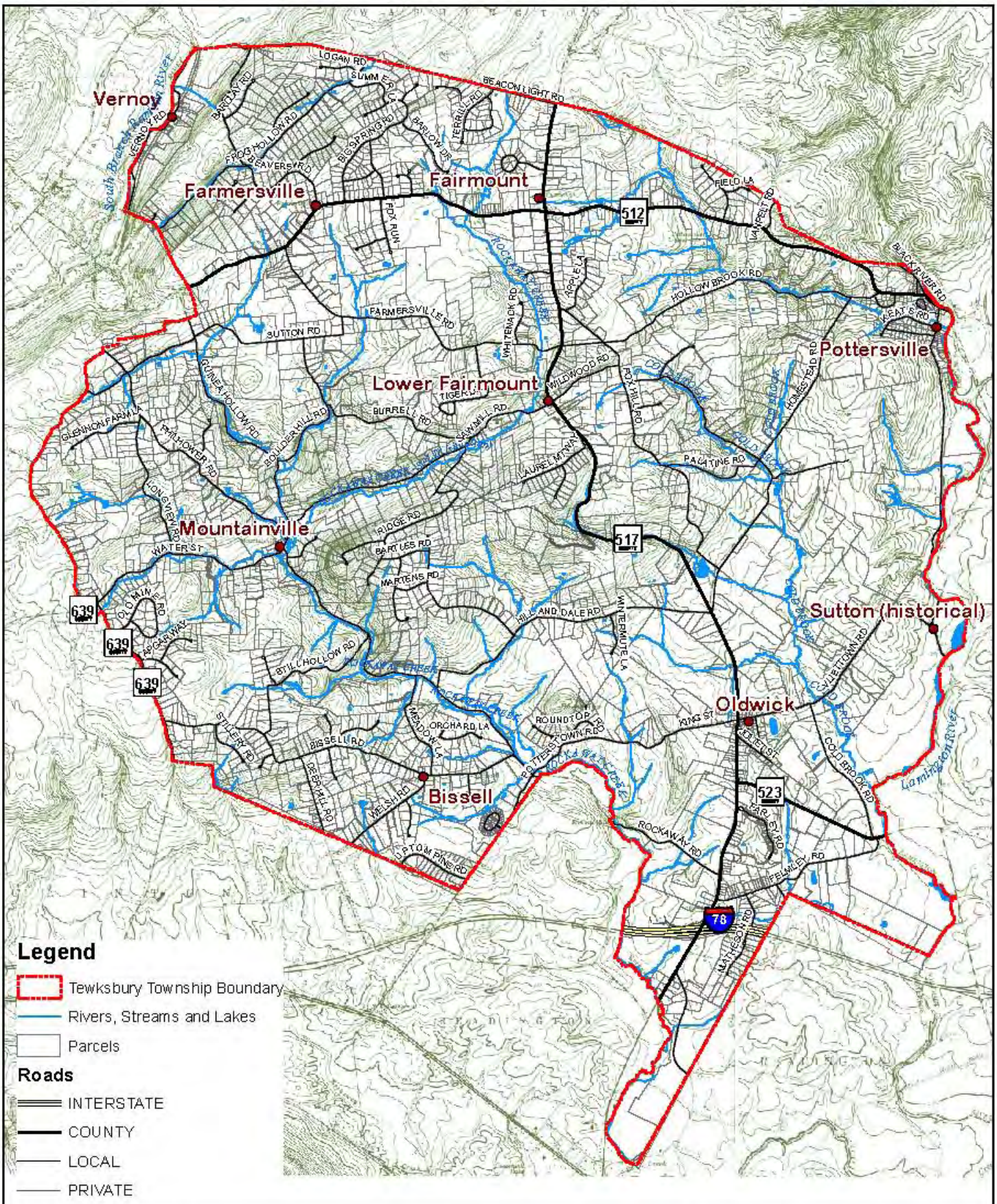
Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 1c: 2007 Aerial Photos

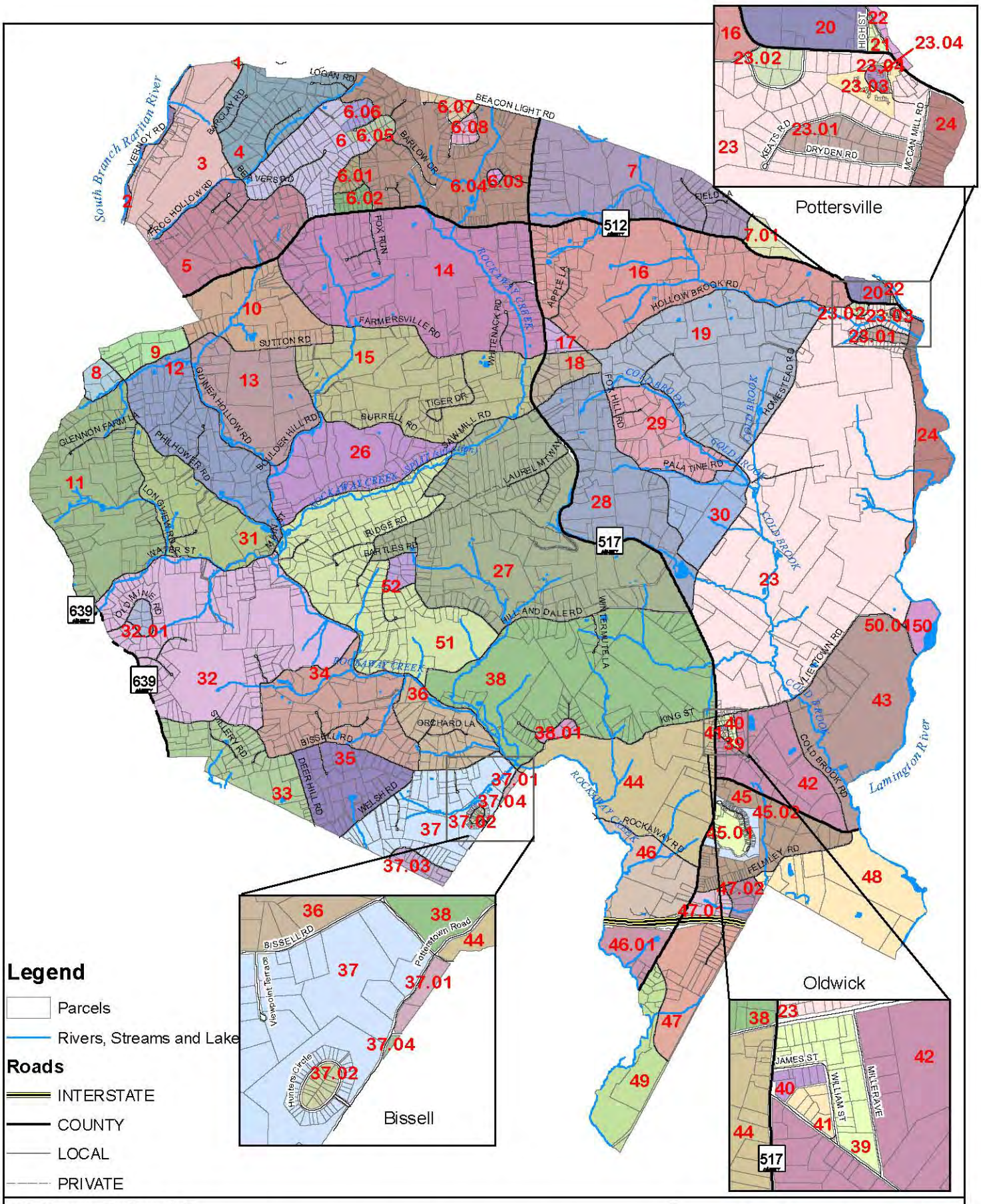
Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 1d: Named Places & Roads on Topographic Images

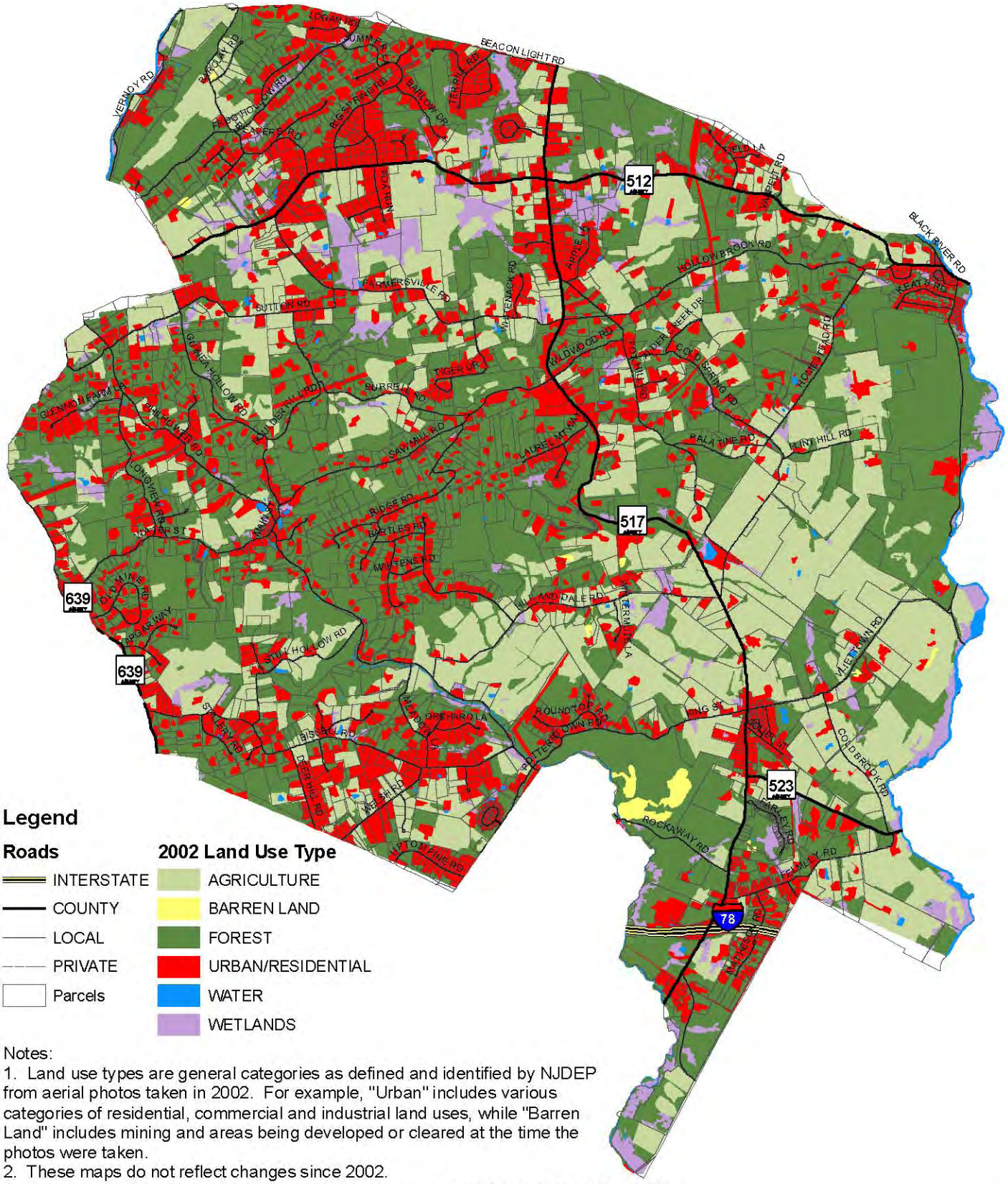
Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 1e: Parcels Grouped by Block

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services



Legend

Roads

- INTERSTATE
- COUNTY
- LOCAL
- PRIVATE
- Parcels

2002 Land Use Type

- AGRICULTURE
- BARREN LAND
- FOREST
- URBAN/RESIDENTIAL
- WATER
- WETLANDS

Notes:

1. Land use types are general categories as defined and identified by NJDEP from aerial photos taken in 2002. For example, "Urban" includes various categories of residential, commercial and industrial land uses, while "Barren Land" includes mining and areas being developed or cleared at the time the photos were taken.
2. These maps do not reflect changes since 2002.
3. Types are broken down into more specific land cover categories in Figures 7a and 7b.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 1f: Land Use Type from 2002 Aerial Photos

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services

References: Introduction

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Internet Resources: Introduction

Environmental Education

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

Free GIS Software

ArcExplorer (free GIS software): http://www.esri.com/software/arcexplorer/index.html

GIS Maps for New Jersey on the Internet

i-MapNJ (an on-line environmental mapping tool):
http://www.state.nj.us/dep/gis/newmapping.htm

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: http://www.state.nj.us/dep/gis/index.html
Download GIS data: http://www.state.nj.us/dep/gis/downloadintra.html
NJ Geographic Information Network: https://njgin.state.nj.us/NJ_NJGINExplorer/index.jsp

Hunterdon County's Official Home Page: http://www.co.hunterdon.nj.us/

Tewksbury Township's Official Home Page: http://www.tewksburytwp.net/

2: LOCAL & REGIONAL CONDITIONS

A. Climate & Meteorology

Climate

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 Office of the New Jersey State Climatologist (ONJSC) divides New Jersey into five distinct climate regions. Tewksbury resides in the *Northern Zone*, grouped with the Valley and Ridge, Highlands and part of the Piedmont physiographic provinces (see **Section 2C** for descriptions of physiographic provinces). Since this region is surrounded by land, it can be characterized as having a continental type of climate with minimal influence from the Atlantic Ocean, except when the winds come from the east. 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, 2008).

Climate varies naturally over long periods of time. Climatologists believe that recent changes in climate are the result of human activities, and are attempting to predict the effects and magnitude of future trends. The NJ State Climatologist compiled data for 19 weather stations within New Jersey and created time-series graphs of many variables (e.g. min. and max. temperature, precipitation) for the NJ Climate Report Card (Robinson, 2005). The weather stations nearest to Tewksbury that were evaluated for this climate study were Flemington and Somerville, which have been monitored since 1879 and 1880, respectively (Hartman, 2002).

Precipitation and Temperature

As the prevailing westerlies 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 New Jersey Weather and Climate Network maintains weather stations, which transmit real-time data and weather forecasts on the Internet. Of these stations, Teetertown (Hunterdon County) and Chester (Morris County) are nearest to Tewksbury Township. However, historical data are not available for these sites. The nearest weather station with historical data available for precipitation and snow is in Pottersville (Somerset County); and for temperature, precipitation and snow is in Flemington. **Table 2.1** displays monthly average highs and lows and mean temperature, average monthly precipitation, and record highs and lows (and the year it occurred in parentheses).

Measurable precipitation falls in this area on approximately 116 to 120 days per year. In Flemington, annual precipitation has averaged 46.24 inches (for the period 1898-2007), while the Pottersville area is wetter, averaging 52.77 inches (for the period 1968-2007) (see **Table 2.1**).

Rainfall is distributed fairly evenly throughout the year, with February being the driest month. On average, June and July have the most precipitation, but appear drier because evapotranspiration exceeds precipitation (ONJSC, 2008). During the warm season, thunderstorms (which often occur in the evening) are responsible for most of the rainfall. About twice as many thunderstorms occur here as in the coastal zone, where the nearby ocean helps stabilize the atmosphere. Record rainfalls are more likely to occur in the fall, due to tropical storms (see **Table 2.2**).

An average of 31.8 inches of snow falls annually measured at the Flemington station and 26.3 inches at Pottersville (about 10" of snow equals 1" of rain). Each winter, about 11 to 12

days receive snowfall greater than or equal to 0.5" in Tewksbury Township. Days with snowfall greater than 4" occur only about twice per winter in this area (ONJSC, 2008). Measured in Pottersville, the earliest snow on record was on October 28 (in 2008, with 2.5"; previous record was Nov. 12, in 1968, with 2"), and the latest was April 23 (in 1986, with 4") (ONJSC, 2008).

Hunterdon County has a growing season of about 167 days. The average date for the last killing spring frost is April 29th (in one year out of 10, the last freeze may be May 9 or earlier). The first frost in fall is around October 13th (in one year out of 10, the first frost may be October 2 or earlier) (Jablonski, 1974). The exact dates vary within the county as well as from one year to another.

During the winter, temperatures are not generally cold enough to keep the soil frozen for the whole winter. Winter rains are frequently warm enough to thaw the soil. Heavy rain on partly thawed soils is very erosive.

Table 2.1: Temperature & Precipitation at Flemington and Pottersville, NJ

Month	Flemington						Pottersville
	Based on data from 1898-2008				Based on data from 1926-2000		Based on data from 1968-2008
	Temperature			Mean Precip.	Temperature		Mean Precip.
	Avg. High	Avg. Low	Mean		Record High	Record Low	
January	38.6°F	20.3°F	29.5°F	3.60 in.	74°F (1932&1950)	-18°F (1984)	3.94 in.
February	40.4°F	20.6°F	30.5°F	3.10 in.	77°F (1930)	-16°F (1934)	2.97 in.
March	50.6°F	28.8°F	39.7°F	3.94 in.	88°F (1998)	-6°F (1984)	4.08 in.
April	62.5°F	37.8°F	50.1°F	3.89 in.	94°F (1976)	14°F (1969)	4.58 in.
May	73.3°F	47.6°F	60.5°F	3.94 in.	99°F (1939)	25°F (1966)	4.89 in.
June	81.7°F	57.1°F	69.4°F	4.05 in.	102°F (1934)	34°F (1978)	5.12 in.
July	86.5°F	62.5°F	74.5°F	4.75 in.	106°F (1936)	41°F (1957)	5.11 in.
August	84.2°F	60.7°F	72.5°F	4.45 in.	104°F (1955)	37°F (1965)	4.41 in.
September	77.8°F	53.6°F	65.7°F	3.94 in.	105°F (1953)	27°F (1963)	4.91 in.
October	66.8°F	42.1°F	54.5°F	3.65 in.	97°F (1941)	18°F (1952)	4.37 in.
November	53.9°F	33.0°F	43.5°F	3.50 in.	84°F (1950)	2°F (1938)	4.41 in.
December	41.8°F	24.0°F	32.9°F	3.82 in.	75°F (1984)	-14°F (1948)	4.18 in.
Average Annual Precipitation:				46.37 in.			53.28 in.
Source: ONJSC, May 2009 and 1968-2000							

Extreme Weather

During the warm season, thunderstorms are responsible for most of the rainfall. Most areas receive 25 to 30 thunderstorms per year. In addition, each year between 1 and 10 nor'easters bring strong winds and heavy rains to the state. Approximately five tornadoes appear each year in New Jersey (usually relatively weak ones). Between 1973 and 2007, a total of 7 tornadoes were reported in Hunterdon County. Hail is not frequent, but can be destructive. On July 18, 2006, 1.25" hail fell in Califon Borough and Tewksbury Township, while on August 17, 2003, 1.75" hail tore down wires and trees in Tewksbury (NOAA, 2009).

Table 2.2 lists some of the highest snow and rainfall received in one day (although multiple day storms can have higher totals), for the period 1968 to 2000 (the most recent data available on the Internet).

Tropical storms and hurricanes can contribute significant rainfall and can cause flooding. Tewksbury's topography is higher than most of the surrounding areas, and thus serves as the headwaters zone for several streams feeding the Raritan River. Some storms which have affected Tewksbury are described here. Hurricane Floyd battered New Jersey on September 16, 1999 and brought with it record breaking amounts of rain and damaging winds. Storm totals of 7.1 inches of rain were recorded in Pottersville (higher in some areas), resulting in the worst flooding of the Raritan basin on record, exceeding previous records set during Tropical Storm Doria on August 28, 1971. A nor'easter that brought 3.95 inches of rain to Tewksbury, and up to

7.25 inches elsewhere, caused widespread flooding on April 15-16, 2007. It caused the worst flooding in the Raritan Basin since Floyd, and, combined with high winds, was the second-worst rainstorm (not related to a hurricane) in the state's history. On June 28, 2006, several days of heavy rains culminated in flooding on the South Branch of the Raritan River at Stanton and High Bridge. Heavy rains on Oct 12, 2005 caused flooding on the South Branch of the Raritan at Stanton; this contributed to October 2005 being recorded as the wettest month in New Jersey since record keeping began in 1895, with a statewide average of 11.91 inches of precipitation. On September 24, 2004, the remnants of Hurricane Jeanne dropped over 4 inches of rain on the area, resulting in flooding of the South Branch of the Raritan at Stanton. A series of thunderstorms on July 27, 2004 resulted in flooding of the South Branch Raritan at Stanton. Heavy thunderstorms between August 12 and 14, 2000 (which in some areas totaled 15") caused widespread flooding, including, in Tewksbury, the Rockaway Creek, as well as the South Branch of the Raritan. The 3rd highest rainfall on record at Pottersville occurred on October 19, 1996, resulting in flooding of the South Branch at both High Bridge and Stanton gaging stations (ONJSC, 1968-2000 and NOAA, 2009).

Table 2.2: Highest Daily Precipitation Measured at Pottersville, NJ

Rank	Greatest one-day snowfall		Greatest one-day rainfall	
	Amount	Date	Amount	Date
1st	22.0 in.	Jan. 1996	7.10 in.	Sept. 1999
2nd	15.0 in.	Feb. 1983	6.86 in.	Aug. 1971
3rd	13.5 in.	Feb. 1979	6.08 in.	Oct. 1996
4th	12.0 in.	Jan. 1978	5.31 in.	June 1972
5th	12.0 in.	Feb. 1995	4.54 in.	July 1984
Source: ONJSC, 1968-2000				

River gage height and forecasts are available in real-time on the internet from USGS and NOAA(see **Internet Resources**).

At the other extreme, extended periods of time with less than normal amounts of precipitation result in drought; agriculture suffers, wells can fail and water supplies can be threatened.

NJDEP provides information about droughts according to Drought Region, using indicators of 90-day precipitation, 90-day stream flow, reservoir levels and ground water levels for each region. Tewksbury Township lies within the Central Drought Region (see **Figure 2a**).

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.

Significant droughts in recent years included 1997-1999 and 2001-2002. A drought spanning September 1997 through September 1999 included a "snow drought" – one of the least snowy seasons on record. This drought was ended by Tropical Storm Floyd. Another year-long drought occurred between October 2001 and November 2002, when drought was ended by a series of nor'easters that resulted in a wetter than normal November. The drought of record for the region, however, is considered 1963-1965, when three consecutive years included 3 of the 4 driest years since record-keeping began in 1895 (NOAA, 2009).

Table 2.3: Lowest Annual Precipitation*

Rank	Year	Amount (inches)	Deviation from Mean
1st	1965	30.46	-19.33
2nd	1963	33.95	-15.84
3rd	1930	34.60	-15.19
4th	1964	34.65	-15.14
5th	1895	35.22	-14.57
*Average of 10 stations in northern NJ from 1895-2008; with a mean of 46.32 inches annually. ONJSC, 2009			

B. 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, 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*, (ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter, and lead). 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 in New Jersey. The state is now in compliance with all NAAQS, except for ozone. New Jersey Department of Environmental Protection (NJDEP) developed the Air Quality Index (AQI) to provide a descriptive rating and a color code (e.g. green=good) in real-time on the internet for many sites. The site closest to Tewksbury is located in Chester (Morris County), and is monitored for nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and meteorological conditions. Flemington is the closest site within the same air monitoring region, the Northern Delaware Valley Region, which includes Hunterdon, Sussex, and Warren Counties. Flemington is currently monitored for ozone (O_3), smoke shade (an indirect measure of particulate pollution) and meteorological conditions (see **Figure 2a**). The Phillipsburg station is also relevant to Tewksbury, and is manually monitored for particulates ($PM_{2.5}$).

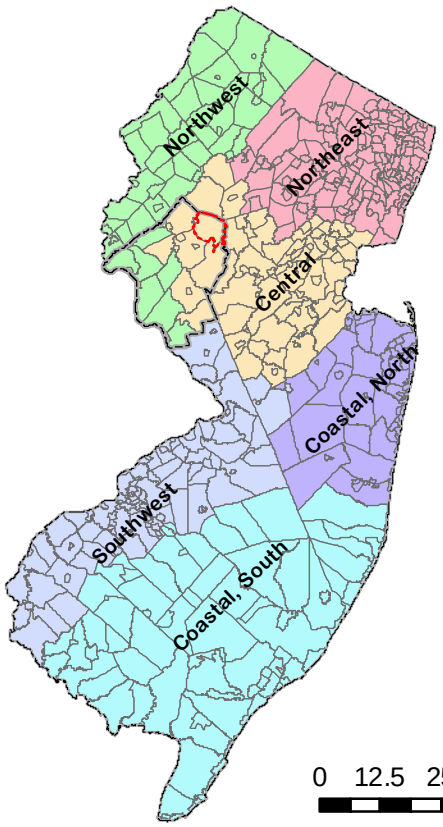
In Tewksbury, the Oldwick Materials, Inc. quarry, owned by Stavola Construction Materials Co., Inc., has had violations of air emissions permits (NJDEP, 2007).

The following summaries for ground-level ozone, particulates, air toxics and atmospheric deposition are summarized from either the 2004 Air Quality Report or the 2005 Air Quality Report (not all sections of the 2005 report are available at the time of this writing) published by the NJDEP Bureau of Air Monitoring (NJDEP Bureau of Air Monitoring web site).

Ground-level Ozone

Ground-level ozone 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

Drought Regions of New Jersey

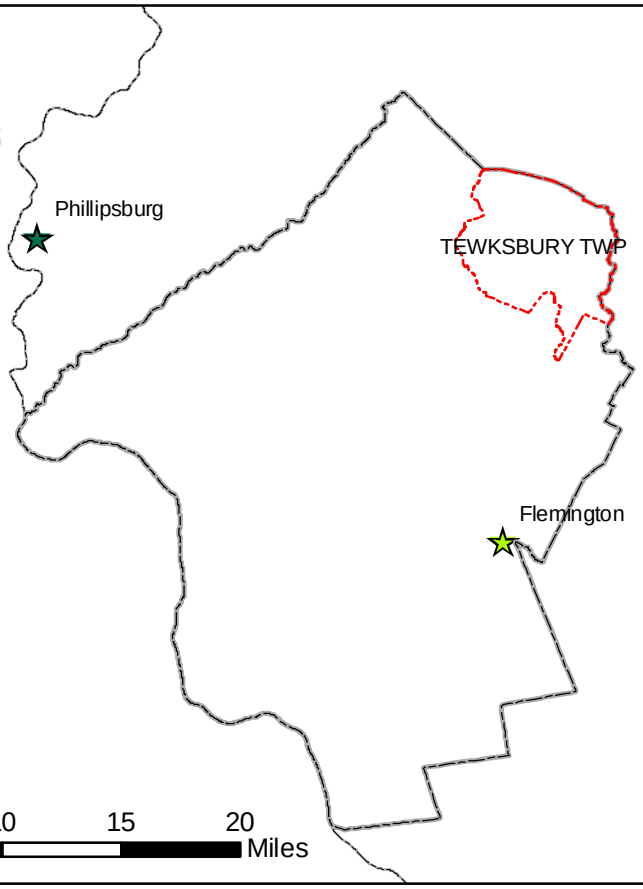


Legend

- TewksburyBoundary
- Hunterdon County Boundary
- New Jersey Boundary

0 12.5 25 50 75 100 Miles

Air Quality Monitoring Sites Near Tewksbury



Legend

- TewksburyBoundary
- Hunterdon County Boundary
- New Jersey Boundary

Site Name

- Chester
- Flemington
- Phillipsburg

0 2.5 5 10 15 20 Miles

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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Figure 2a: Drought Regions & Air Quality Monitoring Sites

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

hottest days of summer can yield unhealthy levels of ozone. Ozone is monitored at both the Chester and Flemington air quality stations.

Table 2.4 presents a summary of the number of days the ozone standards were exceeded per year at both the Chester and Flemington stations. The 1-hour ozone standard is an average of 0.12 parts per million (ppm), and the 8-hour ozone standard (that became effective in 1997) is an average of 0.08 parts per million (ppm). According to preliminary data for 2005, there were no exceedances of the 1-hour standard in 2005. However, the 8-hour ozone standard was exceeded 3 times in Chester and 13 times in Flemington. 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. Based on the 3-year period from January 2001 through December 2003, the USEPA has designated all of New Jersey as non-attainment with respect to the 8-hour ozone standard (NJDEP Bureau of Air Monitoring, 2004 Air Quality Report).

Table 2.4: Ozone Exceedance Days

Year	Ozone Exceedances (days)			
	Chester		Flemington	
	1-hour averages	8-hour averages	1-hour averages	8-hour averages
1985	1	New ambient air quality standards for ozone became effective July 18, 1997	3	New ambient air quality standards for ozone became effective July 18, 1997
1986	6		4	
1987	4		4	
1988	18		14	
1989	2		3	
1990	3		6	
1991	5		1	
1992	1		0	
1993	0		0	
1994	0		0	
1995	2		1	
1996	1		0	
1997	0		0	
1998	0	22	0	21
1999	0	21	2	23
2000	0	6	0	9
2001	0	15	3	12
2002	2	27	1	19
2003	0	5	0	7
2004	0	0	0	6
2005	0	3	0	13

Source: NJDEP Bureau of Air Monitoring, Historical Ozone data

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. Particles larger than 10 microns are usually trapped by the human respiratory system before they reach the lungs, whereas coarse particles smaller than 10 microns (PM_{10}) are considered harmful, 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 gasses.

The nearest monitoring sites for particulates are Phillipsburg (for $PM_{2.5}$), Trenton (for PM_{10}), and Flemington (where "smoke shade" is measured, an indirect measurement of particulates, and used for reporting in the Air Quality Index). In 2004 (the most recent data available), the results at the Trenton site did not exceed the PM_{10} 24-hour maximum standard of 150µg/M^3 [4] or the annual average standard of 50µg/M^3; values were 45µg/M^3 and 18.8µg/M^3 respectively. The annual average at Chester was 10.2µg/M^3, and at Phillipsburg it was 12.2µg/M^3; both below the standard of 15µg/M^3 annual average. PM_{10} 24-hour maximum values of 32.8µg/M^3 in Chester and 37.3µg/M^3 in Phillipsburg were also within the 24-hour maximum standard of 65µg/M^3. Although the particulates sometimes reach "moderate" and "unhealthy for sensitive individuals" levels, the New Jersey standard for Total Suspended Particulates and the

[4] µg/M^3 = micrograms per cubic meter of air (a microgram is one millionth (10^{-6}) of a gram).

NAAQS standards are being met for PM_{10} for annual mean and maximum 24-hour average. However, three years of data are needed to determine compliance with the NAAQS standard for $PM_{2.5}$ (NJDEP Bureau of Air Monitoring, 2004 Air Quality Report).

Air Toxics

In addition to ozone and $PM_{2.5}$, there is increasing concern about a group of air pollutants termed *air toxics*. These pollutants include substances known to cause serious health problems, such as damage to the immune system, neurological, reproductive, developmental and respiratory problems and cancer. Toxic pollutants may also be deposited on soil and water, taken up by plants and consumed by animals.

The list of potential air toxics is very large and includes many different types of compounds from heavy metals to volatile organic compounds (VOCs) such as benzene. In 1979, NJDEP adopted a regulation that specifically addressed air toxics emissions. This rule (Control and Prohibition of Air Pollution by Toxic Substances) 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.

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. The study determined that on-road mobile sources are responsible for 35% of the toxic emissions, off-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, dirt bikes, etc.) account for 33%; area sources contribute 25% (residential, commercial, and small industrial sources), and major point sources account for the remaining 7%.

The NATA study also estimated levels of pollutants geographically. Although Hunterdon is estimated to have lower levels of air toxics than the more populated and industrial areas of the state, it falls within an area expected to have concentrations of benzene at 5-10 times the health benchmark. NJDEP has determined that 19 of the chemicals were predicted to exceed their health benchmarks in one or more counties in 1996. Pollutants of statewide concern include benzene, 1,3-butadiene, carbon tetrachloride, chloroform, diesel particulate matter, ethylene dibromide, ethylene dichloride and formaldehyde. Pollutants of concern in parts of the state include acrolein, polycylic organic matter, chromium compounds, acetaldehyde, perchloroethylene, 7-PAH, arsenic compounds, cadmium compounds, nickel compounds, beryllium compounds and hydrazine.

The NJDEP has established four comprehensive air toxics monitoring sites. They are located in Camden, Elizabeth, New Brunswick and Chester. The Chester site, which is closest to Tewksbury Township, has been measuring air toxics since 2001. Pollutant concentrations are trending downward, but many of them still exceed the NJDEP health benchmarks. At Chester, these include acetaldehyde, acrylonitrile, benzene, carbon tetracholoride, chloromethane, and formaldehyde (NJDEP Bureau of Air Monitoring, 2004 Air Quality Report).

In 2003, NJDEP adopted revisions to the Emissions Statements rule (NJAC 7:27-21), which require additional facility-wide information on 36 toxic air pollutants.

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. Of the 2 sites where atmospheric deposition was monitored in 2005 in New Jersey, the one in Washington Crossing is closest to Tewksbury. This site is also part of the National Atmospheric Deposition Program. Results for 2005 show a mean pH value of 4.47 (normal rainfall has a pH of about 5.6). This is very acidic, but is a slight improvement from the 1980's and early 1990's, when pH averaged around 4.3 (NJDEP Bureau of Air Monitoring, 2005 Air Quality Report and Steering Committee of the New Jersey Comparative Risk Project. March 2003).

A separate study of mercury in lake sediment cores (which may be representative of atmospheric deposition over time) throughout New Jersey demonstrated that, while mercury levels have decreased, they are still present at levels far higher than natural levels (Kroenke et al., 2003).

Radon

Radon is a radioactive gas that is naturally occurring in New Jersey rocks, soil and ground water. Radon gas can become concentrated indoors, where it can increase risks of lung cancer. Because there is no known safe level of exposure to radon, the US EPA strongly recommends taking measures to reduce indoor radon if your radon test shows 4 pCi/L (picocuries per liter of air) or more, and to consider remediation if your test shows between 2 and 4 pCi/L. New Jersey requires new construction to be tested for radon (NJDEP Radon Program, 2009).

Tewksbury Township is rated Tier 1, which means it has High Radon Potential (NJDEP Radon Program, 2009). The average radon level in Hunterdon County is 6 pCi/L (Hunterdon County Department of Health, 2000). In a 1994 study[5], among 26 homes in Tewksbury tested for radon, 73% had radon levels between 4 and 19 pCi/L (Rahman et al., 1994).

C. Existing Infrastructure

Public Water and Sewer Areas

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. Public water purveyors may be government agencies, private companies, or quasi-government groups. A *Well Head Protection Area* (WHPA) in New Jersey is a map area calculated around each PCWS well in New Jersey that delineates the horizontal extent of ground water captured by a well pumping at a specific rate over a two-, five- and twelve-year period of time for unconfined[6] wells (Tier 1, Tier 2 and Tier 3, respectively). WHPA delineations are conducted in response to the Safe Drinking Water Act Amendments of 1986 and 1996 as part of the Source Water Area Protection Program (SWAP). The delineations are the first step in defining the sources of water to a public supply well. Within these areas, potential contamination will be assessed and appropriate monitoring will be undertaken as subsequent phases of the NJDEP SWAP.

[5] It should be noted that the objective was to study clusters of homes with high radon, and the results may or may not be representative of radon levels in the entire township.

[6] An unconfined aquifer is where groundwater is not under pressure; therefore the water level in a well is the same as the water table outside the well. An unconfined aquifer's direct connection to the earth's surface makes it easily recharged, but also easily contaminated. A confined aquifer is where groundwater is located within impermeable layers; therefore the water is at pressure.

There are 4 PCWS wells in Tewksbury Township (see **Figure 2b**) and parts of two additional Well Head Protection Areas for public wells that are located within Califon and Clinton. Areas served by these wells are shown as "Water Purveyor Areas" on **Figure 2b**. According to the description of the GIS data layer, the boundaries mapped are those of the actual water delivery or service area, but do not include areas with legal rights for future service.

The public Sewer Service Areas (SSA) mapped on **Figure 2b** show the planned method of wastewater disposal for specific areas. Areas not designated as SSAs are planned for service by individual subsurface disposal system discharging less than 2,000 gallons per day (gpd). This mapping is used by NJDEP, together with the Water Quality Management Plan (WQMP), to make consistency determinations under the Water Quality Management Planning rules found in N.J.A.C. 7:15.

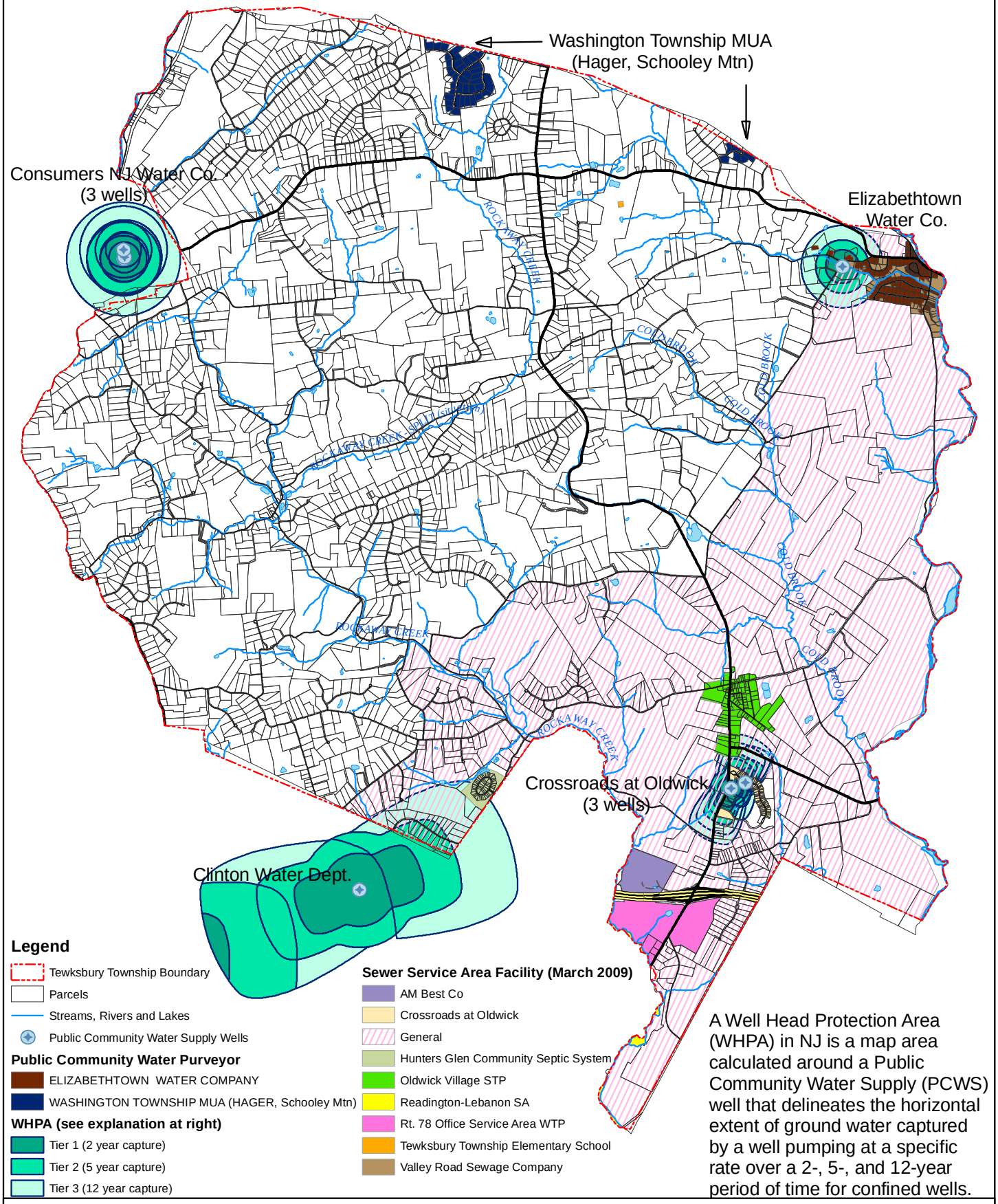
In 2000, a Tewksbury Township intern began gathering information about well and septic system locations. Sources included Hunterdon County records and archived township building records. The township requires "as-built" plans any time a building permit is applied for, and from this the location of the well, septic system and septic drainage area was plotted. For some wells, additional information such as depth, capacity and static head was also collected and placed in the Excel spreadsheet. This data may represent approximately 20-25% of the number of actual wells, septic systems, and septic drainage fields in existence in the township. In addition, the parcel map used to locate the features was sometimes off by tens of feet and the building records kept by the township do not contain field verified information. Despite these limitations, these maps (**Figures 2c and 2d**) can provide a rough template for future testing and analysis (Goodchild, 2008).

Scenic Roads

The Scenic Roads Commission is charged with monitoring the preservation of 33 Township designated scenic roads. Scenic roads are shown on **Figure 2e**.

Table 2.5: Designated Scenic Roads (alphabetical list)

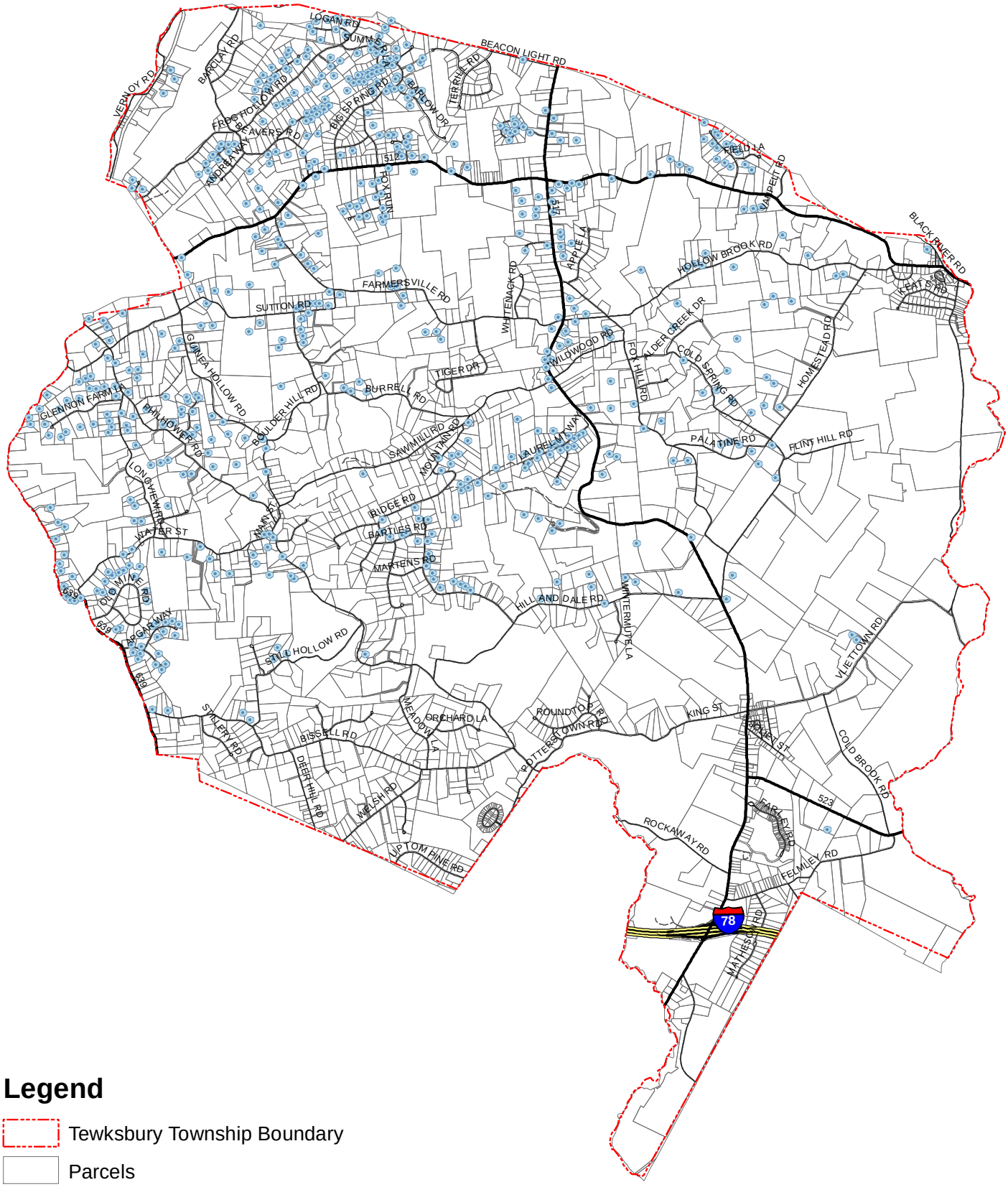
Beavers Road (upper portion)	Flint Hill Road	Philhower Road
Bissell Road	Fox Hill Road	Potterstown Road (portion of)
Black River Road	Frog Hollow Road	Ridge Road
Boulder Hill Road	Guinea Hollow Road	Rockaway Road
Burrell Road	Hill and Dale Road	Saw Mill Road
Church Street	Hollow Brook Road	Still Hollow Road
Cold Brook Road	Homestead Road	Sutton Road (portion of)
Cold Spring Road	McCan Mill Road	Vliettown Road
Deer Hill Road	Meadow Lane	Water Street
Farmersville Road	Mountain Road	Welsh Road
Felmley Road (portion of)	Palatine Road	Wildwood Road



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 2b: Public Water and Sewer Infrastructure

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Legend

- Tewksbury Township Boundary
- Parcels
- mapped private wells (partial list)

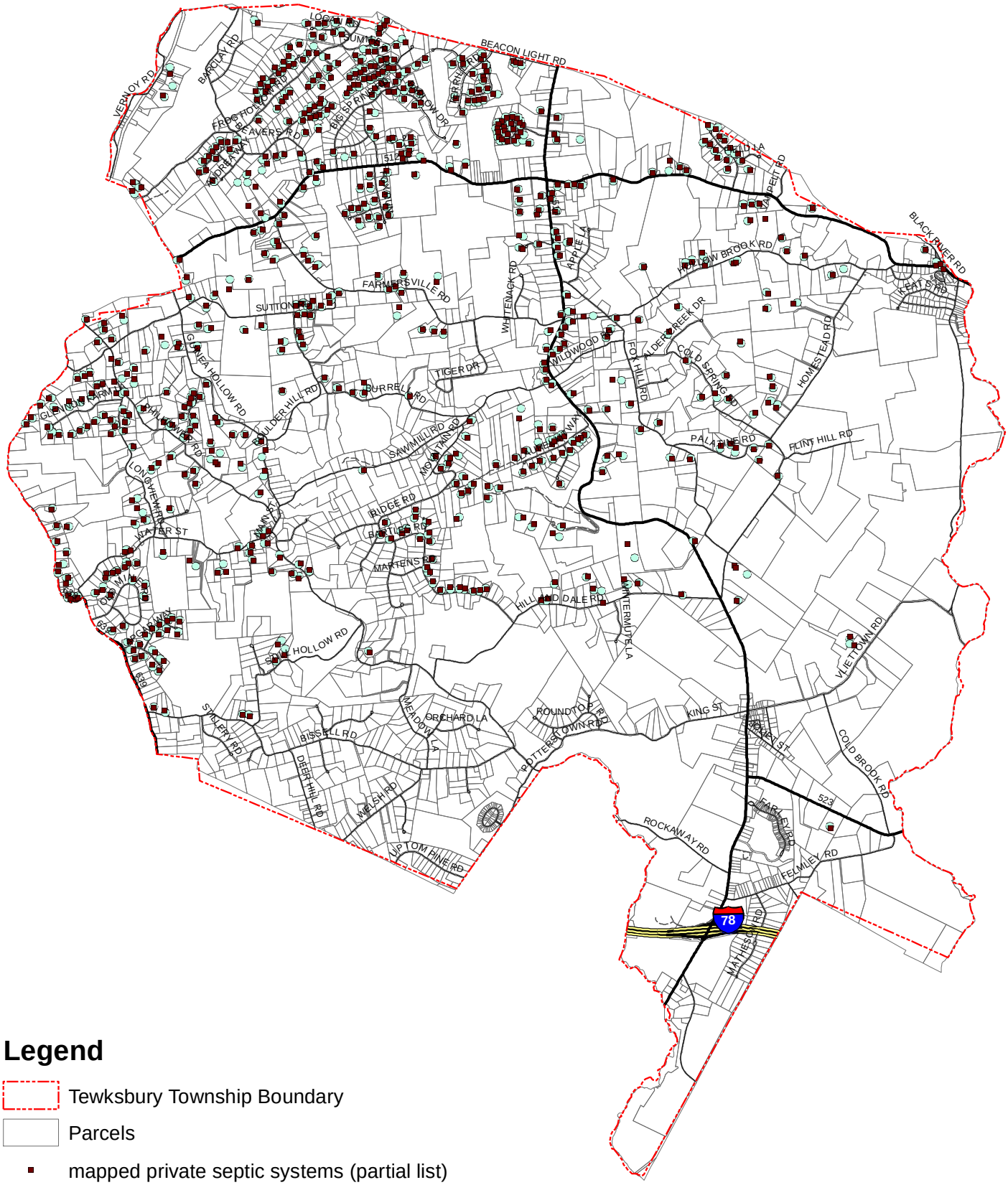
Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 2c: Mapped Private Wells (partial list)

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Legend

- Tewksbury Township Boundary
- Parcels
- mapped private septic systems (partial list)
- mapped private septic drainage field (partial list)

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
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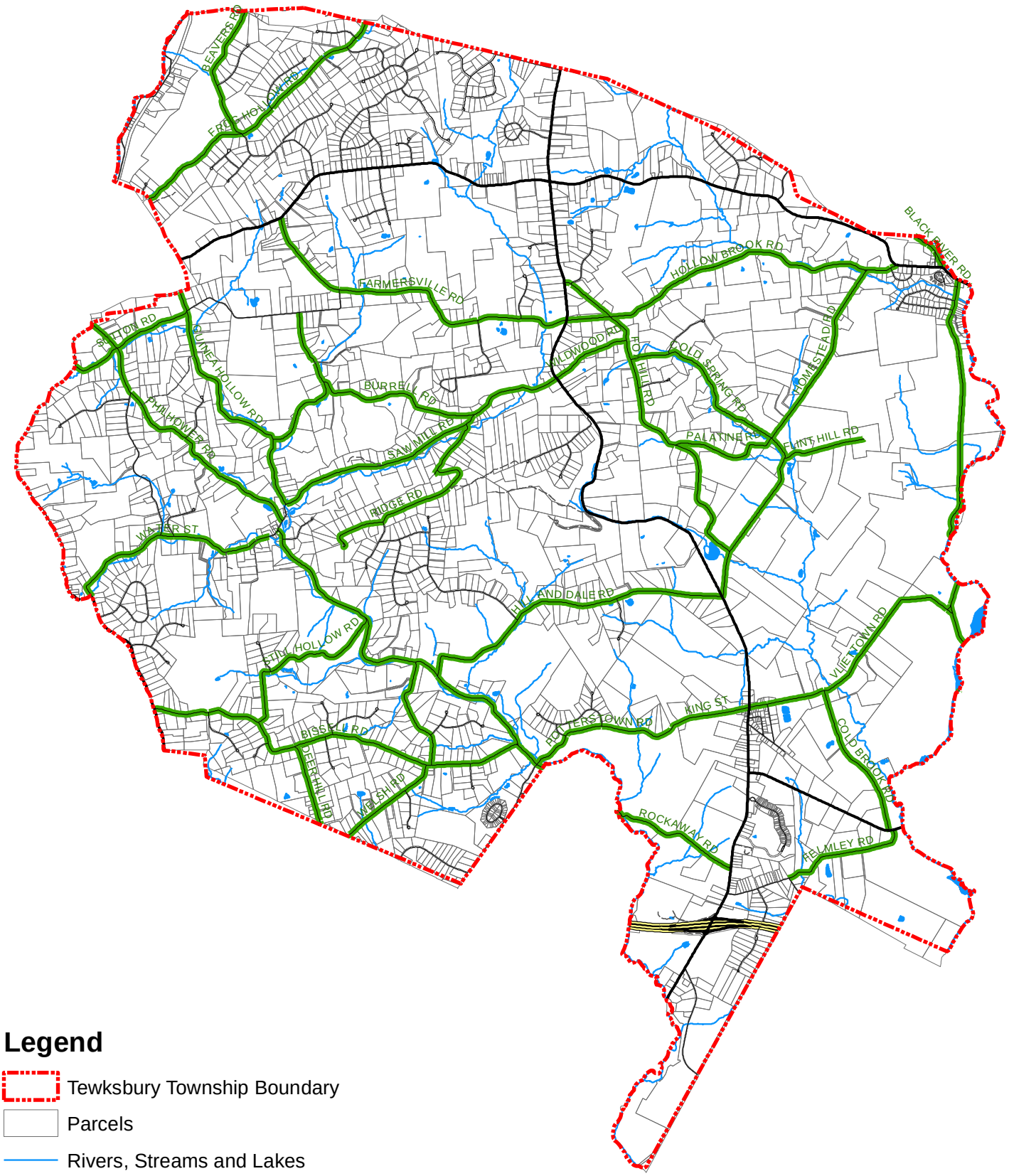
N

0 0.25 0.5 1 1.5 Miles

Figure 2d: Mapped Private Septic Systems (partial list)

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Legend

- Tewksbury Township Boundary
- Parcels
- Rivers, Streams and Lakes
- Scenic Roads

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 2e: Scenic Roads

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

D. Noise and Light Pollution

Light pollution is defined as excess or obtrusive light created by humans. Light pollution obstructs views of stars and planets, disrupts ecosystems and impacts human health and safety. Thousands of stars should be visible in the night sky, but as few as 10% of Americans live in areas where they can view them (Bower, 2000). Ecological impacts of light pollution range from contributing to algal blooms, disrupting feeding and mating of nocturnal animals such as frogs, bats, fireflies and moths, and killing migrating birds. 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 (Guynup, 2003; Bower, 2000).

At least 1/3 of our lighting is wasted because it shines upward or sideways, most of which was created by burning fossil fuels, thereby wasting energy and contributing to global warming and polluting air and water. Links between artificial light and human health, such as cancers, have also been documented. Finally, reduced and non-glaring lighting has been shown to decrease crime (Bower, 2000).

Tewksbury Township is impacted by a number of sources of light pollution. First, the general glow from the New York metropolitan area is visible in the night sky. Local sources include light from the Plukemin Hills housing development, increasing business and residential development along the Route 22 corridor in Readington, and night glow from development in the Clinton area. Transient traffic along both routes 22 and 78 provide a minimal source of light pollution. Additional sources include street lamps along exits on Route 78, exterior lights around our schools and municipal buildings, and unshielded outdoor lights on residences in Tewksbury.

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, 2005).

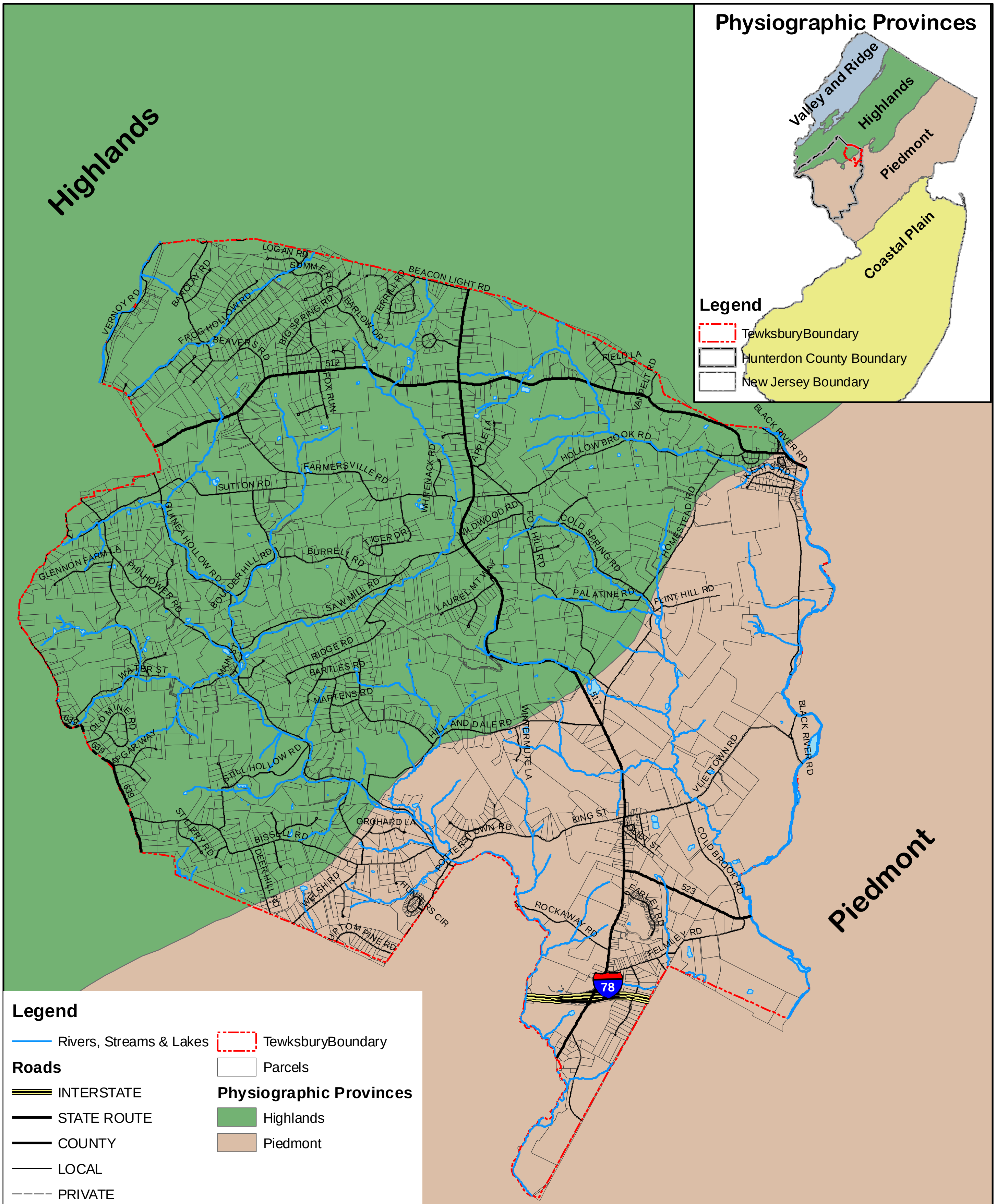
Federal highway noise criteria (which apply only to federal highways) range from 57 to 72 decibels (depending on adjacent land use) (USDOT, FHA, 2006). New Jersey's Noise Control Act of 1971 authorized the NJDEP to develop regulations relating to the control and abatement of noise. While these regulations 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, 2008).

Tewksbury is subjected to noise pollution, such as from cars and trucks on Route 78 (Hunterdon County Planning, 2008) and noise from quarry operations at Oldwick Materials, Inc.

E. Physiography

New Jersey can be divided into four regions, known as *physiographic provinces*, which are areas with similar sequences of rock types, geologic structures and a common geologic history (see **Figure 2f**). The northwestern section of New Jersey is part of the *Valley and Ridge Province*, which is characterized by long, parallel ridges and valleys formed by folded and faulted limestones, shales and sandstones of early and middle Paleozoic age. Erosion-resistant sandstone and siltstone bedrock lie beneath the ridges of the Appalachian Mountains, while shale and limestone underlie the valleys.

Bordering the Valley and Ridge Province to the southeast, the *Highlands Province* consists of metamorphic rocks of Precambrian age. The granites and gneisses are resistant to erosion and create a hilly upland with deep, steep-sided valleys carved by streams. These features are seen in Tewksbury Township.



Data Sources: See Appendix B.
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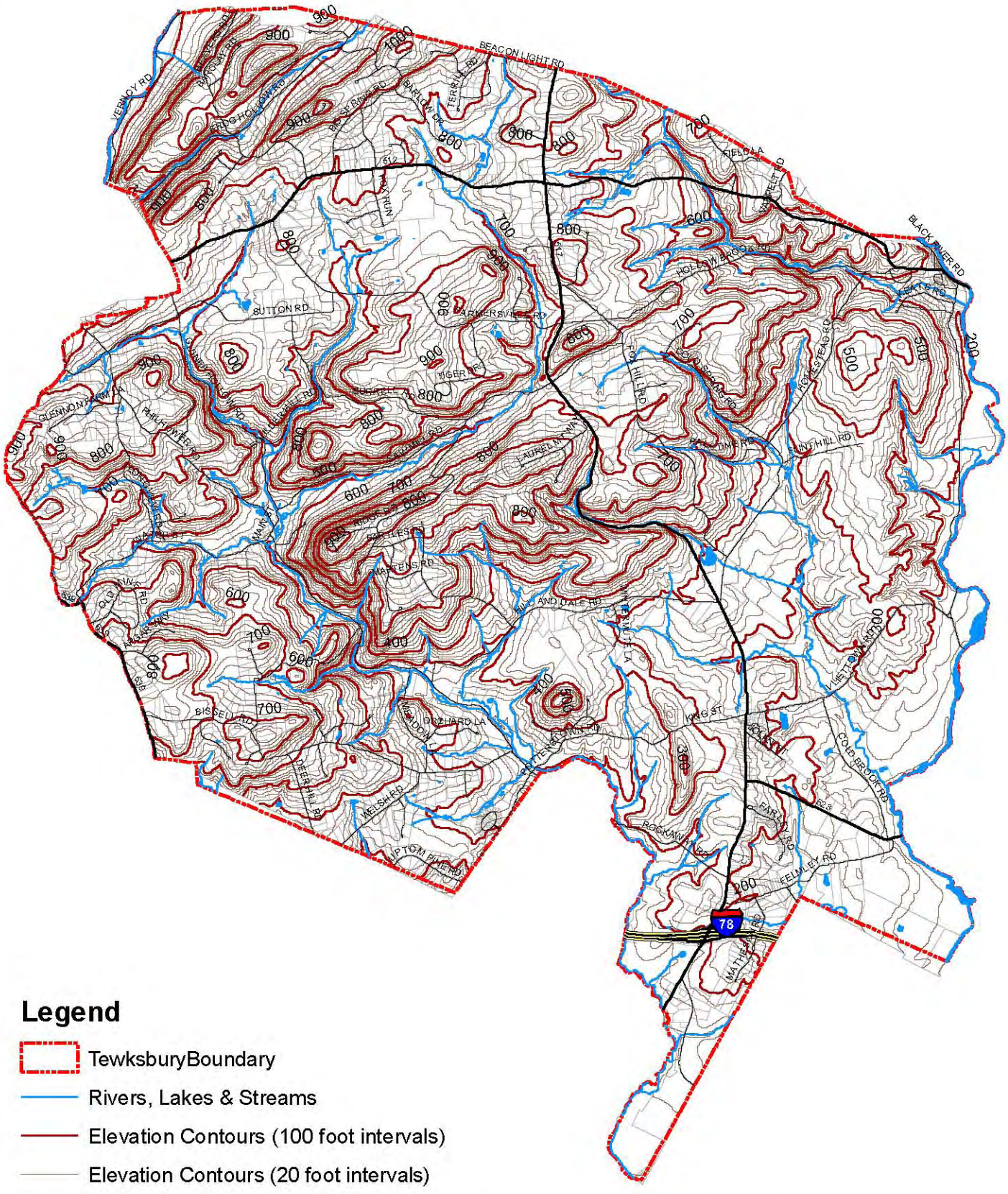
N

0 0.3 0.6 1.2 1.8 Miles

Figure 2f: Physiographic Provinces

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Legend

- TewksburyBoundary
- Rivers, Lakes & Streams
- Elevation Contours (100 foot intervals)
- Elevation Contours (20 foot intervals)

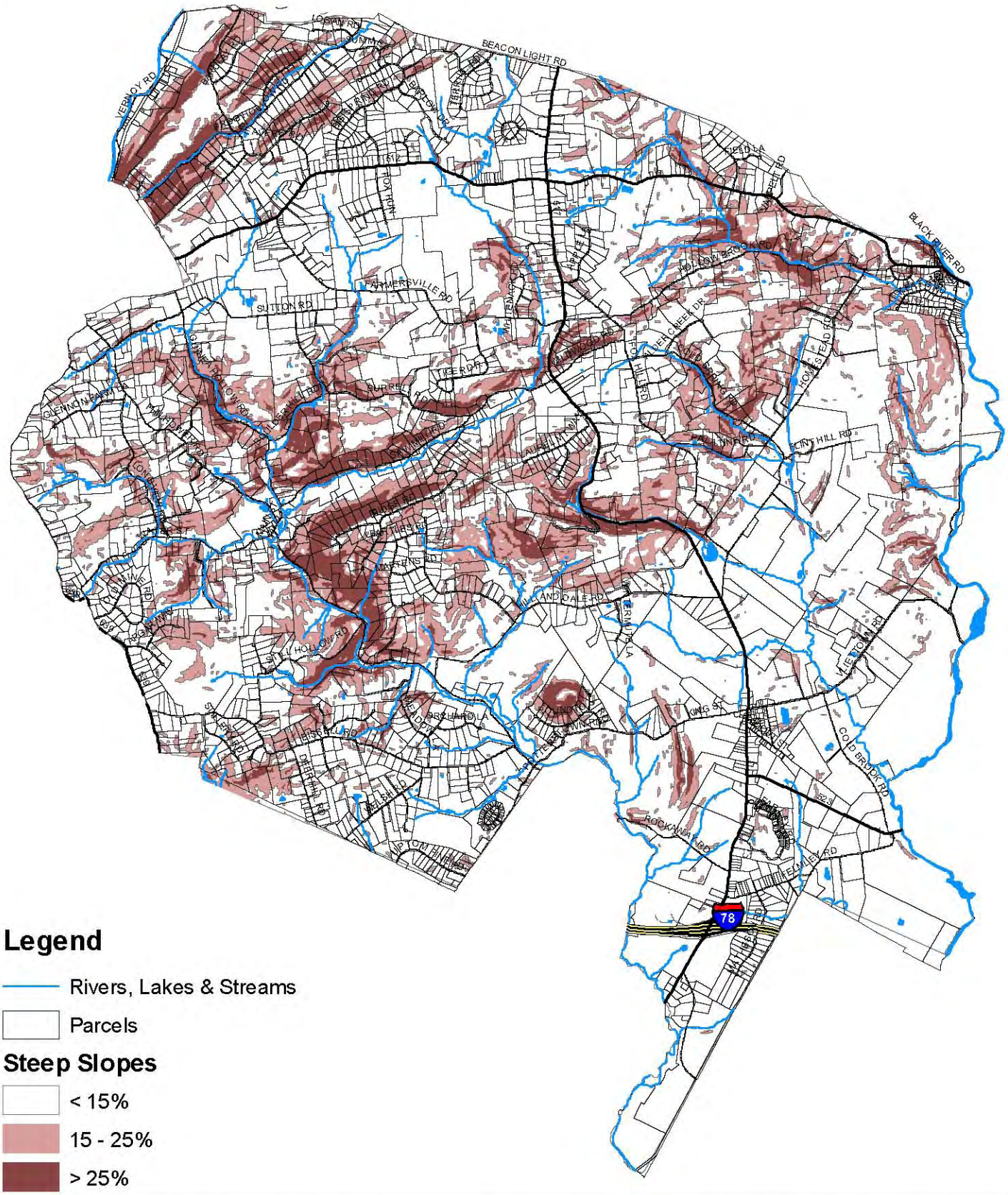
Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 2g: Elevation Contours

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 2h: Steep Slopes

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services

The Highlands Province is separated from the *Piedmont Province* by a series of major faults that cross Tewksbury Township, running diagonally from the southwest to the northeast (see **Figure 2f** and **3a**). The Piedmont Province is characterized by gently rolling hills. The rocks of the Piedmont are of Late Triassic and Early Jurassic age. As sediments eroded from adjacent uplands, and were deposited along rivers and lakes within the basin, they became compacted and cemented to form conglomerate, sandstone, siltstone and shale. *Diabase* is a rock formed by the cooling of magma at some depth in the crust (i.e. the magma did not erupt at the surface), while basalt formed when the magma was extruded onto the surface. Both basalt and diabase are more resistant to erosion than the surrounding sandstone and shale; therefore they form the ridges and uplands. Overlapping the Piedmont Province to the southeast lies the relatively flat terrain of the *Coastal Plain Province*, which consists of unconsolidated sedimentary formations, such as sands, clays, and marls.

F. Topography

Topography depicts the relief features of an area. The elevation in the township ranges from about 120 feet above mean sea level (adjacent to the Lamington River) to over 1,020 feet (at the end of Lenore Road)(see **Figure 2g**). The Highlands portion of Tewksbury tends to have greater elevation and greater elevation differences (therefore more steep slopes). The fault line which separates the Highlands from the Piedmont resulted in a steep escarpment, which runs through Tewksbury. When traveling from south to north, Route 517 and Cokesbury Road both ascend this escarpment (Hintz, 2003).

In **Figure 2g**, each line represents 20 feet of elevation, and is drawn to follow the contour of the land. The closer the contour lines are spaced to each other, the steeper the topography is. Slopes greater than 15% are generally considered "steep slopes" (see **Figure 2h)**. Steep slopes are poor locations for septic systems, and present difficulties for driveway construction and for usable areas around a house. In addition, steeper slopes are more vulnerable to erosion. As the gradient or percent of slope increases, the velocity of runoff water increases, which increases its erosive power. A doubling of velocity of runoff water increases the erosive power fourfold and causes 32 times the amount of material of a given particle size that can be carried (Foth, 1978).

Erosion causes a number of harmful effects on the environment: loss of soil upon which plants and wildlife depend; loss of soil fertility, because the nutrients and organic material are more easily eroded; gully formation; loss of water that might have been useful for plant growth or ground water recharge; sedimentation of streams; and deposition of soil in navigable waters, creating the need for dredging to maintain navigability. Eroded sediment, and the nutrients, pesticides, and other chemicals carried with it, affects aquatic life in many ways. The sediments may bury fish eggs, reduce light available to aquatic plants, and reduce recreational quality and aesthetics.

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2005 Air Quality Report: http://www.state.nj.us/dep/airmon/05rpt.htm
Air Monitoring web site: http://www.state.nj.us/dep/airmon/
Historical Ozone data: http://www.state.nj.us/dep/airmon/histdata.htm

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http://www.state.nj.us/dep/njgs/enviroed/infocirc/provinces.pdf

Internet Resources: Local & Regional Conditions

Climate and Meteorology

Office of the New Jersey State Climatologist (ONJSC)

ONJSC Home Page: http://climate.rutgers.edu/stateclim/
NJ Drought Watch: http://www.njdrought.org/
Drought Status of Central Region: http://www.njdrought.org/status.html#central
Weather and Climate Network: http://climate.rutgers.edu/njwxnet

National Weather Service Advanced (NOAA) Hydrologic Prediction Service (flood predictions):
http://newweb.erh.noaa.gov/ahps2/index.php?wfo=phi&view=1,1,1,1,1,1,1,1&toggles=10,7,8,2,9,15,6

National Weather Service Forecast Pottersville, NJ
http://forecast.weather.gov/MapClick.php?site=phi&FcstType=text&site=PHI&map.x=205&map.y=68

United States Environmental Protection Agency Climate Change: http://epa.gov/climatechange/index.html

USGS Real-Time Flow Stations:

USGS 01397000 South Branch Raritan River at Stanton NJ
http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01397000&PARAmeter_cd=00065,00060

USGS 01396500 South Branch Raritan River near High Bridge NJ
http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01396500&PARAmeter_cd=00065,00060

USGS 01399670 South Branch Rockaway Creek at Whitehouse Station NJ
http://waterdata.usgs.gov/nwis/uv?01399670

USGS 01399500 Lamington (Black) River near Pottersville NJ
http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01399500&PARAmeter_cd=00065,00060

Air Quality

Current Air Quality:

Air Now - Northern NJ: http://www.airnow.gov/index.cfm?action=airnow.showlocal&CityID=160
Chester: http://www.state.nj.us/dep/airmon/che.htm
Flemington: http://www.state.nj.us/dep/airmon/fle.htm

NJDEP Bureau of Air Monitoring

Home Page: http://www.state.nj.us/dep/airmon/
Reports: http://www.state.nj.us/dep/airmon/reports.htm
Air Toxics in New Jersey: http://www.state.nj.us/dep/airmon/airtoxics/overview.htm
What you can do to reduce air toxics? http://www.state.nj.us/dep/airmon/airtoxics/youcan.htm

NJDEP Radon Information: http://njradon.org or call 1-800-648-0394

NJDEP Radon Section: http://www.nj.gov/dep/rpp/radon/index.htm

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

Existing Infrastructure

NJ Astronomical Society - Light Pollution: http://www.njaa.org/light.html

Simple Scale for Evaluating sky darkness: http://darkskyinitiative.org/links/how_dark_my_sky.html

Physiography & Topography

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

3: GEOLOGY

A. Geologic history

The geologic history of New Jersey is summarized in **Table 3.1**.

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, Europe and North America collided, forming the Appalachian Mountains, which at that time were far higher and more rugged than the Rocky Mountains are now.

In the Mesozoic Era (the time when dinosaurs lived), New Jersey was part of the super-continent Pangaea. Flashfloods eroded the mountains, dropping mud and silt in extensive floodplain deposits, gradually filling the valleys. This is known as the "Newark episode," which lasted between about 15 and 23 million years. The rate of deposition averaged between 215 and 325 millimeters per 1,000 years, keeping pace with the rate of basin sinking. Shallow lakes formed at the bottom of the desert basin (known as playa lakes). The sediments became rock under the pressure of each successive layer of mud, silt or sand. Dinosaurs walked on these mudflats, leaving footprints that occasionally became fossilized. Fossils of coelacanths and other fish have also been found in these rock formations (Gallagher, 1997).

Roughly 200 million years ago, the supercontinent broke apart, and the Atlantic Ocean was born. This was accompanied by volcanic activity, which resulted in magma flowing at or near the surface. These exist today as the erosion resistant basalt and diabase outcrops found in the Watchung Mountains, the Palisades, and the Sourland Mountains. When the diabase intruded, the surrounding sedimentary rocks were hardened by heat and pressure, and are known as hornfels rocks, or traprock, which is quarried commercially.

Within the past two million years, the climate alternated between cold and warm. During periods of glaciation, the glaciers came as far south as Belvidere, NJ, and the area below that became a cold tundra. Receding glaciers deposited till. At times, the shoreline of the Atlantic Ocean may have been near Tewksbury Township, while at other times, it may have receded a hundred miles from the present shore.

Table 3.1: Summary of New Jersey's Geologic History

Period	Million Years Ago	Description of Climate and Fossils Found in Corresponding Bedrock
Precambrian Era		
	Up to 544	**Climate:** New Jersey was under the sea. **Fossils:** stromatolites; most life forms were soft bodied and left no fossils
Paleozoic Era		
Cambrian Period	544 – 505	**Climate:** New Jersey was close to the equator, covered by warm tropical seas. **Fossils:** trilobites, brachiopods, stromatolites, worm burrows
Ordivician Period	505 – 440	**Climate:** New Jersey continued to be underwater, as the sea above deepened to oceanic depths. **Fossils:** trilobites, brachiopods, coral, nautiloids, clams, crinoids, and snails
Silurian Period	440 – 410	**Climate:** The sea level rose and fell, with New Jersey remaining at the sea floor. **Fossils:** coral, brachiopods, clams, brine shrimp, primitive fish, eurypterids (sea scorpions), arthrophycus (fossilized feeding burrow made by a worm-like animal)
Devonian Period	410 – 360	**Climate:** Europe collided with North America, forming the mountains which are now the Ridge and Valley and Highlands provinces of New Jersey. The fossils found continued to be aquatic life forms. **Fossils:** brachiopods, clams, trilobites, nautiloids, crinoids, coral, snails, stromatoporoids, ostracodes, bryozoa

Table 3.1: Summary of New Jersey's Geologic History

Period	Million Years Ago	Description of Climate and Fossils Found in Corresponding Bedrock
Mississippian, Pennsylvanian & Permian Periods	360-248	**Climate:** No geologic record of these time periods is present in New Jersey. At some point, the sea subsided, and New Jersey became dry land, at least in part. **Fossils:** none
Mesozoic Era		
Triassic Period	248 – 200	**Climate:** New Jersey was next to Morocco, part of the supercontinent Pangaea. In the dry interior of the continent, the area experienced greater daily and seasonal fluctuations than the coasts. The rugged landscape consisted of high young mountains and deep valleys formed by faults. The brief rainy seasons' flashfloods dropped mud and silt in low areas, where playa lakes formed. In the end of the Triassic the climate became desert-like. The lakes began to dry up and became salty, resulting in an environment where brine shrimp flourished. When a lake went dry, some fish and other aquatic life became fossils. **Fossils:** dinosaur footprints, thecodonts, fish (including coelacanths), phytosaurs, amphibians, insects, plants
Jurassic Period	200 – 145	**Climate:** The breakup of Pangaea resulted in the beginning of the Atlantic Ocean. Igneous intrusions (molten rock forced into earlier rock formations) formed diabase and basalt bedrock. Because the terrain was mountainous, the net geologic action was erosion, not deposition. **Fossils:** There are no late Jurassic deposits in New Jersey; therefore no fossils exist from this period. However, the fauna probably consisted of the same dinosaurs as the American West, including sauropods, armored dinosaurs, ornithopods (forerunner of hadrosaurus), tenontosaurus (relative of the iguanadon). True flowering plants (angiosperms) appeared at this time.
Cretaceous Period	145 – 65	**Climate:** Northern New Jersey was above sea level, while southern New Jersey experienced flooding and ebbing. The sea level changed cyclically from deeper to shallower water in this tropical environment. During flooding, greensand marl (glauconite) was formed. During ebbing, clay and sand were deposited. **Fossils:** Fossil phytoplankton, clams, snails, crustaceans, ammonites, oysters, reptiles, sharks, burrows, worm tubes and vertebrates such as mosasaurs have been found in New Jersey's coastal plain. The fossil dinosaurs found include hadrosaurus (which probably washed downstream during a flood), ornithomimus, *Dryptosaurus aquilunguis* (a 17' predator with a great hand claw), *Hadrosaurus foulkii*, and *Hadrosaurus minor*.
Cenozoic Era		
Tertiary Period	65 – 1.8	**Climate:** The climate was warm, and the sea level was higher, covering the Outer Coastal Plan. **Fossils:** Fossils of land animals include birds, such as the diatryma (a giant flightless bird), tillodont (an extinct mammal the size of a bear, but with rodent-like teeth) and possibly others similar to those found in the South Dakota badlands, such as brontotherium, ancestral horses, entelodonts (resembled giant warthogs), diceratherium (semi-aquatic rhinoceros), peccary, prosynthetoceras (a camal), anchitherium (horse), and a primitive doglike carnivore. Fossils found in the Outer Coastal Plain include brachiopods, corals, sponges, clams, sharks, mollusks, crinoids, mammals (probably washed to the sea in floods), crocodiles, snakes, and early whales.
Quaternary Period	1.8 - present	**Climate:** The climate alternated between cold and warm, resulting in four intervals of glaciation. The glaciers covered northern New Jersey, reaching as far south as Belvidere on the Delaware River. South of the glacial ice, treeless, frozen tundra existed. When water was frozen in glaciers, the sea level was lower, resulting in a shoreline over a hundred miles east of the present coast. **Fossils:** Fossils of many familiar and some extinct animals have been found in nearby areas. There were insects, turtles, and snakes. Herbivores included squirrels, groundhogs, porcupines, beaver, muskrats, voles, mice, eastern cottontail rabbits, white-tailed deer, peccaries, tapirs, giant ground sloth, the elk-moose, giant beaver, American mastodon, and mammoth. Carnivores

Table 3.1: Summary of New Jersey's Geologic History

Period	Million Years Ago	Description of Climate and Fossils Found in Corresponding Bedrock
		included otters, skunks, bobcats, foxes, black bears, coyotes, jaguars, jaguarundi, short-faced bear and a saber-toothed cat.
Sources: Gallagher, 1997; University of California Museum of Paleontology et al., 2003; USGS, 2002		

B. Bedrock Geology of Tewksbury Township

Bedrock is the solid rock beneath the soil and surficial rock. The geology of Tewksbury Township is complex, containing 21 different types of bedrock (see **Table 3.2** and **Figure 3a**). The effects of the rifting that occurred in the Triassic-Jurassic periods are evident in the faults that cross Tewksbury from the northeast to the southwest. One of these border faults crosses Tewksbury from Pottersville to Bissell. North of this fault, the township lies within the Highlands Physiographic Province and is dominated by Precambrian rocks. The Piedmont Physiographic Province lies south of this fault and consists of the sedimentary and igneous rocks of the Triassic and Jurassic Periods of the Mesozoic Era (Mulhall, 2003).

Table 3.2: Characteristics of Bedrock Types Found in Tewksbury Township

Abbre-viation	Geologic Formation	Lithology (physical character of the rocks)	Area of Twp.
Triassic-Jurassic (Mesozoic Era: 248 to 65 million years ago)			
Jp	Preakness Basalt	dark-greenish-gray to black, very fine-grained, dense, and hard former magma flows	0.16%
Jf	Feltville Formation	brownish-red to light gray-red, fine to coarse-grained sandstone; gray and black coarse siltstone; and silty mudstone	1.98%
Jo	Orange Mountain Basalt	hard, dense, fine to very-fine grained greenish-gray to greenish-black rocks	1.30%
Jd	Jurassic Diabase	hard, dense, poorly fractured, medium to coarse grained, dark greenish gray to black rocks	0.27%
JTrp	Passaic Formation	red-brown shales, siltstones, and sandstones	16.50%
JTrpsc	Passaic Conglomerate and Sandstone facies	sand, gravel, pebble, and cobble-sized materials cemented with finer grained carbonate or quartz material	2.33%
JTrpcq	Passaic Quartzite-clast Conglomerate facies		4.73%
JTrpcl	Passaic Limestone-clast Conglomerate facies		6.60%
		Total Area Underlain by Triassic-Jurassic Formations:	*33.87%*
Cambrian-Ordovician (Paleozoic Era: 544 to 248 million years ago)			
Cl	Leithsville Formation	dolomite, carbonate minerals	0.40%
Ch	Hardyston Quartzite	tightly cemented, dense, sedimentary rock	0.33%
		Total Area Underlain by Cambrian-Ordovician Formations:	*0.72%*
Precambrian (Precambrian Era: billions to 544 million years ago)			
Ybh	Hornblende Granite	Granites have medium to course grained structure, are hard and tough	28.37%
Yba	Microperthite Alaskite	a granitic rock containing few, if any, dark minerals.	0.52%
Yps	Pyroxene Syenite	an ultramafic igneous rock consisting essentially of mineral of the pyroxene group.	3.01%
Yk	Potassium Feldspar Gneiss	Gneiss is a medium to coarse-grained banded metamorphic rock; characterized by a layered appearance caused by the minerals from quartzo-feldspathic minerals in discontinuous layers. The ferromagnesian minerals are commonly biotite and/or hornblende with pyroxene being less common.	0.89%
Yb	Biotite-Quartz-Feldspar Gneiss		10.22%
Yp	Pyroxene Gneiss		0.89%
Ye	Epidote Gneiss		0.01%
Ylo	Quartz-Oligoclase Gneiss		12.85%
Ylb	Biotite-Quartz-Oligoclase Gneiss		0.15%
Yd	Diorite	grey to dark grey intermediate intrusive igneous	6.63%

Abbre-viation	Geologic Formation	Lithology (physical character of the rocks)	Area of Twp.
		rock	
Ya	Amphibolite	Amphiboles are minerals of either igneous or metamorphic origin, typically dark-colored and heavy, with a weakly foliated or flaky structure. The small flakes of black and white in the rock often give it a salt-and-pepper appearance.	1.86%
		Total Area Underlain by Precambrian Formations:	*65.41%*
Sources: Mulhall, 2003; NJGS Bedrock Geology GIS data; Van Houten, 1969; USGS, 2002			

Precambrian Era – Igneous and Metamorphic Rocks

The Precambrian igneous and metamorphic rocks of the Highlands province are the oldest in NJ, formed between 1.3 billion and 750 million years ago by melting and recrystallization of sedimentary rocks that were deeply buried, subjected to high pressure and temperature, and intensely deformed. These rocks, mainly granites and gneisses, are resistant to erosion and produce a hilly upland cut by the deep steep-sided valleys of major streams (NJGS, 1999). Despite the fact that these rocks have undergone several episodes of tectonic deformation due to continental collisions and separations, they are poorly fractured except at locations near major faults such as the Fairmount and Tanners Brook Faults. Near these faults, the southeastern block, which moved downward with respect to the northwestern block, is usually more fractured as a result of this past movement. These normal faults were formed as a result of tensional forces pulling apart or rifting the Newark Basin (Mulhall, 2003).

The relative lack of faulting is due to the nature of these rocks, which allows for the attenuation of tectonic forces within the minerals. These rocks generally behave in a plastic or malleable manner in comparison to more brittle sedimentary rocks such as dolomite and shale. Because of the nature of the Precambrian igneous and metamorphic rocks, fractures not associated with major faults are often not highly interconnected or closely spaced (Mulhall, 2003).

Precambrian igneous and metamorphic rocks underlie most of the north-western two-thirds of Tewksbury Township. These are primarily comprised of *granite* and *gneiss* with some *diorite*, *syenite*, and *amphibolite* (Mulhall, 2003).

Paleozoic Era

The Ordovician Period experienced a period of uplift, followed by another invasion of a warm sea (Lucey, 1970). The rocks laid down during this era in what is now Tewksbury Township are Cambrian sedimentary rocks, which underlie less than 1% of the township. The Cambrian sedimentary units are comprised of the Hardyston Quartzite and Leithsville dolomite (Mulhall, 2003).

The *Hardyston Quartzite* crosses the northern portion of Tewksbury near Vernoy as a narrow band of tightly cemented, dense, sedimentary rock. The *Leithsville Formation* also forms a thin band across the northern portion of the township near Vernoy. The Leithsville is a dolomite, which is comprised of carbonate minerals that are susceptible to slow dissolution from acidic rainwater. This process produces cavities, caves, caverns and other solution openings in the rock. Within Tewksbury Township, the Leithsville Formation has very limited extent. However, this formation extends to the northeast into Long Valley where water entering the aquifer system may ultimately flow beneath the valley toward Tewksbury Township (Mulhall, 2003).

Gradually, as the basin deepened, more and more silt was deposited, cutting off the deposition of limestone. At the end of this period, the Taconic mountain building occurred,

which raised, moved, folded and faulted Precambrian formations eastward, eventually depositing them on top of these younger Paleozoic formations (Lucey, 1970).

Mesozoic Era – conglomerate, siltstone and shale

The Triassic Border Fault formed as a result of shearing between the Precambrian thrust sheet and the existing Paleozoic rocks. This resulted in block mountains with basins on either side. The Border Fault is nearly vertical where it outcrops, but flattens with depth.

Erosion from the high mountains gradually filled the basins with sediments, forming the Late Triassic Newark Group. The Newark Group lies in a southwest-trending basin that extends from Rockland County, New York, to northeastern Lancaster County, Pennsylvania. This is the largest of the Triassic rift valleys that extend from Nova Scotia to North Carolina. The Newark Group consists of non-marine sedimentary rocks 16,000-20,000 feet thick, and associated intrusions of volcanic rocks. Older rocks, which lie beneath the Newark Group, are exposed to the north in the Highlands and Ridge and Valley Provinces. Younger strata overlap the Newark Group in the Coastal Plain Province to the southeast. The layers generally dip 10 – 20° northwest. In contrast to the Precambrian rocks, which are poorly fractured except in the immediate vicinity of the border faults, the Triassic-Jurassic sedimentary rocks exhibit two types of fracturing. Bedding fractures resulted from changes in the characteristics of the sediments at the time of deposition. In addition, fracturing occurred when weak sedimentary layers were pulled apart as the continents separated. Often these fractures will have a vertical or near vertical orientation and will extend a few inches to a few feet across (Van Houten, 1969; Mulhall, 2003).

Near the Triassic Border Fault, fast flowing streams surged down the steep mountains, depositing alluvial fan sediments and quartzite and limestone boulders up to three feet in diameter on the valley floor. These resulting Triassic conglomerates are dominated by quartzite, which is more resistant to erosion. As the streams flowed away from the mountains, the velocity slowed and, having already dropped the larger boulders and pebbles, carried and deposited the smaller particles farther from the mountains, which became sandstones, shale and mudstones. The rocks of the Passaic Formation furthest from the Highlands contain grey-bed sequences of thin-bedded to finely laminated shale and siltstone that include lake deposits (Lucey, 1970).

The portion of Tewksbury Township within the Piedmont Physiographic Province is underlain by Triassic-Jurassic sedimentary, igneous, and metamorphic rocks, which were formed 245 to 145 million years ago. Together, these Triassic-Jurassic rocks are encountered beneath approximately 34% of Tewksbury Township. The thickness of the combined Passaic Formation and associated facies may exceed 11,000 feet (Mulhall, 2003).

The Passaic Formation Conglomerate Facies are comprised of three mapped units within Tewksbury Township. *The Passaic limestone-clast conglomerate* unit is located along the border fault from the township's western boundary to east of the intersection of Homestead and Flint Hill Roads and extending south to Oldwick. The *Passaic quartzite-clast conglomerat*e unit is located to the east of the limestone conglomerate and extends to the township's eastern boundary near Pottersville. The *Passaic Conglomerate & Sandstone* unit extends along the Township's eastern boundary. Together, these three conglomerate units are located beneath about 14% of the Township. The conglomerate units are comprised of sand, gravel, pebble, and cobble-sized materials deposited by high-velocity streams in a series of alluvial plains at the base of mountains located to the north and west in the present day Highlands Province. These coarse-grained deposits were later cemented with finer grained carbonate or quartz materials. Based on the topography of Tewksbury in areas underlain by the conglomerates, these rocks most likely remain tightly cemented because they continue to form steep slopes and high hills (Mulhall, 2003).

The *Passaic Formation* is encountered in Tewksbury Township southeast of the border faults and the conglomerates. The red-brown shales, siltstones, and sandstones of the Passaic

Formation encompass approximately 3,350 acres or 16.5% of Tewksbury Township (Mulhall, 2003).

Mesozoic Era – diabase, basalt and sedimentary rocks

Volcanic activity was associated with the rifting of the continent as the Atlantic Ocean formed, which allowed magma to flow through the resulting fractures. Diabase is a rock formed by the cooling of magma below the surface of the earth. Basalt is formed by magma that has been extruded onto the surface as lava, where the magma cools much more quickly in the open air, and there is little time for the growth of crystals. Both are more resistant to erosion than the surrounding sandstones and shales, and therefore form ridges and uplands (NJGS, 1999).

In the northeastern section of Tewksbury Township, near Pottersville, an area of *diabase* intruded into the older Passaic Formation. These sheets, dikes and sills cooled slowly into hard, dense, poorly fractured, medium- to coarse-grained, dark greenish-gray to black rocks. Near the margins of the intrusions, the diabase is usually fine to very-fine grained. The magma's heat metamorphosed the surrounding Passaic Formation rocks within 1,000 feet in all directions, turning the red-brown shales into metamorphic bluish-gray hornfels. Sheet-like diabase intrusions may exceed 1,200 feet in thickness and the dikes may range from 10 to 50 feet thick. Based on the USGS mapping, in Tewksbury Township, diabase is found on 54 acres between Keats and Homestead Roads, which is about 0.27% of the township (Mulhall, 2003).

The *Orange Mountain Basalt* and *Preakness Basalt* form the base and peak of Round Top, which is between Bissel and Oldwick. The Orange Mountain Basalt is primarily comprised of three flows separated by thin layers of red siltstone. These igneous extrusions cooled rapidly on the surface of the earth into hard, dense, fine to very-fine grained greenish-gray to greenish-black rocks. At some locations, the flows exhibit characteristic basalt features such as columnar joints, pillows and pahoehoe (lava flow with rope-like or glassy outer surface), which formed as a result of rapid cooling. The Orange Mountain Basalt may reach a thickness of almost 600 feet and within Tewksbury Township encompasses approximately 265 acres near Potterstown, Rockaway, and Bissel Roads. The peak of Round Top consists of the Preakness Basalt. Similar to the older Orange Mountain Basalt, the Preakness Basalt is comprised of dark-greenish-gray to black, very fine-grained, dense, and hard former magma flows. The Preakness is also composed of three major basalt flows. The Preakness Basalt is encountered beneath approximately 32 acres or 0.16 % of the Township at the peak of Round Top (Mulhall, 2003).

The *Feltville Formation* is the youngest sedimentary bedrock formation in Tewksbury Township and is mapped northeast of Bissel, surrounding the base of Round Top. Geologically, the Feltville is very similar to the Passaic Formation and is comprised of brownish-red to light gray-red, fine to coarse-grained sandstone; gray and black coarse siltstone; and silty mudstone. The Feltville Formation may exceed 500 feet in thickness. Within Tewksbury, these rocks are encountered on 402 acres, approximately 2% of the township (Mulhall, 2003).

Mining

Seven abandoned mines exist in Tewksbury Township, five of which mined magnetite, and two mined graphite (see **Figure 3a** and **Table 3.3**) (NJGS, 2006).

Magnetite is a valuable source of iron ore and is the most magnetic mineral on Earth (Wikipedia, 2008). Beginning as early as the 1600's until about 1996, iron ore (magnetite) was mined extensively in the Highlands region and created a once-thriving industry of national importance (NJGS, 1999; Volker & Witte, no date). Within Tewksbury, the mine located at Cokesbury, on the western edge of the township, operated the longest – a period of 97 years from 1776 to 1873. All of the magnetite mines within Tewksbury had ceased operations by 1883 (NJGS, 2006).

Graphite was mined from about 1848 to 1941 at 13 locations in the Highlands, including two in Tewksbury. Total production figures for the graphite mines are not available; however, apparently they could not compete financially with other sources of graphite. The chemical composition of graphite (organic carbon) provides indirect fossil evidence of life that existed 1.3 billion years ago in the Precambrian sea. The graphite likely formed from metamorphosed remains of algae that had accumulated in an oxygen deficient part of the marine environment (Volker & Witte, no date).

Table 3.3: Abandoned Mines in Tewksbury Township

Name	Year Began	Year Ended	Mineral
Cokesbury Mine	1776	1873	magnetite/iron
Burrell Mine	1878	1878	magnetite/iron
Sutton Farm Graphite Mine			graphite
Sutton Farm Mine	1873	1881	magnetite/iron
Fox Hill Mine	1873	1880	magnetite/iron
Fisher Mine			graphite
Welch Farm Exploration	1883	1883	magnetite/iron
Source: NJGS GIS data, 2006.			

Currently, Stavola Quarries, LLC operates a quarry for crushed stone in the Jurassic Orange Mountain Basalt.

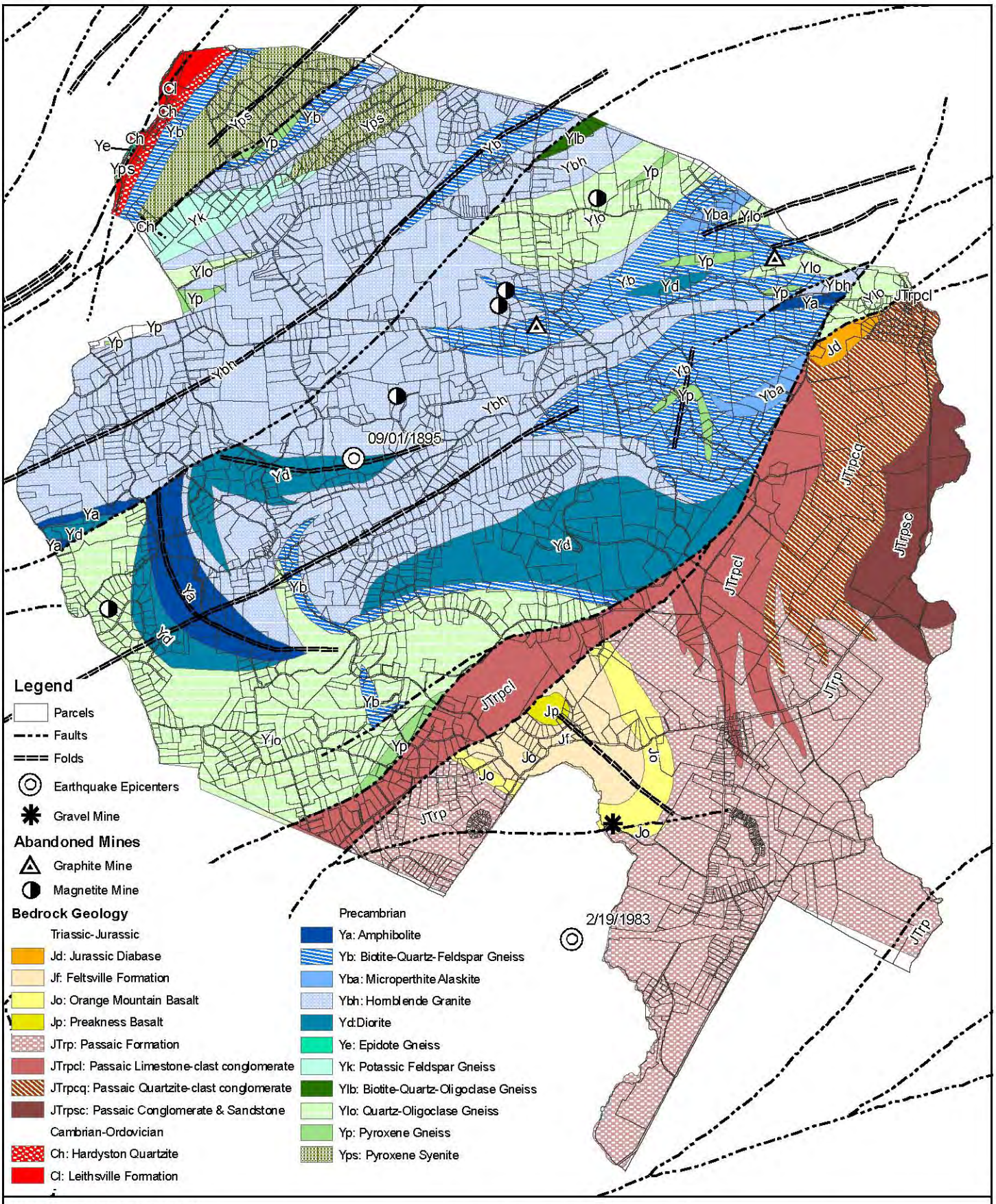
Earthquakes

Damaging earthquakes are rare in Tewksbury Township, but possible. Soils influence the potential for damage from earthquakes. Most areas of Tewksbury have shallow depth to bedrock, which dampens the movement of earthquakes (NRCS, 2006). However, soft soils (e.g. silt, clay, and fine sand) amplify the motion of earthquake waves, increasing ground shaking, while wet sandy soils can liquefy (Stanford, 2003).

An earthquake occurring September 1, 1895 had its epicenter in Tewksbury Township. It had a magnitude of 4.1 – the second most powerful earthquake of known magnitude recorded in New Jersey (see **Figure 3a)**. On February 19, 1983 an earthquake with a magnitude of 2.7 was recorded in Califon, just outside of Tewksbury. A number of other earthquakes have occurred in the vicinity, all with magnitudes of 2.9 or less (NJGS, 2007).

C. The Surficial Geology of Tewksbury Township

Surficial materials are the unconsolidated sediments that overlie bedrock formations and that are the parent material for soils. In Hunterdon County they include stream, wetland, glacial, windblown, and hillslope sediments and weathered bedrock material. The weathered bedrock



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 3a: Bedrock Geology, Faults, Folds, Mines & Earthquakes

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services

material may be as much as 200 feet thick, although most are generally less than 20 feet thick. The size of particles in the surficial materials ranges from coarse gravel to clay and peat. Surficial materials affect the movement of ground water from the surface into underlying bedrock aquifers, and some are aquifers themselves (See **Figure 3b** and **Table 3.4**).

Table 3.4: Types of Surficial Geology Found in Tewksbury Township

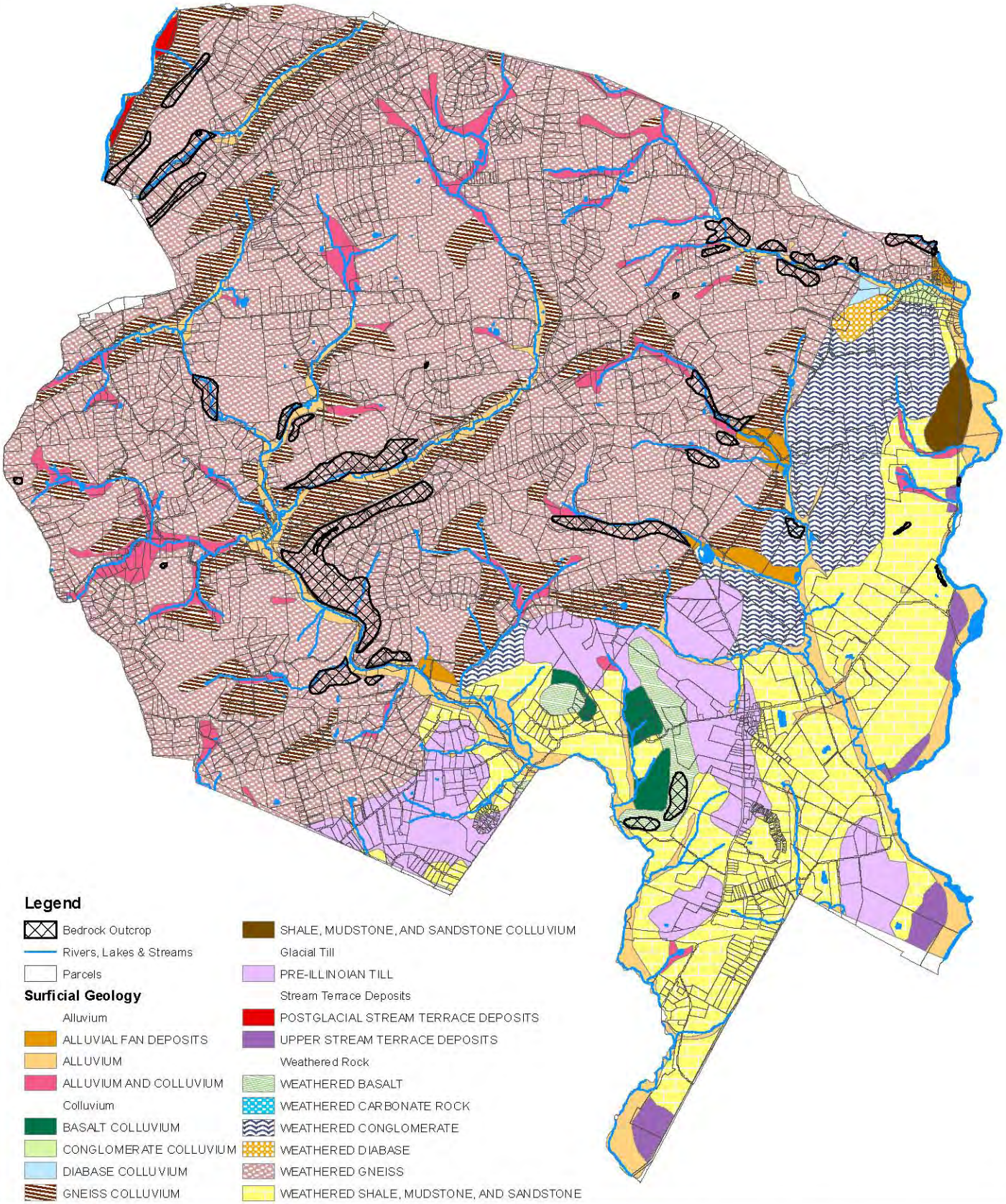
Deposit Type	Definition
Alluvium	any sediment deposited by flowing water
Alluvium Fan Deposits	deposited by rivers and streams; soil textures have high sand and silt contents
Bedrock Outcrop	a more or less solid layer of rock found on the surface of the land or below the soil
Eolian deposits	transported by wind; are not typically deep deposits, but may exist as a thin deposit overlying another type of parent material; soil textures dominated by medium and fine sands
Colluvium	transported down-slope by gravity; soil textures dependent on particle-size of colluviated parent material
Glaciofluvial Deposits	deposits of glacial origin, but transported and deposited by river and streams; soil textures dominated by high sand, gravel and silt contents
Stream terrace deposits	alluvial deposits on a stream terrace
Till	glacial deposits; soil textures dominated by high sand and gravel contents
Weathered rock	the bedrock near the surface has been subjected to physical and chemical changes by atmospheric agents (i.e. the weather); soil textures depend on type of rock from which the soil is weathered
Source: NRCS Soils Online Study Guide: http://www.nj.nrcs.usda.gov/partnerships/envirothon/soils/	

During the beginning of the Cenozoic Era (the current era), erosion continued along the Triassic Border Fault, exposing the underlying Paleozoic rocks. During the last million years of geologic history, Continental ice sheets invaded New Jersey at least three times. The first of these glaciation events, the pre-Illinoian, occurred about 800,000 years ago and covered all of what is now Tewksbury Township. The ice of the Illinoian and the late Wisconsinan glaciers did not reach Tewksbury Township (Lucey, 1970; Witte, 1998).

Sediment that was deposited directly by the pre-Illinoian glacier, known as *glacial till*, exists in the south eastern part of Tewksbury Township (see **Figure 3b**). It occurs as erosional remnants of sandy to silty till on flat upland areas, to a maximum thickness of 30 feet. It is too thin to be an aquifer, and the fine particles may actually retard the movement of surface water into the underlying bedrock (NJGS, 2002).

The rest of the township is covered with non-glacial surficial material including weathered bedrock, colluvium (gravity transported), and alluvium (water transported). Throughout New Jersey, weathered bedrock may be as thick as 300 feet on carbonate bedrock and 100 feet on gneiss and conglomerate bedrock but is generally less than 20 feet thick elsewhere. Colluvium occurs in wedge-shaped deposits at the base of hillslopes, and may be as much as 50 feet thick. Alluvium occurs in floodplains and terraces along streams and is generally less than 30 feet thick. Weathered gneiss and conglomerate may be a local unconfined aquifer where thick and sandy. Otherwise, non-glacial materials are too thin to be aquifers (NJGS, 2002).

Bedrock outcrops may be found in Tewksbury along some of the stream channels and at the gravel mine (see **Figure 3b**).



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 3b: Surficial Geology

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services

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4: SOILS

A. Soil Survey Maps

The *soil* is the unconsolidated mineral material on the immediate surface of the earth and that 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 (USDA NRCS, 2006). 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 that provides technical assistance based on sound science in the conservation and management of soil, water, and other natural resources to private land owners and local, state, and federal agencies and policy-makers.

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 help people understand soils and their uses. Soil surveys help identify the best way 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).

The NRCS prepared a soil survey of Hunterdon County in 1974 (Jablonski, 1974), which was updated in 1986 and digitized into GIS in 1999. 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 managing farms and wetlands (USDA NRCS, 2006).

Beginning in 2005, the NRCS made its soil surveys available online (USDA NRCS, 2006). This provides the means for keeping the information current and available to the public. Users specify a geographic "area of interest" (must be less than 10,000 acres) and then may view a wide variety of tables of soil properties and soil interpretations. However, for this report, the entire SSURGO (Soil Survey Geographic Database) spatial data and tabular data for Hunterdon County were downloaded for use in the GIS (USDA NRCS, 2006) [7].

B. 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,

[7] The maps in this report are the most recent available as of February 2008 (Tabular Data Version 5, 12/7/2006; Spatial Data Version 1, 1/6/2005; Spatial Format=ArcView Shapefile; Coordinate System=UTM Zone 18, Northern Hemisphere (NAD 83)); SSURGO version 2.2; Template database version 32.

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 uses of the soil.

There are 40 soil series found in Tewksbury, such as Parker, Patenburg and Gladstone. A total of 66 different map units are present in Tewksbury[8]. These map units are listed in **Table 4.2**, along with several important properties of these soils, and shown on **Figure 4a**. **Figures 4b** through **4h** illustrate the distribution of some soil characteristics. A large portion of the soils in Tewksbury have limitations due to shallow depth to bedrock. Some areas have poor drainage, high water table or steep slopes.

C. Characteristics of Tewksbury Township Soils

Depth to Restrictive Layer (Bedrock and Fragipan)

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. Each soil map unit is characterized by a range of depths to bedrock that is typical for the majority of that soil type. Depth to bedrock is an important factor when determining the suitability of land for building roads, foundations and septic systems.

For the most part, Tewksbury Township has shallow depths to bedrock, ranging from zero (bedrock is exposed at the surface, with no soil above it) to 116 inches. There are some soil units in Tewksbury that are not restricted by bedrock, including the Gladstone, Califon and Raritan. **Figure 4b** shows the minimum depths to bedrock for the majority of each soil unit (see **Table 4.2** and **Figure 4b**).

In some cases, a fragipan layer is encountered with or without the presence of shallow bedrock. A *fragipan* is a subsoil layer, typically high in clay, which is a higher density than the soil above it. A fragipan layer becomes cemented and very hard when dry, and brittle when moist. The layer is low in organic matter and slowly or very slowly permeable to water and also restricts root growth (Soil Science Society of America, 2008). When present in Tewksbury, the fragipan layer varies in depth between 15 and 40 inches in depth (see **Figure 4b**).

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, while SHWT between 1 and 3 feet also provides obstacles to development. 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 (Hintz, 2003).

The majority of Tewksbury Township does not have concern with a seasonal high water table (see **Figure 4c**). Areas that do have a shallow depth to SHWT are primarily located near

[8] Note that nomenclature, some attribute categories, and some interpretations have changed since previous reports, such as the 2004 Master Plan.

streams. Flooding typically occurs in certain soils, including the Bowmansville, Fluvaquent, Udifluvent, Raritan and Rowland units (see **Figure 6b for floodplains**).

Hydrologic Soil Group

The *hydrologic soil grouping* describes a group of soils having similar runoff potential under similar storm and cover conditions (how much would run off compared to the rate that water would infiltrate into the ground). The majority of the township has moderate to slow infiltration rates, while some areas have very slow infiltration rates (see **Figure 4d**). The definitions of the hydrologic soil groups are shown in **Table 4.1**.

Table 4.1: Hydrologic Soil Grouping

Class	Definition
A	High infiltration rates. Soils are deep, well drained 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.
B/D	Drained/undrained hydrology class of soils that can be drained and are classified. Moderate to very slow infiltration rates.
C	Slow infiltration rates. Soils with layers impeding downward movement of water, or soils that have moderately fine or fine textures.
C/D	Drained/undrained hydrology class of soils that can be drained and classified. Slow to very slow infiltration rates.
D	Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.
Source: USDA NRCS Soil Survey Geographic (SSURGO) Database, January 20, 2006.	

Septic Suitability

The NRCS SSURGO database provides an interpretation of limitations of each soil for *septic suitability*. The interpretation shown in **Figure 4e** is based on the N.J.A.C. 7:9A Standards for Individual Subsurface Sewage Disposal Systems, Subchapter 10 Disposal Fields. Factors which may affect the functioning of the system, and therefore limit septic suitability, are excessively coarse substratum (which allows effluent to percolate to ground water too rapidly); presence of water (including depth to high water table, flooding, and hydric soils); depth to restrictive layer (bedrock or restrictive substratum) and steep grades over 25%. N.J.A.C 7:9A prohibits septic systems in soils subject to flooding, which in Tewksbury includes Bowmansville, Fluvaquents, Raritan and Rowland. In addition, septic disposal fields are prohibited in locations with the combination of slope greater than 10% and less than 50 feet upslope of any bedrock outcrop where signs of ground water seepage can be detected (NJDEP, 1999).

In Tewksbury, the suitability of soils for septic tank absorption fields is very limited. Portions of some soil units have areas where septic system disposal fields would not be permitted due to flooding, hyrdic soils, or steep slopes; while some areas have no technical limitations and some areas were not rated (such as the quarry and rough broken land). These general suitability guidelines would need to be used in combination with on-site testing, the SSURGO interpretation report "Sewage Disposal (NJ)," and N.J.A.C.7:9A subchapter 10 to determine what types of disposal field installations would be appropriate in any given situation. In soils with more than one limiting factor, a disposal field must be a type approved as an acceptable option for each of the soil suitability classes that apply (NJDEP, 1999).

Erodibility

Erosion is the wearing away of the land surface by running water, wind, ice, or other geological agents. Erosion is often accelerated as a result of human activities. The *erodibility* takes into account the affects of infiltration rate, permeability and total water capacity and factors

that resist the forces of the rainfall and runoff. The majority of Tewksbury Township is rated "potentially highly erodible," while a large portion is "highly erodible," and small areas are considered not highly erodible (see **Figure 4f)**. Map units that are described as "eroded" are also displayed on this map (SSURGO, 1991)

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, and does not refer to saturation due to recently altered drainage (manmade or natural). The categories are as follows: well drained, moderately well drained, excessively drained, somewhat excessively drained, poorly drained, and somewhat poorly drained. For the most part, Tewksbury Township has well drained soils. The steeper slopes and rocky soils tend to be somewhat excessively drained, while small patches are moderately well drained, somewhat poorly drained or poorly drained (see **Figure 4g).**

Prime Farmland Soils

Prime Farmland Soils include soils that have the best combination of physical and chemical characteristics for economically producing sustained high yields of crops when treated and managed according to acceptable farming methods and is also available for these uses. These soils have the soil quality, growing season, and moisture supply needed; they 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 (USDA NRCS NJ, 2006).

Farmlands of statewide importance include those soils with characteristics that are nearly Prime Farmland. They 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 (USDA NRCS NJ, 2006). Tewksbury Township has a high proportion of prime farmland soils and farmland of statewide importance, which include many of the loamy soils with low slopes, such as Annandale gravelly loam 3 to 8% slope, Gladstone gravelly loam 3 to 6% slope, Pattenburg gravelly loam 2 to 6% slope, and Raritan silt loam 0 to 3 and 3 to 8% slope (see **Figure 4h).**

Other

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. For those soils that experience frequent or occasional flooding, duration of annual flooding in a normal year and the months during which flooding occurs in a normal year are also noted (see **Table 4.2**; shown in **Figure 6b** with floodplains).

Potential Frost Action is an interpretation rating of the susceptibility of the soil to frost heaving. Most soils within Tewksbury are moderately susceptible to frost action. The remainder is highly susceptible, with the exception of the map unit Fluvaquents and Udifluvents, 0 to 3 percent slopes, frequently flooded, which is rated low, and quarry and rough broken land, which are not rated for frost action.

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 greater than seven days. Hydric Soils are noted in **Table 4.2**, and are shown with wetlands in **Figure 6c**.

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US Department of Agriculture, Natural Resources Conservation Service (NRCS). 2005. Soil Survey Geographic Data: SSURGO version 2.2, Template Database Version 32. http://soildatamart.nrcs.usda.gov/

Internet Resources: Soils

Hunterdon Soil Conservation District: http://www.nj.gov/agriculture/divisions/anr/nrc/conservdistricts.html

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://soildatamart.nrcs.usda.gov/

NRCS Soils Online Study Guide: http://www.nj.nrcs.usda.gov/partnerships/envirothon/soils/

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

Web Soil Survey: How to Use it: http://websoilsurvey.nrcs.usda.gov/app/Help/WSS_HomePage_HowTo.pdf

Table 4.2: Characteristics of Soil Types Found in Tewksbury Township[9]

Map Unit Symbol	Map Unit Name	Depth to Restrictive Features (inches)	Seasonal High Water Table Depth (inches)	Annual Flood Frequency, Duration, Months	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Limitations (NJ)
AbrB	Abbottstown silt loam, 2 to 6 percent slopes	F: 15-30 B: 40-60	6	none	C	HIGH	somewhat poorly		SI	*Very Limited:* DTWT, RS, RH, ECS
AnoB	Annandale gravelly loam, 3 to 8 percent slopes	F: 24-36 B: 73-79	>60	none	C	MODERATE	WELL		P	*Very Limited:* RS, RH, DTB
AnoC2	Annandale gravelly loam, 8 to 15 percent slopes, eroded	F: 18-30	>60	none	C	MODERATE	WELL		SI	*Very Limited:* RS, RH
ANWTB	Annandale and Gladstone gravelly loams, 3 to 8 percent slopes	F: 24-36 B: 40-48	>60	none	C	MODERATE	WELL		P	*Very to Somewhat Limited:* RS, RH, ECS
ANWTC	Annandale and Gladstone gravelly loams, 8 to 15 percent slopes	F: 24-36 B: 40-48	>60	none	C	MODERATE	WELL		SI	*Very to Somewhat Limited:* RS, RH, ECS
AtdB	Athol gravelly loam, 2 to 6 percent slopes	B: 69-81	>60	none	B	MODERATE	WELL		P	*Somewhat Limited:* DTB
AtdC2	Athol gravelly loam, 6 to 12 percent slopes, eroded	B: 69-81	>60	none	B	MODERATE	WELL		SI	*Somewhat Limited:* DTB
AtdD2	Athol gravelly loam, 12 to 18 percent slopes, eroded	B: 69-81	>60	none	B	MODERATE	WELL			*Somewhat Limited:* DTB
BefB	Bedington Channery silt loam, 2 to 6 percent slopes	B: 54-66	>60	none	B	MODERATE	WELL		P	*Somewhat Limited:* ECS
BhnA	Birdsboro silt loam, 0 to 2 percent slopes	none	>60	none	B	MODERATE	WELL		P	*Not limited*
BhnB	Birdsboro silt loam, 2 to 6 percent slopes	none	>60	none	B	MODERATE	WELL		P	*Not limited*

[9] The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation.

Map Unit Symbol	Map Unit Name	Depth to Restrictive Features (inches)	Seasonal High Water Table Depth (inches)	A nnual Flood Frequency, Duration, Months	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Limitations (NJ)
BoyAt	Bowmansville silt loam, 0 to 2 percent slopes, frequently flooded	none	6	FREQUENT Brief Nov.-May	B/D	HIGH	poorly	yes	SI	*Very Limited:* DTWT, F, H
BucB	Bucks silt loam, 2 to 6 percent slopes	B: 40-53	>60	none	B	MODERATE	WELL		P	*Very Limited:* RS, ECS
BucC2	Bucks silt loam, 6 to 12 percent slopes	B: 40-60	>60	none	B	MODERATE	WELL		SI	*Very Limited:* RS, ECS
CakA	Califon loam, 0 to 3 percent slopes	F: 20-30	18	none	C	HIGH	moderately well		P	*Very Limited:* RS, RH, DTWT
CakB	Califon loam, 3 to 8 percent slopes	F: 20-30	18	none	C	HIGH	moderately well		P	*Very Limited:* RS, RH, DTWT
CanBb	Califon gravelly loam, 0 to 8 percent slopes, very stony	F: 20-30	18	none	C	HIGH	moderately well			*Very Limited:* RS, RH, DTWT
ChcB	Chalfont silt loam, 2 to 6 percent slopes	F: 15-30 B: 42-72	12	none	C	HIGH	somewhat poorly		SI	*Very Limited:* DTWT, RS,RH, ECS
CoaA	Cokesbury loam, 0 to 3 percent slopes	F: 20-30	6	none	D	HIGH	poorly	yes		*Very Limited:* DTWT, RS, RH, H
CoaBb	Cokesbury loam, 0 to 8 percent slopes, very stony	F: 20-26	6	none	D	HIGH	poorly	yes		*Very Limited:* DTWT, RS, RH, H
DufC2	Duffield silt loam, 6 to 12 percent slopes, eroded	B: 48-60	>60	none	B	MODERATE	WELL		SI	*Somewhat Limited:* DTB
FmhAt	Fluvaquents, loamy, 0 to 3 percent slopes, frequently flooded	none	15	FREQUENT	B/D	HIGH	somewhat excessively	yes		*Very Limited:* DTWT, F, H
FNAT	Fluvaquents and Udifluvents, 0 to 3 percent slopes, frequently flooded	none	24	FREQUENT very brief -brief Dec.-May	C	LOW	moderately well			*Very Limited:* DTWT, F
GkaoB	Gladstone gravelly loam, 3 to 8 percent slopes	none	>60	none	B	MODERATE	WELL		P	*Not limited*

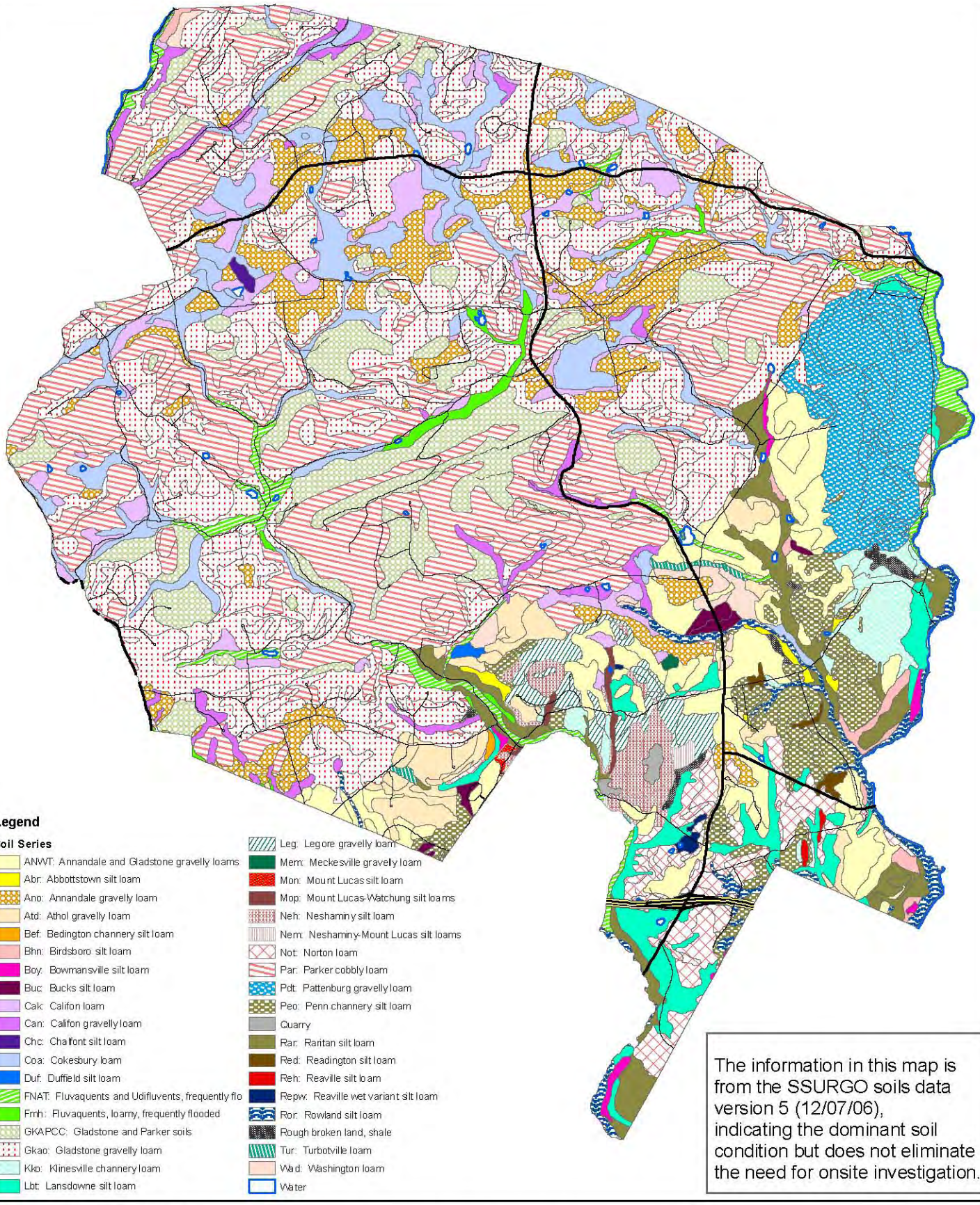
Map Unit Symbol	Map Unit Name	Depth to Restrictive Features (inches)	Seasonal High Water Table Depth (inches)	Annual Flood Frequency, Duration, Months	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Limitations (NJ)
GkaoC2	Gladstone gravelly loam, 8 to 15 percent slopes, eroded	B: 40-60	>60	none	B	MODERATE	WELL		SI	*Somewhat Limited:* ECS
GkaoD	Gladstone gravelly loam, 15 to 25 percent slopes	none	>60	none	B	MODERATE	WELL			*Not limited*
GKAPCC	Gladstone and Parker soils, 8 to 15 percent slopes, extremely stony	B: 40-60	>60	none	B	MODERATE	WELL			*Somewhat to Very Limited:* ECS, DTB
KkoC	Klinesville channery loam, 6 to 12 percent slopes	B: 10-20	>60	none	D	MODERATE	somewhat excessively			*Somewhat Limited:* ECS
KkoD	Klinesville channery loam, 12 to 18 percent slopes	B: 10-20	>60	none	D	MODERATE	somewhat excessively			*Somewhat Limited:* ECS
LbtB	Lansdowne silt loam, 2 to 6 percent slopes	B: 54-66	21	none	C	HIGH	somewhat poorly		SI	*Very Limited:* RS, RH, DTWT, ECS
LegB	Legore gravelly loam, 2 to 6 percent slopes	B: 48-60	>60	none	B	MODERATE	WELL		P	*Somewhat Limited:* ECS, RS
LegC	Legore gravelly loam, 6 to 12 percent slopes	B: 48-60	>60	none	B	MODERATE	WELL		SI	*Somewhat Limited:* ECS, RS
LegD	Legore gravelly loam, 12 to 18 percent slopes	B: 39-51	>60	none	B	MODERATE	WELL			*Very Limited:* RS, ECS
MemC2	Meckesville gravelly loam, 6 to 12 percent slopes, eroded	F: 26-40 B: 54-66	>60	none	C	MODERATE	WELL		SI	*Very Limited:* RS, RH, DTB
MonB	Mount Lucas silt loam, 2 to 6 percent slopes	B: 48-99	18	none	C	HIGH	moderately well		P	*Very Limited:* DTWT, DTB
MopBb	Mount Lucas-Watchung silt loams, 0 to 6 percent slopes, very stony	none	18	none	C	HIGH	moderately well			*Very Limited:* DTWT
NehCb	Neshaminy silt loam, 6 to 12 percent slopes, very stony	none	>60	none	B	moderate	WELL			*Not limited*

Map Unit Symbol	Map Unit Name	Depth to Restrictive Features (inches)	Seasonal High Water Table Depth (inches)	A nnual Flood Frequency, Duration, Months	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Limitations (NJ)
NehDb	Neshaminy silt loam, 12 to 18 percent slopes, very stony	B: 54-66	>60	none	B	MODERATE	WELL			*Somewhat Limited:* DTB
NehEb	Neshaminy silt loam, 18 to 35 percent slopes, very stony	B: 54-66	>60	none	B	MODERATE	WELL			*Very Limited:* S, DTB
NemCb	Neshaminy-Mount Lucas silt loams, 6 to 12 percent slopes, very stony	B: 48-99	>60	none	B	MODERATE-HIGH	WELL			*Somewhat Limited:* DTB
NotB	Norton loam, 2 to 6 percent slopes	B: 63-76	>60	none	C	MODEATE	WELL		P	*Very Limited:* RS, RH
NotC2	Norton loam, 6 to 12 percent slopes, eroded	B: 77-91	>60	none	C	MODERATE	WELL		SI	*Very Limited:* RS, RH
NotD2	Norton loam, 12 to 18 percent slopes, eroded	B: 77-91	>60	none	C	MODERATE	WELL			*Very Limited:* RS, RH
ParC	Parker cobbly loam, 3 to 15 percent slopes	B: 35-47	>60	none	B	MODEARTE	somewhat excessively			*Very Limited:* DTB
ParD	Parker cobbly loam, 15 to 25 percent slopes	B: 36-47	>60	none	B	MODERATE	somewhat excessively			*Very Limited:* DTB
ParEe	Parker cobbly loam, 18 to 40 percent slopes, extremely stony	B: 39-47	>60	none	B	MODERATE	somewhat excessively			*Very Limited:* DTB, S
PdtB	Pattenburg gravelly loam, 2 to 6 percent slopes	B: 54-66	>60	none	B	MODERATE	WELL		P	*Somewhat Limited:* DTB, RS
PdtC2	Pattenburg gravelly loam, 6 to 12 percent slopes, eroded	B: 54-66	>60	none	B	MODERATE	WELL		SI	*Somewhat Limited:* DTB, RS
PdtD	Pattenburg gravelly loam, 12 to 18 percent slopes	B: 54-66	>60	none	B	MODERATE	WELL			*Somewhat Limited:* DTB, RS
PdtE	Pattenburg gravelly loam, 18 to 40 percent slopes	B: 54-66	>60	none	B	MODERATE	WELL			*Very Limited:* S, DTB, RS

Map Unit Symbol	Map Unit Name	Depth to Restrictive Features (inches)	Seasonal High Water Table Depth (inches)	Annual Flood Frequency, Duration, Months	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Limitations (NJ)
PdtmB	Pattenburg gravelly loam, moderately wet, 2 to 6 percent slopes	B: 54-66	>60	none	C	HIGH	moderately well		P	*Somewhat Limited:* DTB, RS
PeoB	Penn channery silt loam, 2 to 6 percent slopes	B: 20-40	>60	none	C	MODERATE	WELL		P	*Somewhat Limited:* ECS
PeoC2	Penn channery silt loam, 6 to 12 percent slopes, eroded	B: 20-40	>60	none	C	MODERATE	WELL		SI	*Somewhat Limited:* ECS
PeoD	Penn channery silt loam, 12 to 18 percent slopes	B: 20-40	>60	none	C	MODERATE	WELL			*Somewhat Limited:* ECS
QY	Quarry	B: 0	>60	none	--	---	--			--
RarAr	Raritan silt loam, 0 to 3 percent slopes, rarely flooded	F: 22-33	18	RARE Brief Nov.-March	C	HIGH	moderately well		P	*Very Limited:* RS, RH, F, DTWT
RarB	Raritan silt loam, 3 to 8 percent slopes	none	18	none	C	HIGH	moderately well		P	*Very Limited:* DTWT
RedB	Readington silt loam, 2 to 6 percent slopes	F: 24-36 B: 40-60	27	none	C	MODERATE	moderately well		P	*Very Limited:* RS, RH, ECS, DTWT
RehB	Reaville silt loam, 2 to 6 percent slopes	B: 20-33	18	none	C	HIGH	somewhat poorly		SI	*Very Limited:* DTWT, ECS
RepwA	Reaville wet variant silt loam, 0 to 2 percent slopes	B: 18-33	6	none	D	HIGH	poorly	yes		*Very Limited:* DTWT, RS, RH, H, ECS
ROPF	Rough broken land, shale	B: 0	>60	none	D	NONE	WELL			--
RorAt	Rowland silt loam, 0 to 2 percent slopes, frequently flooded	none	24	FREQUENT Brief Nov-Mar	C	HIGH	moderately well			*Very Limited:* F, DTWT

Map Unit Symbol	Map Unit Name	Depth to Restrictive Features (inches)	Seasonal High Water Table Depth (inches)	Annual Flood Frequency, Duration, Months	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Limitations (NJ)
TurB	Turbotville loam, 2 to 6 percent slopes	B: 80-116	12	none	C	HIGH	somewhat poorly		P	*Very Limited:* DTWT, RS, RH, DTB
WadB	Washington loam, 3 to 8 percent slopes	none	>60	none	B	MODERATE	WELL		P	*Not limited*
WadC2	Washington loam, 8 to 15 percent slopes, eroded	none	>60	none	B	MODERATE	WELL		SI	*Not limited*
Water	Water	--	0			--				--

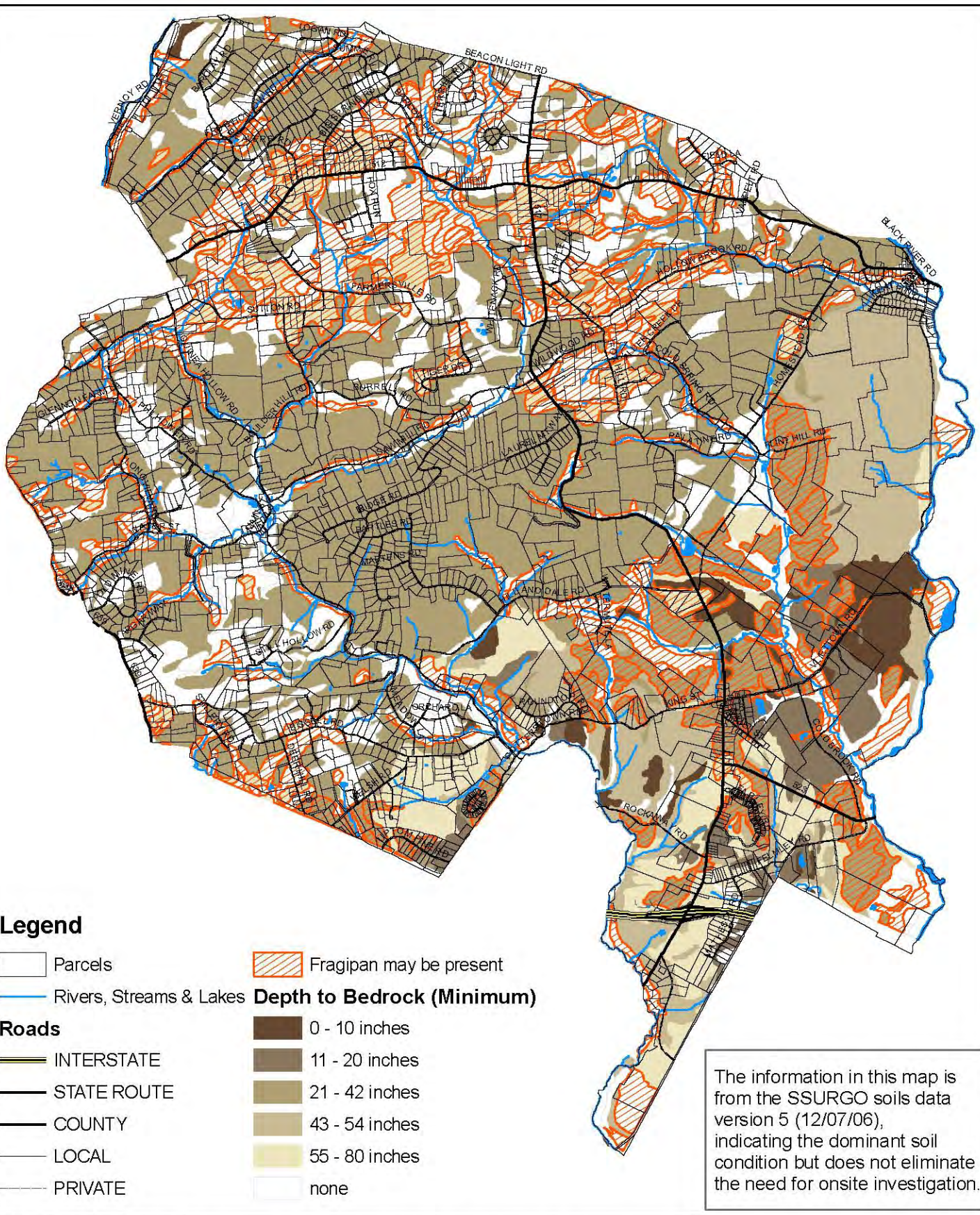
Depth to Restrictive Features: **F**=Fragipan; **B**=Bedrock
Hydrologic Group: see **Table 4.1**
Farmland: **P**=Prime; **SI**=Statewide Importance
Septic Limitations (NJ): Very limited, somewhat limited, not limited, not rated
ECS=Excessively Coarse Substratum; **DTB**=Depth to Massive Bedrock; **DTWT**=Depth to Water Table; **F**=Flooding; **H**=Hydric soil; **RS**=restrictive substratum; **RH**=restrictive horizon; **S**=Too Steep



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 4a: Soil Series

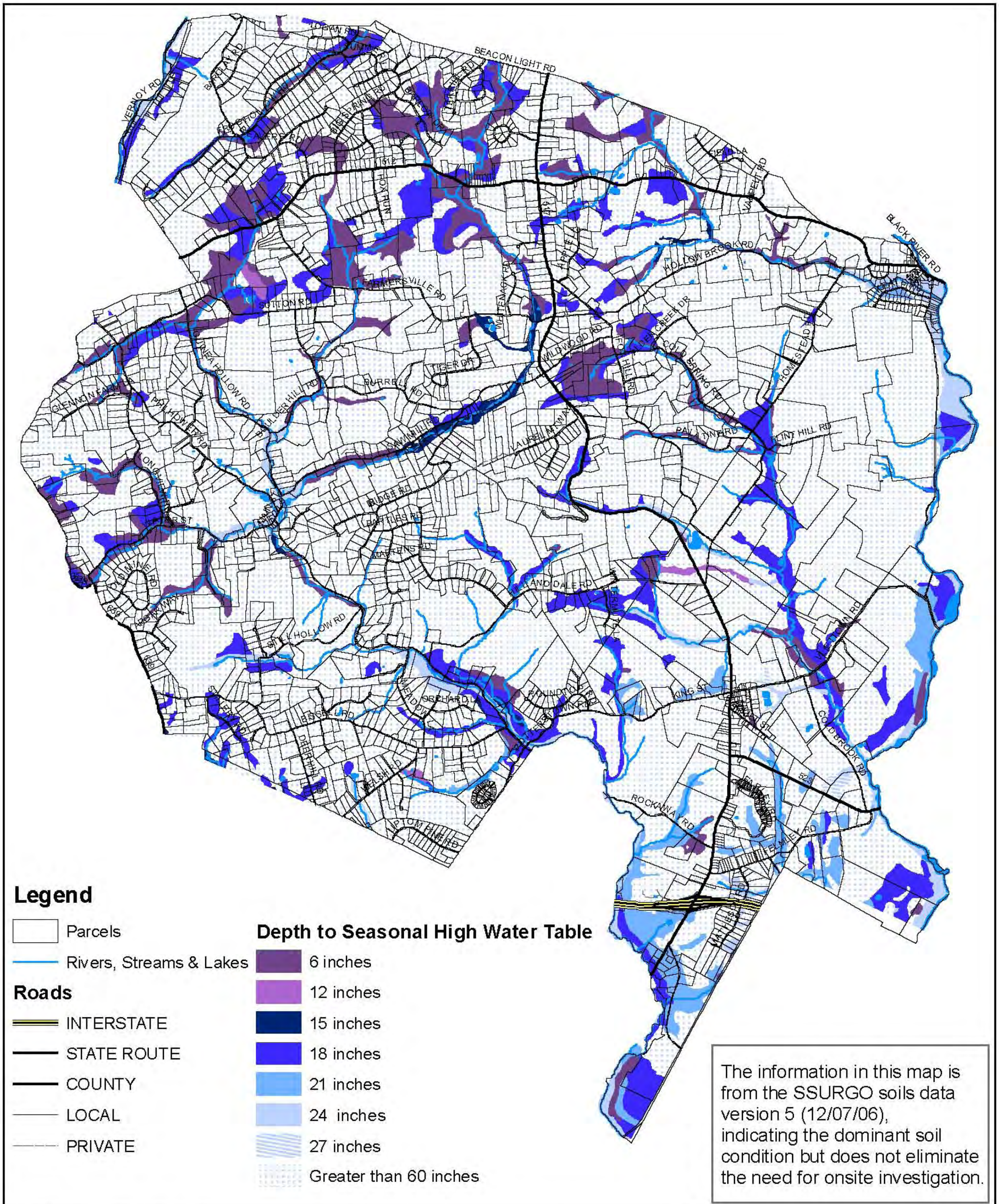
Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 4b: Soils - Depth to Restrictive Layer (Bedrock or Fragipan)

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 4c: Soils - Seasonal High Water Table Depth

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

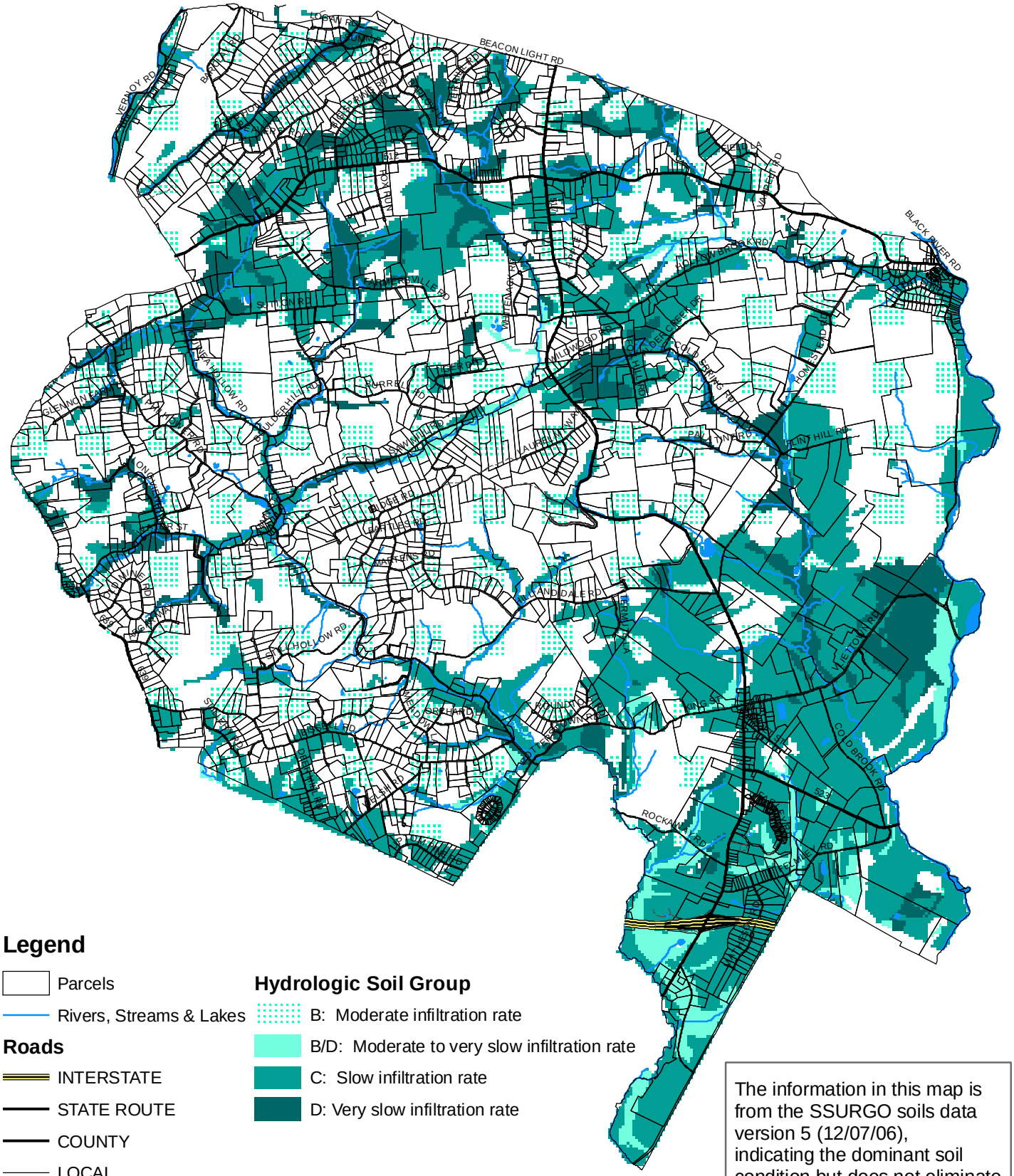
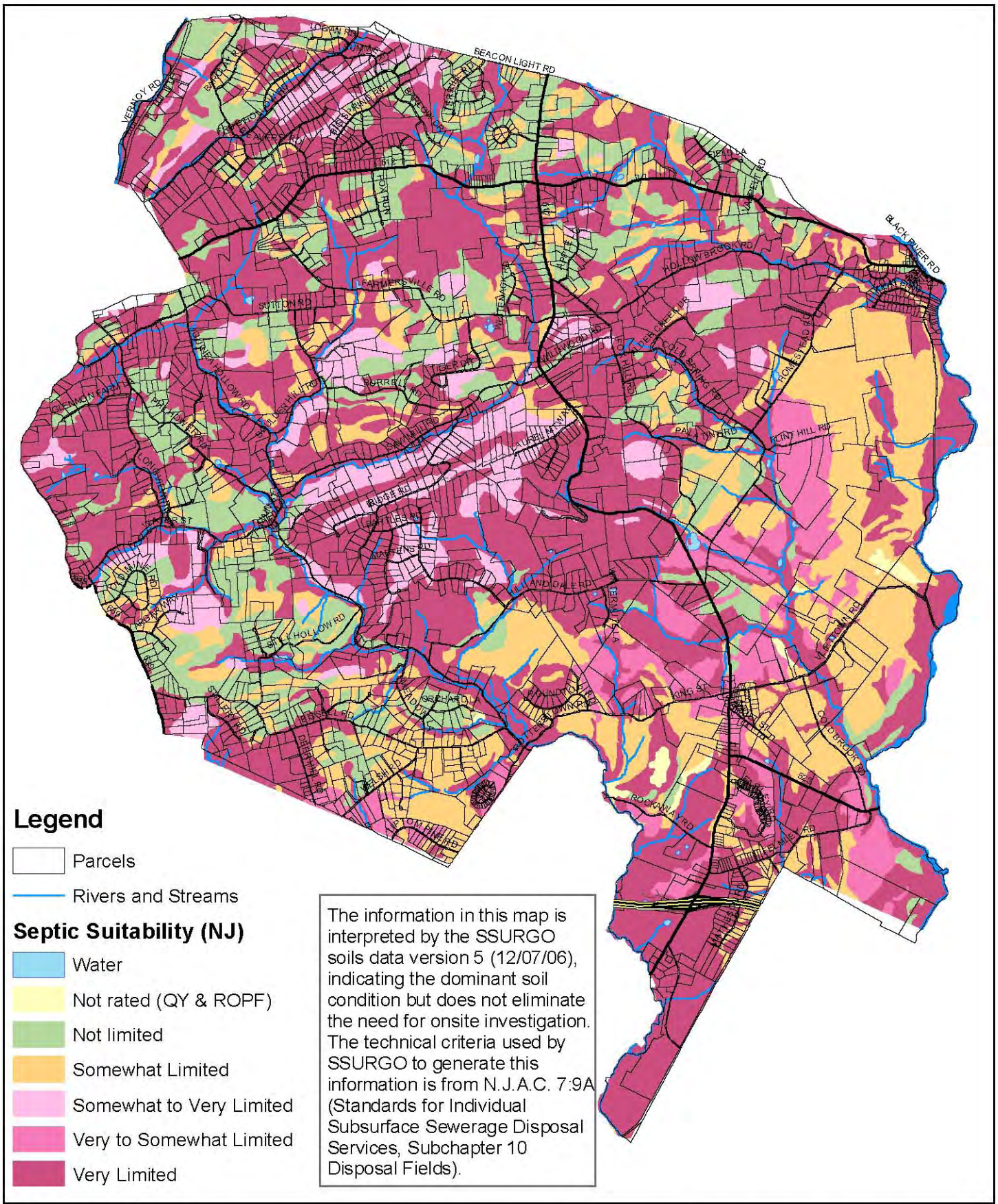


Figure 4d: Soils - Hydrologic Soil Grouping

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Legend

- Parcels
- Rivers and Streams

Septic Suitability (NJ)

- Water
- Not rated (QY & ROPF)
- Not limited
- Somewhat Limited
- Somewhat to Very Limited
- Very to Somewhat Limited
- Very Limited

The information in this map is interpreted by the SSURGO soils data version 5 (12/07/06), indicating the dominant soil condition but does not eliminate the need for onsite investigation. The technical criteria used by SSURGO to generate this information is from N.J.A.C. 7:9A (Standards for Individual Subsurface Sewerage Disposal Services, Subchapter 10 Disposal Fields).

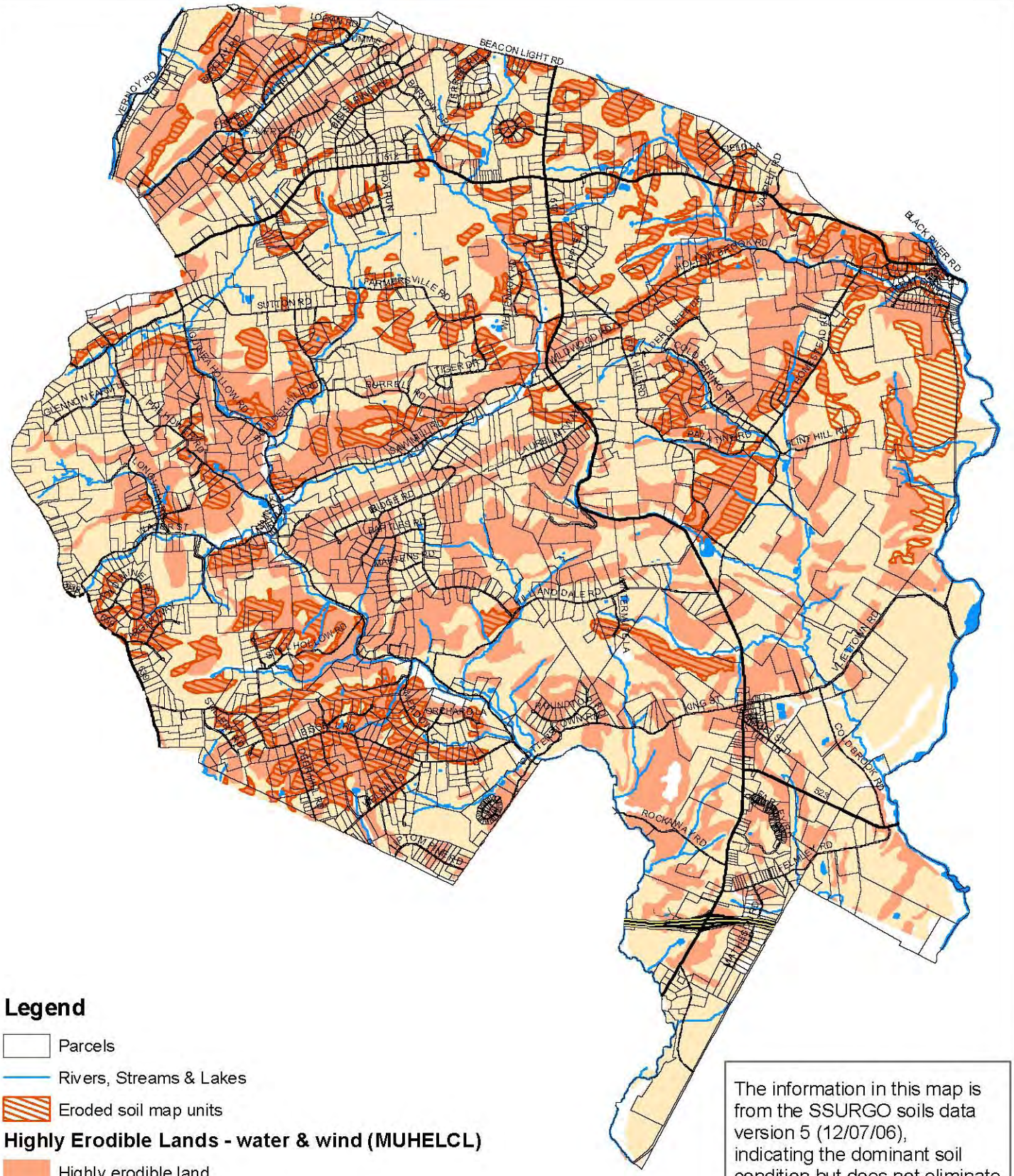
Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 4e: Soils - Septic Suitability (NJ)

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services



Legend

- Parcels
- Rivers, Streams & Lakes
- Eroded soil map units

Highly Erodible Lands - water & wind (MUHELCL)

- Highly erodible land
- Potentially highly erodible land

The information in this map is from the SSURGO soils data version 5 (12/07/06), indicating the dominant soil condition but does not eliminate the need for onsite investigation.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
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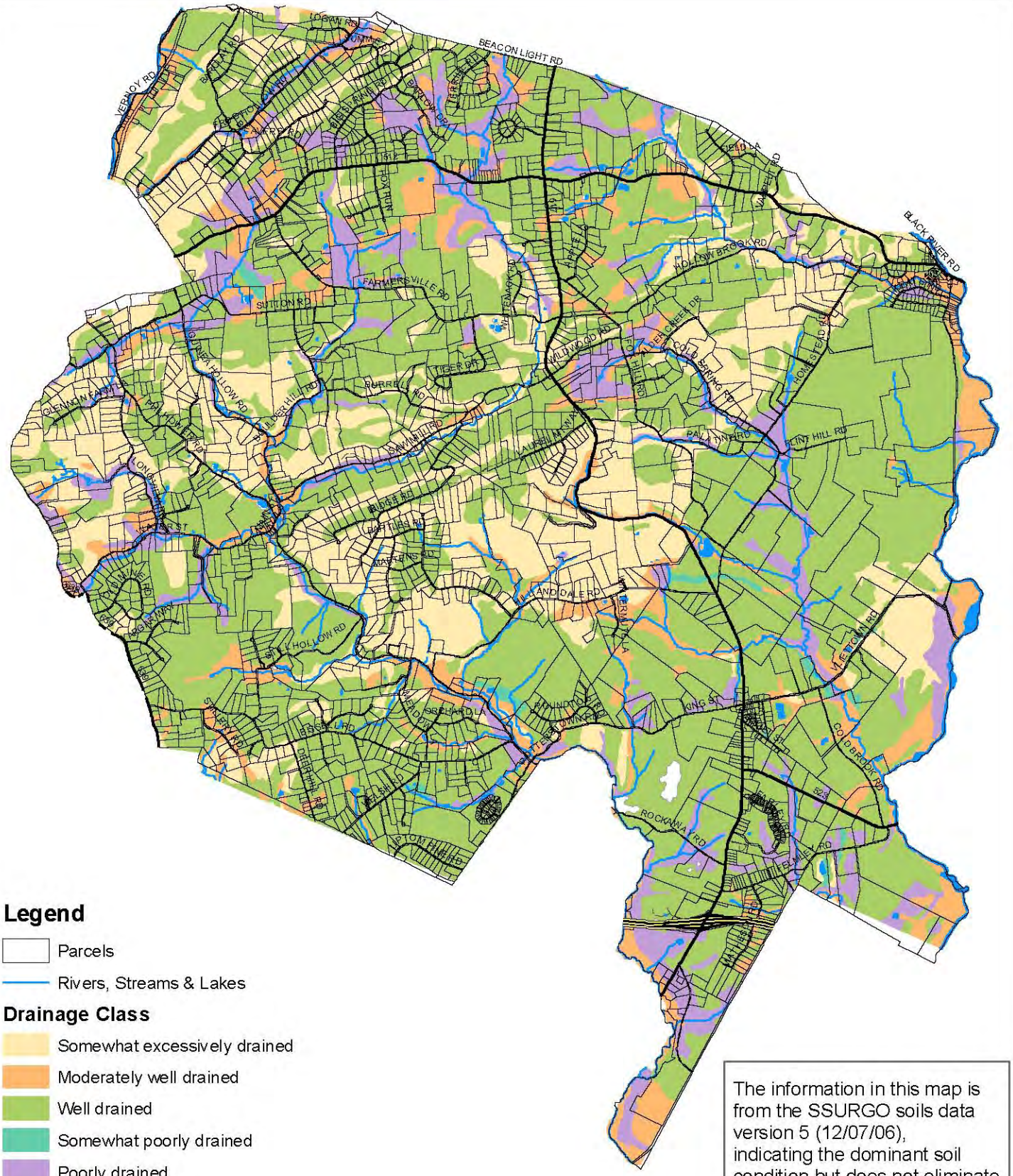
N

0 0.25 0.5 1 1.5 Miles

Figure 4f: Soils - Erodible and Eroded Soils

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services



Legend

- Parcels
- Rivers, Streams & Lakes

Drainage Class

- Somewhat excessively drained
- Moderately well drained
- Well drained
- Somewhat poorly drained
- Poorly drained
- Not classified

The information in this map is from the SSURGO soils data version 5 (12/07/06), indicating the dominant soil condition but does not eliminate the need for onsite investigation.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
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N

0 0.25 0.5 1 1.5 Miles

Figure 4g: Soils - Drainage Class

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 4h: Soils - Prime Farmland Soils

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

5: GROUND WATER

A. Water Cycle

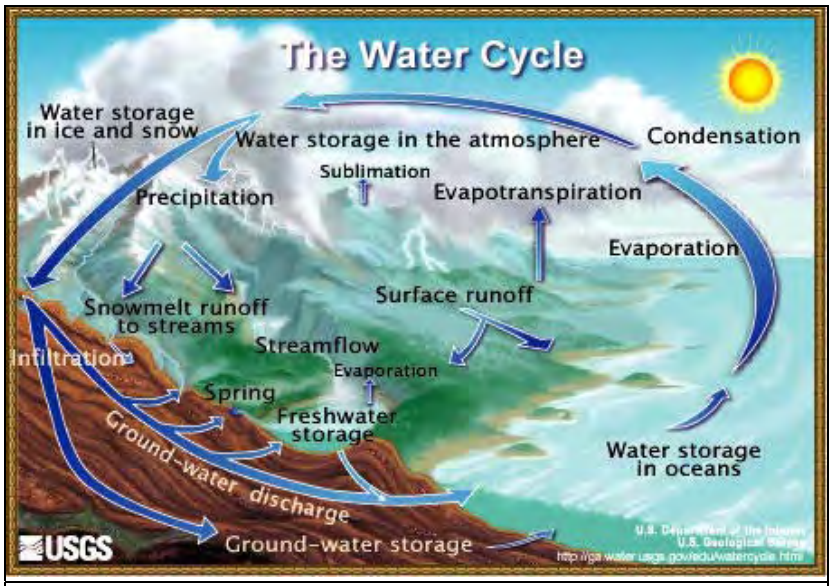


Figure 5a: The Water Cycle
Source: USGS, no date

Water is essential to all life on Earth. The abundance of water distinguishes the Earth from any other planet, but the amount of water on Earth has remained constant for millennia. Even though the quantity of water is great, only a small portion can be used for drinking water and other human needs. Ninety-seven percent of the world's water supply is saltwater stored in the oceans. The remaining 3% is fresh water. However, most of this is unavailable for human use because it is frozen in the polar ice caps, glaciers, and icebergs; too difficult to tap (below 1.6 miles depth); or too polluted. This leaves 0.003% of water that is available as fresh surface or ground water that humans can use (Miller, 1988).

Surface water is water that is visible above the ground surface, such as creeks, rivers, ponds, lakes, and wetlands. *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 rock formation where water is present in usable quantities. Water is constantly recycled through the *hydrologic cycle*, also known as the *water cycle* (see **Figure 5a**). 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, where it 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, called the *aquifer*, where most wells obtain their water.

Pollutants can enter water as it travels the water cycle. Surface runoff can pick up chemicals and soil on its way, depositing these pollutants in waterways. This is especially true of "uncontrolled runoff" on soils that are vulnerable to erosion, as discussed in **Section 6G** of this report. 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). However, ground water in Tewksbury, because it is present in fractures, can potentially move much more quickly. "The rates of movement in … large fractures may approach those observed in surface streams" (Heath, 1983; Freeze and Cherry, 1979). A contaminant could travel quickly through fractures, with little soil contact to allow for filtration or degradation of pollutants. Thus, a well located on a large fracture might have a very good yield, but may be highly susceptible to contamination.

The response of the aquifer to withdrawals from a well or wells determines the well's performance. Drawdown and recovery tests may be performed to determine whether the well will produce enough water for its intended use, and whether that use can be sustained for the foreseeable future. The well's *drawdown* is the difference between the water level before pumping (*static water level*) and the water level during pumping (see **Figure 5c**). A *cone of depression* is the conical-shaped depression of the water table around a pumping well caused by the withdrawal of water. Because of pumping, ground water in the vicinity of the well will deviate from the natural direction of ground water flow and flow towards and into the well (see **Figure 5b**). A cone of depression that extends to an area another well draws from may interfere with the performance of both wells.

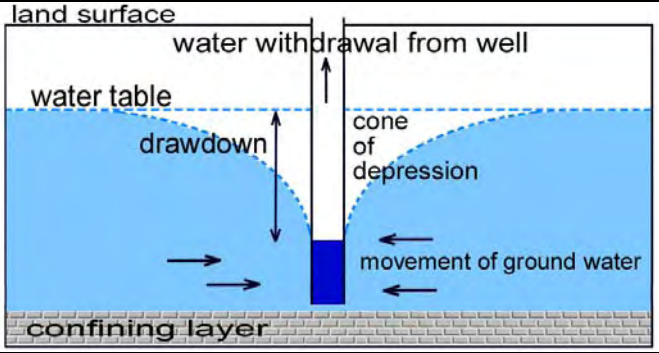


Figure 5b: Illustration of Drawdown and Cone of Depression

B. The Aquifers in Tewksbury Township

Almost half of New Jersey's drinking water comes from ground water. In the northern half of New Jersey, aquifer boundaries roughly correspond to the physiographic provinces (see **Figures 2d: Physiographic Provinces** and **5c: Aquifers**). A primary purpose of the Highlands Water Protection and Planning Act (Highlands Act) (NJSA 13:20-1 et al) (see **Section 10A**) is to protect the precious water resources that supply drinking water to more than half of New Jersey's population.

Tewksbury Township relies exclusively on ground water, through individual wells or public community wells completed in fractured bedrock aquifers. The majority of Tewksbury Township is underlain by aquifers in either the Precambrian crystalline rocks (the Highlands province in the northern region) or the Late Triassic Newark Group of sedimentary rocks (the Piedmont province in the southern half of the township). Both types of bedrock yield water mostly from *secondary porosity*[10] and permeability provided by fractures. Therefore, the

[10] *Porosity* is the measure of voids in soil or rock, which are available to hold water (like holes in a sponge). *Primary porosity* is due to spaces between the soil or rock particles or within porous rock particles. *Secondary porosity* is found in fractures in bedrock. Aquifers with primary porosity store far more water than those with only secondary porosity.

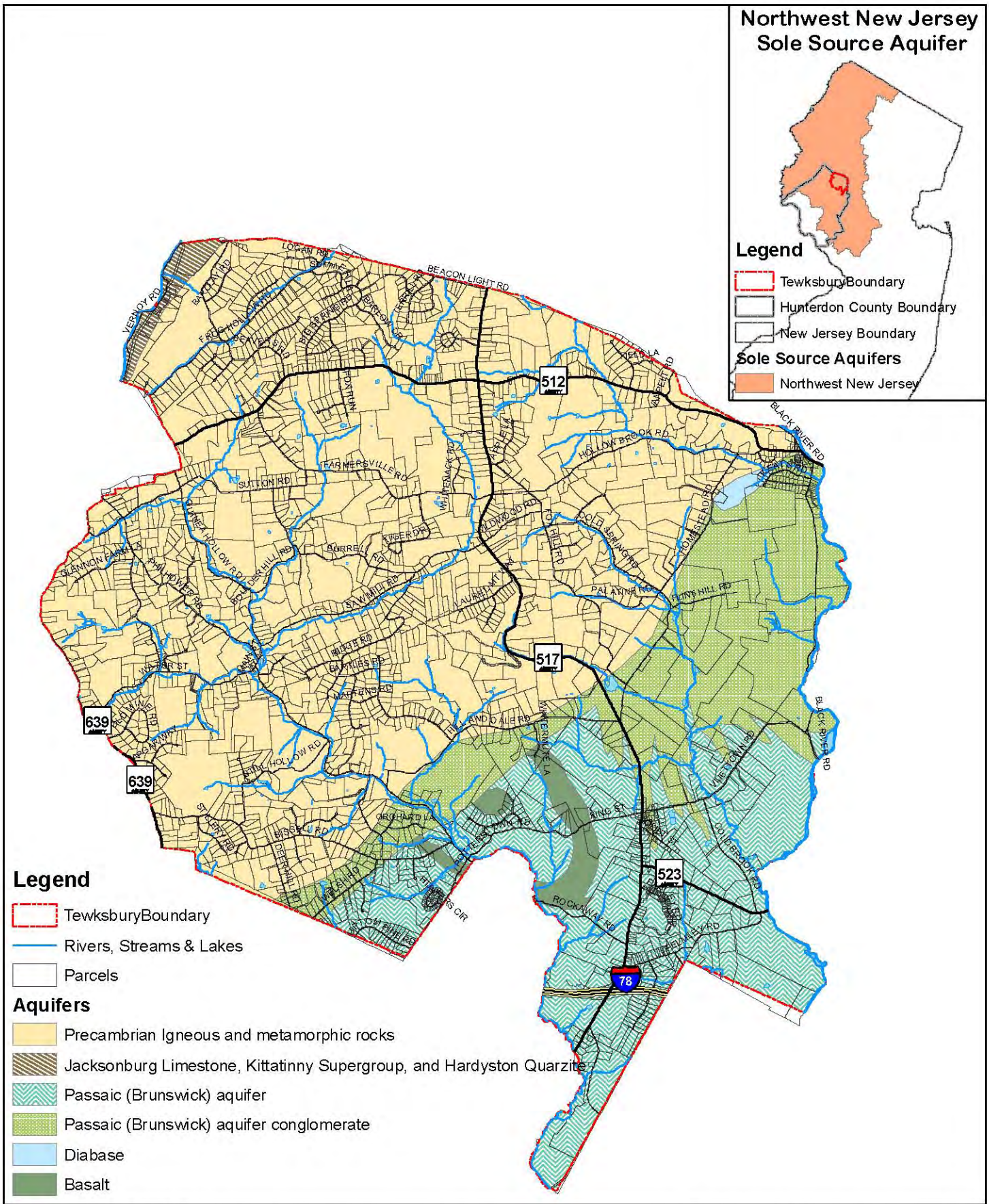


Figure 5c: Aquifers & Sole Source Aquifers

Tewksbury Township ER1, 2009
Prepared by Kratzer Environmental Services

distribution and orientation of these fractures control the rates and directions of ground water flow. The water bearing structures underground may bear little resemblance to the overlying topography.

In bedrock aquifers such as are found in Tewksbury, rocks near the land surface experience weathering, caused by freezing and thawing of water, which has widened fractures and dissolved some of the intergranular cement in the sedimentary rocks. Rocks below the weathered zone, which is usually about 75 feet thick, have no primary porosity (Lewis-Brown, 1995). *Unconfined* conditions commonly exist above this level because pores and fractures in this material are usually well-connected. Below this level, *confined* conditions are caused by the presence of low-permeability layers containing relatively few fractures.

The density of housing and application of surface/subsurface improvements can impact aquifers and may result in reduced recharge, lowered yields, increased interference, and degradation of ground water quality. Furthermore, these changes can alter stream flow dynamics resulting in higher flows after storm events and lowered flows between events. In areas of the Township where aquifer yields and/or recharge are limited or strained, additional housing/improvements may impact current users of ground water (Mulhall, 2003).

Tewksbury Township recognizes the value of the ground water to its current and future residents, downstream users, and ecological receptors. For this reason, the Township seeks to protect the ground water resource. An Evaluation of Groundwater Resources of Tewksbury Township, Hunterdon County, New Jersey was completed by M^2 Associates in 2003 for Tewksbury Township and adopted as part of the Master Plan. Mulhall used the well data compiled in a 1966 report titled Geology and Ground Water Resources of Hunterdon County, N.J. prepared by Haig F. Kasabach, which provides extensive data on well yields and specific capacities with respect to geologic formations.

According to this report, comparisons of local and regional data indicate that the many rock types beneath Tewksbury Township should be considered as five bedrock aquifer types or hydrogeologic zones. The hydrogeologic characteristics of these aquifers are dependent on the type of bedrock and nature of the fractures and other openings. The type of bedrock limits recharge rates, sustained yields, interference effects, ground water quality, and contaminant removal/dilution rates (Mulhall, 2003). In general, the yield of a well is primarily dependent on the number and size of fractures directly intersected by the well bore. Other water-bearing units provide water by leakage through confining units. Wells near surface water bodies can also derive a significant amount of water from the surface water body by *induced infiltration* (Lewis-Brown, 1995). These wells located near surface water often have higher yields (Vecchioli and Palmer, 1962 in Lewis-Brown, 1995), but can be vulnerable to pollution if the surface water carries pollutants.

According to USGS (in Mulhall, 2003), weathering of fractured rock is greatest within 75 feet of ground surface and is negligible at depths greater than 500 feet below ground surface. Measurements by NJDEP indicate that fracture closure occurs within 300 feet of the surface in the Highlands and within 300-400 feet in the Piedmont (EPA, 1988). In the Cambrian dolomites and Triassic-Jurassic Passaic Formation, wells are drilled to deeper depths because there is a good potential to encounter additional water-bearing fractures and therefore, to increase the yield. In contrast, in the Precambrian igneous and metamorphic rocks, Cambrian Hardyston Quartzite, and Jurassic diabase and basalt, increased yields are unlikely beyond 150 feet, but often exceed this depth in order to provide storage of additional water to meet peak demand needs (the typical 6-inch diameter well bore of a residential well can store nearly 1.5 gallons per foot) (Mulhall, 2003).

The aquifers in Tewksbury Township are discussed in the paragraphs below and shown in **Figure 5c**, while aquifer characteristics are summarized in **Tables 5.1 and 5.2**.

PRECAMBRIAN and CAMBRIAN HARDYSTON QUARTZITE

The majority (65.7% or 13,361 acres) of the Township is underlain by the **Precambrian igneous and metamorphic rocks and Hardyston Quartzite** aquifers. Mulhall summarizes that both Kasabach and the NJDEP rate the Precambrian igneous and metamorphic rocks as poor yielding aquifers with low yields, a conclusion that is supported by local well data.

Generally, the Precambrian aquifers are unconfined (fractures are open to the overlying weathered residual soils). Water is mostly obtained from the weathered and fractured zone in the upper 300 feet. High yields may be found in or near major fault zones (USGS, 2005b). However, fractures not associated with major faults are often not highly interconnected or closely spaced. As indicated by Kasabach (1966), in these rocks, if a well is completed near a stream or major fault, the yield may increase because the fractures intersected by the well extend to the stream or fault where additional water can be stored and transmitted. In areas where fractures are distant from each other or not interconnected, each fracture will have a differing water level (Mulhall, 2003).

Data for wells completed in the **Precambrian rock**s beneath Tewksbury Township indicate a median yield greater than elsewhere in Hunterdon County. However, the specific capacity data and estimates of aquifer transmissivity indicate that to compensate for this increased yield, the water level beneath Tewksbury Township must be drawn down to greater depths and that ultimately, the higher yields cannot be sustained. The Precambrian aquifer cannot transmit more water beneath Tewksbury Township than it can beneath other Townships in Hunterdon County (Mulhall, 2003).

According to Kasabach (1966), the **Cambrian Hardyston Quartzite** has hydrogeologic characteristics similar to the Precambrian igneous and metamorphic rocks. Therefore, he included them in his evaluation of the Precambrian rocks. Given the limited extent of the Hardyston Quartzite beneath the Township (66.75 acres or 0.33%) and the poor aquifer characteristics, this unit is not considered a significant water resource for the municipality (Mulhall, 2003).

CAMBRIAN LEITHSVILLE FORMATION

The Cambrian carbonate rocks of the **Leithsville Formation** are encountered beneath approximately 0.4 percent (80 acres) of Tewksbury Township (Mulhall, 2003). Cambrian Leithsville dolomites usually form very good aquifer systems due to the presence of cavities, caverns, and caves. These enlarged openings can store and transmit very large quantities of water, ranking them among the most productive aquifers in New Jersey. For the same reason that carbonate rock aquifers are capable of very high well yields, they are also highly susceptible to contamination from anthropogenic sources. As a result, additional measures are often necessary to protect water quantity and quality. Wells completed in carbonate rocks often range widely in depth because of the presence of solution features. In these rocks, wells are usually terminated at a depth at which a high-yielding zone is encountered and not deepened to further increase storage (Mulhall, 2003).

The aquifer system with the highest capacity to transmit water beneath Tewksbury Township also encompasses the smallest area. However, given the high capacities for these carbonate rocks to store and transmit ground water, the Leithsville dolomite is an important water resource for the Township and region (Mulhall, 2003).

Table 5.1: Well Depths of the Aquifers of Tewksbury Township

Aquifer Unit	% of Twp.	Well Depth Range (feet)			Median Well Depth (feet)	
		Typical Statewide*	Hunterdon County**	Tewksbury**	Hunterdon County**	Tewksbury**
Precambrian and Hardyston Quartzite	65.7%	35 to 800	32 to 533	38 to 405	102•	111
Cambrian Leithsville	0.4%	150 to 400	-	105 to 200	-	-
Passaic Formation Conglomerate Units	13.7%	30 to 1,500	-	105 to 461	-	227
Passaic Formation Shale, Sandstone, Mudstone, Siltstone	16.5%	30 to 1,500	-	86 to 315	-	160
Diabase and Basalt	1.7%	-	-	-	-	-
Feltville	2.0%	-	-	-	-	-

•Note: Mulhall states that these older data may be biased to shallower depths because wells with casing installed to depths less than 50 feet were included and water was derived from the weathered mantle overlying competent bedrock. Based on current NJDEP and Hunterdon County Health Department regulations, a well used for domestic purposes must have steel casing installed to a minimum depth of 50 feet below ground surface to minimize the potential for contamination in shallow portions of an aquifer to degrade water quality within the well. Extending the casing to depths equal to or greater than 50 feet reduced the potential for deriving water from the weathered materials overlying competent bedrock (Mulhall, 2003).

Sources: * USGS, 2005b; **Mulhall (2003)

Table 5.2: Characteristics of the Aquifers of Tewksbury Township

Aquifer Unit	Yield (gallons per minute)		Median Specific Capacity (gpm/ft)		Estimated Aquifer Transmissivity (gpd/ft)		State Rank*
	Hunterdon	Twp.	Hunterdon	Twp.	Hunterdon	Twp.	
Precambrian and Hardyston Quartzite	Range=0-66 Med. Dom=7 Med. Ind.=15 n=203	Range=3-40 Med=20 n=37	Med=0.43 to 0.83 n=124	0.45 n=37	860 to 1,660	900	D
Cambrian Leithsville	Med. Dom.=15 Med. Ind.=250	Med. Ind.=150	Med.=1.83	Med. Ind.=5.8 n=1	3,660	12,000 n=1	C-B
Passaic Formation Conglomerate Units	Range=0-87 Med=12 n=94	14	Med.=1.08	0.27	2,160	532	C
Passaic Formation Shale, Sandstone, Mudstone, Siltstone	Range=0-100 Med=15 n=528	Range=9-70 Med=20 n=19	Range=0-30.3 Med=1.41 N=272	Range=.11-15 Med=0.47	2,820	938	C
Diabase and Basalt	5	-	0.109	-	218	-	E,D
Feltville**	6	-	0.113	-	226	-	E, D

Notes: Range=full range of values; Med. Dom. = Median for Domestic Wells; Med. Ind.=Median for Industrial Wells; n=number of wells evaluated; specific capacity = yield / drawdown (used to develop reasonable approximations of an aquifer's capability to transmit water for comparison to other aquifers within a region); transmissivity of a formation is usually determined by hydrogeologists by a pumping test

* State Rank 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

** According to Mulhall, the Feltville Formation is not hydrogeologically differentiated from Diabase & Basalt Formations.

Sources: Mulhall, 2003; USGS, 2005b; State Ranks are from NJGS GIS data

PASSAIC FORMATION CONGLOMERATE FACIES

The hydrogeologic zone encompassing the third largest portion (13.7% or 2,776 acres) of Tewksbury Township is comprised of the three **Triassic-Jurassic conglomerate** units.

The **Passaic Formation conglomerate facies** are encountered near the border faults between the Piedmont and Highlands Provinces. Given the proximity to this fault, it would be expected that these rocks are highly fractured and capable of transmitting large volumes of water. In addition, in some areas of the state where these conglomerates are highly weathered or fractured, the cementing matrix has been removed and only the original coarse-grained materials remain, resulting in productive aquifers. However, in areas where the quartzite and/or carbonate matrix has not been washed away or dissolved, the tightly cemented conglomerates will have very limited abilities to transmit and store water. Poorly weathered and, therefore, tightly cemented conglomerates are often apparent because they form steep hills or slopes (Mulhall, 2003).

Tewksbury's steep topography and local well data indicate that these conglomerates continue to be well cemented and poorly transmissive aquifers. These rocks have median yields, depths, and specific capacities substantially lower than those of the Precambrian rocks, which, as previously noted, are themselves considered very poor aquifers. These wells must be drilled to significant depths to provide sufficient water (Mulhall, 2003).

PASSAIC FORMATION

Approximately 3,353 acres (16.5%) of Tewksbury Township are underlain by the aquifer system comprised of P**assaic Formation sedimentary rocks**.

The **Passaic Aquifer** is composed of sandstone, siltstone, and shale of the Passaic Formation. Ground water is stored and transmitted in fractures. The water-bearing units are composed of fissile[11] shale and siltstone, and the confining units are composed of massive siltstone. The Passaic formations are characterized by several layers of extensively fractured rocks (water-bearing units) that typically are 1 to 10 feet thick interbedded with layers of sparsely fractured rocks (confining units) that typically are 30 to 100 feet thick. These geologic formations extend thousands of feet below ground, but the density of fractures decreases with depth. Water-bearing, interconnected fractures are present only from the land surface to a depth of about 300-400 feet (EPA, 1987) or 500 feet (Houghton, 1990 in Lewis-Brown, 1995). For this reason, wells extended beyond this depth usually do not increase well productivity (the extra storage provided by the greater length of the well bore-hole may be necessary, however, to supply enough water for the well's intended use). While not as high yielding as carbonate rock aquifers, the extensive fracturing and interconnection of these fractures in the Passaic Formation shales, siltstones, mudstones, and sandstones provide for an aquifer system capable of transmitting and storing sufficient volumes of water to meet most needs.

Although the Passaic Formation rocks may be a good aquifer regionally, Tewksbury Township well data indicate that the Passaic Formation within the township has a poor capacity to transmit water, similar to the Precambrian igneous and metamorphic rocks beneath the Township (Mulhall, 2003). Kasabach (1966) indicates that initial yields in the Passaic Formation are high and that these yields decrease with time as fractures are dewatered. Therefore, continued monitoring to assess long-term yields is warranted (Mulhall, 2003).

[11] *Fissile* means capable of being split.

JURASSIC IGNEOUS & METAMORPHIC ROCKS

Kasabach (1966) indicates that the diabase, basalt and metamorphosed Feltville formations are hydrogeologically the same within Hunterdon County. Within Mulhall's 2003 report, these rock types are combined. Collectively, these **Jurassic igneous and metamorphic rocks** are encountered beneath approximately 3.7% (or 754 acres) of the Township.

Diabase underlays approximately 54.5 acres or 0.27% of the Township. Kasabach (1966) and the USGS (Lewis-Brown, 1995) agree that diabase intrusions in the Newark Basin are very poor aquifers. Since the diabase is significantly younger than the Precambrian rocks, there is less of a weathered mantle above hard bedrock and as a result, yields, specific capacities, and aquifer transmissivities for diabase systems are significantly lower than encountered in Precambrian igneous and metamorphic rocks. The Kasabach (1966) report does not include data for any wells completed in diabase within Tewksbury Township (Mulhall, 2003).

The **Feltville Formation** is encountered beneath approximately 2% (402 acres) of Tewksbury. Geologically, these rocks are very similar to the Passaic Formation. However, within Tewksbury Township, the Feltville Formation experienced the metamorphic effects caused by heating from basalt extrusions and/or diabase intrusions on shales, siltstones, and mudstones, which resulted in the formation of very hard and dense hornfels. The USGS studies (Lewis-Brown 1995) and the Kasabach (1966) report indicate very low yields and specific capacities for these hornfels. The metamorphosed Passaic Formation rocks have aquifer characteristics very similar to diabase and basalt. The Kasabach (1966) report does not include any data for wells completed in this formation (Mulhall, 2003).

The **Orange Mountain Basalt and Preakness Basalt** combined encompass about 1.5% (297 acres) of Tewksbury Township. In Jurassic basalt, various types of vesicles and bubbles formed as the magma cooled. While these can store water, unless they are connected to other openings or fractures, little if any of this water can be transmitted to wells. The basalts may have a thickness of 500-600 feet, and like the Precambrian formations, high yielding fractures are unlikely to be encountered at depths exceeding 150 feet (Mulhall, 2003).

Only one well is reported by Kasabach (1966) in Tewksbury Township as completed in the basalt, but Mulhall cautions that its high yield (25 gpm) is not typical of basalt, and it is likely that this well is influenced by induced infiltration from the nearby Rockaway Creek (Mulhall, 2003).

The diabase, basalt and metamorphosed Feltville formations beneath Tewksbury are the poorest aquifer systems in the township. They have a capacity to transmit water that is equal to approximately 25% of that of the Precambrian and Passaic Formations and approximately 50% of the transmission capacity of the Passaic conglomerates beneath Tewksbury Township.

C. Sole-Source Aquifers

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, June 1988). 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).

In November 1985, NJDEP petitioned the EPA to designate nearly all of the state as a SSA (excluding urban areas around Trenton and in Northeastern NJ). However, some areas did not meet the technical criteria for SSA designation (US EPA, June 1988). All of Tewksbury Township is designated part of the Northwest New Jersey 15 Basin SSA (see **Figure 5b inset**).

D. Recharge

Ground water *recharge* is defined as water added to an aquifer (for example, precipitation that seeps into the ground). 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 coincide with, or are slightly offset from, surface water divides (Lewis-Brown, 1995) (watersheds are described in **Section 6A** and shown in **Figure 6a**). 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 is used in Figure 5d). New Jersey receives an average of 44 inches of precipitation annually, and references vary widely about how much reaches the aquifer (Lewis-Brown, 1996; Kasabach, 1966; USGS, 2005a) in areas like Tewksbury. This is because of the complexity of many factors that 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, see Section 5A). Evaporation likewise, 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 areas have large areas covered with impermeable surfaces, hastening runoff to surface water, instead of allowing precipitation to percolate into the ground.

Expressing the water cycle (see **Section 5A**) in mathematical terms is known as the *hydrologic water balance*. An equation balances the mass of all water entering the basin with that leaving the basin, in simple terms, as follows[12] (Mulhall, 2003):

Water Entering = Water Leaving

Or

Precipitation = Ground Water Runoff + Surface Water Runoff + Evapotranspiration

[12] In this usage, *groundwater runoff* includes both water that infiltrates the soils and shallow bedrock and is transmitted to surface water (streams, wetlands) as well as water that recharges the aquifer.

While precipitation can be measured directly, the other parameters cannot. The Water Balance can be used to evaluate the assumptions made in estimating these indirect parameters and provides a general range of possible values for these parameters.

Solving the equation with inputs appropriate in Tewksbury, if precipitation = 50 inches/year, surface water runoff = 18 inches/year, and evapotranspiration = 26 inches/year, then ground water runoff = 6 inches/year. However, some portion of the ground water runoff figure includes water captured and stored in soils above the aquifer (e.g. wetlands, perched water tables above impermeable layers, etc.). In New Jersey, steel casings must be installed in wells to a depth of 50 feet; therefore water must be capable of infiltrating to at least this depth in order to be captured by a residential well (Mulhall, 2003).

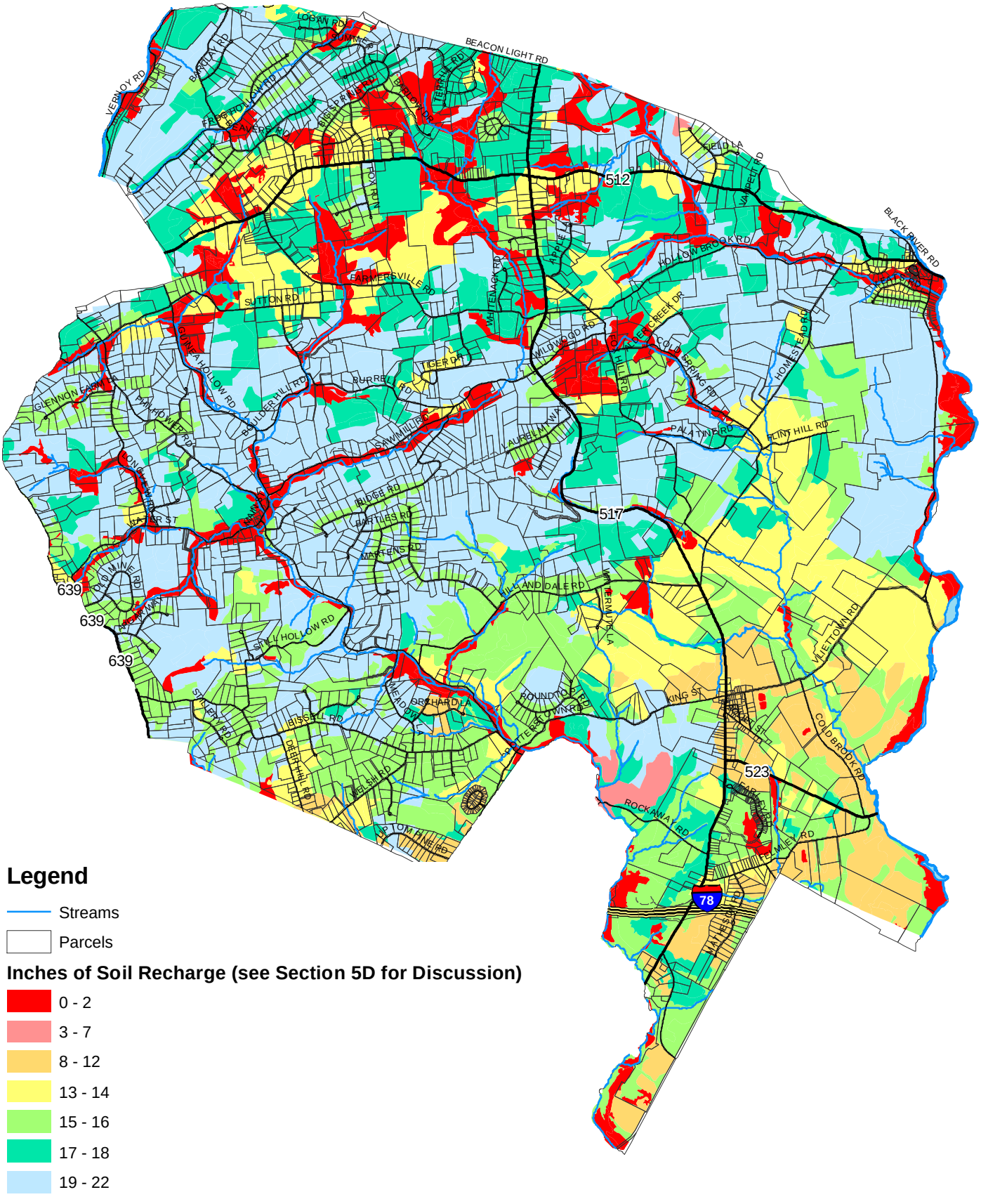
To ensure that water is available during all weather conditions for human consumption as well as ecosystems dependent on water, the NJDEP established the Planning Threshold, or *dependable yield*, to be used for planning purposes. *Dependable yield*, is defined as "the water yield maintainable by a ground-water 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" (NJDEP OEP, 1996). Robert Canace, 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 sections below discuss methods of quantifying recharge, and the applicability of each method.

New Jersey Geological Survey Recharge Method GSR-32: Soil Recharge

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-cover, surface runoff, and evapotranspiration. This method was then applied by NJGS to create a GIS coverage (see Figure 5d). 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 (lesser amounts actually enter the aquifer); 2.) assumes that all water that migrates below the root zone recharges the aquifer (which doesn't 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 (NJ Water Supply Authority, 2002).

As previously mentioned, only a portion of water entering the ground actually recharges the aquifer, but since GSR-32 did not attempt to quantify this amount, this method would be better described as *soil recharge*.



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 5d: NJGS "Soil Recharge"

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

The method estimated average annual subsurface recharge rates from 0 to 22 inches per year in Tewksbury (excluding surface water, wetlands and hydric soils). Applying the 20% consumptive use limit to these figures results in usable recharge from 0 to 4.4 inches per year. However, Mulhall (2003) states that some of the highest rates of soil recharge were calculated for rock outcrops, steep slopes and areas with shale bedrock exposed where runoff rates would in actuality be highest and recharge the lowest. He concludes that the GSR-32 evaluation is *not reliable* for assessing Tewksbury's ground water resources, but that the Township should be aware of the method and its limitations, since it is sometimes presented to Planning Boards as supporting evidence that adequate ground water is available (Mulhall, 2003).

New Jersey Geological Survey Ground Water Potential

In 2005, the NJ Geological Survey developed a qualitative representation of the potential for aquifer recharge for Hunterdon County, NJ built upon the combination of ground-water recharge value rankings (discussed above, and better referred to as "soil recharge") and well-yield-based aquifer rankings (see **Figure 5e**). This effort was also in response to N.J.S.A. 58:11A, 12-16 et seq.

The limitations to the soil recharge information are discussed above, while the well-yield-based aquifer rankings were based on high-yield industrial wells (see **Section 5B**), resulting in an overlay of limited usefulness.

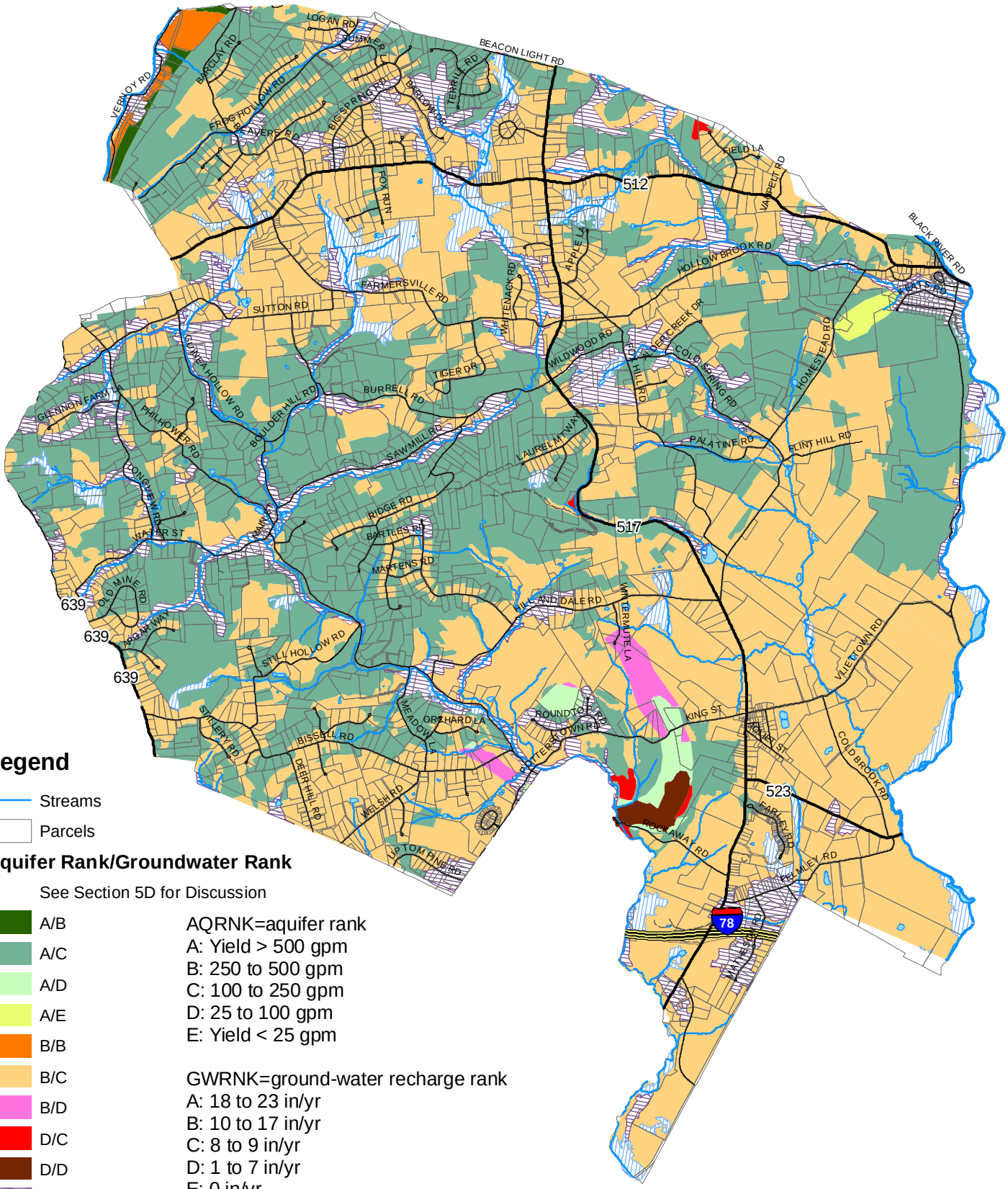
Tewksbury Ground Water Resources Study

In 2003, the previously mentioned Evaluation of Groundwater Resources of Tewksbury Township, Hunterdon County, New Jersey (Mulhall, 2003) used additional available data on ground water recharge estimates to provide an updated assessment of Tewksbury's ground water conditions.

Table 5.3: Aquifer Recharge and Safe Yield in Tewksbury Township

Major Geologic Unit	Aquifer Recharge		Dependable Yield		
	Average Year (inches/year)	Drought Year (inches/year)	(inches / year)	(gpd / acre)	(DU / acre)*
Precambrian and Hardyston Quartzite					
7Q10 Method	1.8	1.8	0.4	26	0.10
Posten Method	4.0	4.0	0.8	60	0.22
Cambrian Carbonate (Leithsville)					
Computer Model	22	14.7	2.9	2.9	0.81
7Q10 Method	3.0	3.0	0.6	0.6	0.17
Passaic Formation Conglomerate Units					
7Q10 Method	1.4	1.4	0.3	0.3	0.07
Posten Method	2.8	2.8	0.6	0.6	0.15
Passaic Formation Shale, Sandstone, Mudstone, Siltstone					
7Q10 Method	2.4	2.4	0.5	0.5	0.13
Computer Model	8.2	5.5	1.1	1.1	0.30
Jurassic Igneous & Metamorphic (Diabase and Basalt & Feltville)					
Computer Model	3.2	2.1	0.4	0.4	0.12
Posten Method	2.1	2.1	0.4	0.4	0.12
* **DU**=Dwelling Units; based on 100 gpd/person from N.J.A.C. 7:10-12 & 2.7 persons/DU from 2000 Census					
Source: Mulhall, 2003 (adapted from Tables 8 and 10)					

A summary of these estimates of ground water recharge and dependable yield is shown in **Table 5.3**. Assuming that each person uses 100 gallons of water per day (the number indicated in N.J.A.C. 7:10-12.6) and a population of 5,541 people (US Census, 2000), Mulhall calculated



Legend

Streams

Parcels

Aquifer Rank/Groundwater Rank

See Section 5D for Discussion

A/B	AQRNK=aquifer rank
A/C	A: Yield > 500 gpm
A/D	B: 250 to 500 gpm
A/E	C: 100 to 250 gpm
B/B	D: 25 to 100 gpm
B/C	E: Yield < 25 gpm
B/D	GWRNK=ground-water recharge rank
D/C	A: 18 to 23 in/yr
D/D	B: 10 to 17 in/yr
L/L	C: 8 to 9 in/yr
W/W	D: 1 to 7 in/yr
	E: 0 in/yr
	L: hydric soils-no recharge calculated
	W: wetlands and open water--no recharge calculated

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 5e: Ground Water Potential (Combined Aquifer & Recharge Ranks)

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

that the residents of Tewksbury Township currently consume approximately 0.55 million gallons per day or 202.2 million gallons per year of ground water. Based on the dependable yields (shown in **Table 5.3**), the hydrogeologic zones of Tewksbury Township could sustain a population ranging from 5,580 to 12,220. Mulhall concludes, "The current population suggests that the Township may be starting to fully utilize its available ground water resources. Continued growth may be sustained in some portions of the Township but should be monitored for potential adverse impacts. This assessment of the dependable yield usage is based on population and does not include water usage for agricultural irrigation and/or commercial demands. Large water demands imposed by these agricultural or commercial operations would result in a reduced sustainable population and number of dwelling units. For every 100 gpd used for these operations, the sustainable population would be reduced by 1 person"(Mulhall, 2003).

In addition to these estimates of safe yield, sound planning must also consider septic system impacts on the aquifer (Mulhall, 2003), which is discussed in the next section.

Highlands Regional Management Plan: Water Deficits

According to the Highlands Regional Management Plan, "Sustaining the Highlands Region's water resources is a matter of statewide importance. Increases in human population and changes in land use threaten those water resources by contributing to over-withdrawal of ground water and surface water systems, and a reduction of recharge rates. Human demand for water, generated by growth, results in depleted aquifers, reduced base flows in streams and reduced safe yields of reservoirs. The protection of base flow is critical to maintaining viable aquatic ecosystems and protecting potable water supplies, particularly during periods of drought….Where water resources are stressed, management strategies are necessary to reduce and where feasible eliminate deficits, and to ensure that supplies are not depleted further. These strategies should also endeavor, wherever possible, to mitigate existing water demands and ensure that future demands are only granted upon the condition of reduction of water deficits" (Highlands Water Protection and Planning Council, 2008 (RMP), p.243).

To assess the sustainability of Highlands water resources, the Highlands Council conducted a net water availability analysis using hydrologic data and annual water use and withdrawal data ranging from years 2000-2005. The details of the analysis are described in the Water Resources Volume II (Highlands Water Protection and Planning Council, 2008). The results for the subwatersheds within Tewksbury are shown in **Table 5.4**, revealing that two of these may already have deficit water availability: the Lamington River (Halls Bridge Road to Pottersville gage) and the Lamington River (below Halls Bridge Road).

The conformance process with municipalities and counties will be an opportunity to update and verify the data used in this assessment with local-scale information about water use and water supply from local governments and utilities. The process will allow for both updating and validating the method and verifying whether initial estimates are correct. These methods and policies will also be used by NJDEP for the next New Jersey Statewide Water Supply Plan (Highlands Water Protection and Planning Council, 2008) and in the Water Quality Management Planning Rules that were adopted May 21, 2008 (NJDEP, 2008).

Table 5.4: Highlands Region Water Availability by HUC14 Subwatershed; Tewksbury Subwatersheds

Subwatershed Name HUC14	Ground Water Capacity (MGD)	Ground Water Avail-ability (MGD)	TOTAL C/D Uses (MGD)	Net Water Avail-ability (MGD)	Cond. Avail. Water for C/D Uses (MGD)	Agriculture Ground Water Availability (Conservation Zone) (MGD)	Agri-culture C/D Uses (MGD)	Agriculture Net Water Avail-ability (MGD)
Raritan River South Branch (Califon bridge to Long Valley) 02030105010060	3.2737	0.164	0.1541	0.0096				
Cold Brook 02030105050060	1.4496	0.072	0.0233	0.0492		0.145	0.011	0.134
Lamington River (Halls Bridge Road to Pottersville gage) 02030105050070	3.1167	0.156	0.4838	(0.3280)	0.0312	0.312		0.312
Rockaway Creek (above McCrea Mills) 02030105050080	3.9790	0.199	0.0724	0.1266		0.398	0.005	0.393
Rockaway Creek (Rockaway South Branch to McCrea Mills) 02030105050090	0.5245	0.026	0.0117	0.0145				
Rockaway Creek South Branch 02030105050100	1.6583	0.332	0.1701	0.0829				
Lamington R (below Halls Bridge Road) 02030105050110	0.5596	0.028	0.0672	(0.0392)	0.0056			
C/D Uses = Consumptive & Depletive Uses; MGD=Million Gallons per Day								
Source: Highlands Water Protection and Planning Council, 2008 (Water Resources Volume II)								

E. Nitrate Dilution Modeling

Most water used by humans in the township is recycled through septic systems, and recharges the aquifer for downstream users. However, the water from these wastewater disposal systems does not meet Federal or State Drinking Water Quality Standards and, therefore, requires dilution within the aquifer to sufficiently reduce contaminant concentrations (Mulhall, 2003).

A 2007 study by NJDEP determined that nitrate is a suitable surrogate for assessing impact of development using individual subsurface sewage disposal systems on ground water quality (NJDEP, 2007). Nitrate is also used as an indicator of anthropogenic impacts to ground water, especially impacts associated with sewage disposal, such as pathogenic bacteria or viruses and other man-made chemical compounds. Nitrate is not naturally found in ground water, but can enter ground water from septic systems, fertilizers, manure storage and spreading, and decomposing plants. Elevated nitrates can cause methemoglobinemia (Blue Baby Syndrome) in infants. Since nitrate and other contaminants are not easily removed from ground water, proactive planning can ensure that adequate dilution is available (Mulhall, 2003).

A method of protecting ground water quality through science-based planning is the use of *Nitrate Dilution Modeling* to evaluate the potential impacts to ground water from septic systems. Mulhall (2003) used the Trela-Douglas nitrate dilution model for Tewksbury Township. The model predicts recommended lot sizes to maintain water quality based on drought recharge and current and predicted levels of nitrate. **Table 5.5** shows a summary of these results. During droughts, dilution that usually comes from precipitation is reduced or absent, which could result in elevated nitrate levels in the ground water. Mulhall used two methods of determining drought recharge for each aquifer unit (shown in **Table 5.3**). Background concentrations of nitrate in ground water were found to range from 0.76 mg/L in the Passaic to 3.15 mg/L in the carbonate

aquifers (see **Table 5.5**). Mulhall calculated target nitrate concentrations ranging from 5.38 to 6.58 mg/L, based on the NJDEP antidegradation policy (Mulhall, 2003).

The calculated range of minimum lot sizes to maintain water quality varies from 1.26 to 6.11 acres in the carbonate geology to 7.78 to 15.85 acres in the Passaic conglomerate units. Mulhall cautions, however, that these permitted limitations would allow contaminant concentrations in ground water to increase up to more than 7 times above current background levels. In addition, in areas of the township with existing lot sizes smaller than the recharge areas needed, it may be necessary to preserve or protect upstream open areas within the same watershed to ensure sufficient ground water recharge and dilution capacity to support the existing demands (Mulhall, 2003).

Table 5.5: Nitrate Concentrations and Dwelling Unit Densities in Tewksbury Township

Major Geologic Unit	Aquifer Recharge		Recharge Area for Septic Contaminant Dilution (acres)
	Background Nitrate* (mg/L)	Anti-degradation Limit Nitrate (mg/L)	
Precambrian and Hardyston Quartzite			
7Q10 Method	0.76	5.38	13.35
Posten Method			5.84
Cambrian Carbonate (Leithsville)			
Computer Model	3.15	6.58	1.26
7Q10 Method			6.15
Passaic Formation Conglomerate Units			
7Q10 Method	1.6	5.8	15.85
Posten Method			7.78
Passaic Formation Shale, Sandstone, Mudstone, Siltstone			
7Q10 Method	1.6	5.8	9.11
Computer Model			3.92
Jurassic Igneous & Metamorphic (Diabase and Basalt & Feltville)			
Computer Model	1.6	5.8	10.19
Posten Method			10.19
* Background nitrate concentration from Hoffman (2001) in Mulhall (2003) **Anti-degradation limit determined from N.J.A.C. 7:9-6 in Mulhall (2003)			
Source: Mulhall, 2003 (adapted from Table 11)			

Highlands Regional Management Plan: Septic System Densities

Septic system density is one of various factors used in determining the land use capability of areas in the Highlands Region. The Highlands Water Protection and Planning Act Rules (N.J.A.C. 7:38, December 2006) provide guidance on Regional Master Plan approaches relating to septic system density. Two objectives of the Highlands Council are 1) restrict the potential for increased risks to human health from ground water that exceeds 10 milligrams per liter (mg/L) of nitrates and, 2) restrict increased human health and ecologic impacts from other pollutants that are associated with nitrates. Background and details concerning nitrate management are found in the Highlands Water Protection and Planning Council Water Resources Volume I (2008).

The Highland Council used the Trela-Douglas nitrate dilution model, as was used by Mulhall (2003) in the ground water report commissioned by Tewksbury Township. Model inputs and target nitrate concentrations differed from those used by Mulhall. Annual recharge values were estimated using GSR-32 under assumed drought conditions, using the New Jersey Drought of Record spanning 1961-1965 (see **Section 5D** for discussion of NJGS method GSR-32; see **Table 5.3** for Mulhall's recharge estimates). The Highlands Council has developed the following target nitrate concentrations:

Existing Community Zone – 2 mg/L (NJDEP proposed statewide threshold)
Conservation Zone (CZ) – 1.87 mg/L (estimated median concentration)
Protection Zone (PZ) – 0.72 mg/L (estimated median concentration)
Clustered Development – 10.0 mg/L (as required by N.J.A.C. 7:15, would be applied to the developed portion of the cluster, with application of the relevant Highlands Zone target (CZ, PZ) to the entire project area).

The Highlands RMP requires that all new residential development using septic systems be designed in a manner that minimizes the risk of well contamination due to the flow of septic system plumes within or between developed lots, addressing general ground water flow patterns, major fracture systems and other appropriate geological, geophysical and hydrogeological issues, and well construction (Highlands Water Protection and Planning Council, 2008).

F. Ground Water Quality

Pollution, such as nitrates, bacteria, metals, pesticides and antibiotics, can enter ground water via non-point sources (including septic systems and runoff from fields and roads), point sources (including discharge pipes), and rain. The New Jersey Comparative Risk Project (2003) identified a number of possible human health risks from drinking water, including lead (which, when present, is usually from the plumbing (NJDEP, 2004)), radon, arsenic, MTBE, nitrates, and waterborne pathogens.

The New Jersey Private Well Testing Act (N.J.S.A. 58:12A-26 et seq.) became effective in September 2002. The PWTA requires mandatory statewide well testing upon the sale or lease of a house served by a private well. The well water must be tested for primary contaminants[13] (bacteria, volatile organic compounds, arsenic, lead and nitrates) and secondary contaminants[14] (pH, iron and manganese). Beginning March 16, 2004, gross alpha particle activity is also required in Hunterdon County. A report summarizing the first 6 years of data generated by the PWTA revealed that arsenic, gross alpha, nitrate and bacteria standards are sometimes exceeded in Tewksbury Township (a new arsenic Maximum Contaminant Level of 5 µg/l became effective in 2006) (see **Table 5.6**). The report concluded that: 1) certain geologic formations in the Piedmont region contain layers that may leach arsenic into the ground water as it passes through, and 2) wells drilled into bedrock aquifers are more susceptible to fecal coliform contamination than wells in the coastal plain. In time, the data from the PWTA may be used to determine water quality trends and assessments of the safety of private well sources (NJDEP Division of Water Supply / Bureau of Safe Drinking Water and Division of Science, Research and Technology, July 2008).

One site in the Passaic aquifer is part of the NJ Geological Survey Ambient Ground Water Quality Monitoring Network (AGWQM). The goal of this program is to evaluate the status of and trends in ambient ground water quality as a function of land use. The program began in 1999, sampling each site once every 5 years (Serfes and Bousenberry, 2007).

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

[14] Secondary contaminants and 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.

Table 5.6: Private Well Testing Act Results 2002-2007

Parameter	Tewksbury			Hunterdon County	New Jersey
	Number of Wells Sampled	Exceedances	% Exceedances	% Exceedances	% Exceedances
VOC	372	0	0%	0.6%	1.4%
Arsenic	268	7	2.6%	18%	11.8%
Gross Alpha	236	3	1.3%	4%	9.6%
Nitrate	372	2	0.54%	0.80%	2.7%
Bacteria	*Township data not available*			3.9%	2.2%

Source: NJDEP Division of Water Supply / Bureau of Safe Drinking Water and Division of Science, Research and Technology, July 2008

G. Ground Water Quality Standards

The New Jersey Ground Water Quality Standards (GWQS; N.J.A.C. 7:9C) 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 5H**), 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 (see **section 6D** for surface water classifications), 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. *Class II* waters are those not specifically designated Class I or Class III. The designated use of Class II ground waters is to provide potable water using conventional treatment. Class II criteria specify the levels of constituents above which the water would pose an unacceptable risk for drinking water. *Class III* ground waters can be used for anything other than for potable water (NJDEP, 2008).

Tewksbury's waters are designated Class II (to provide potable water with conventional treatment). 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. In fact, NJDEP has designated two sites in Tewksbury where ground water contamination has been identified (see **Section 5I** and **Figure 5f**).

H. Ground Water Discharges

New Jersey regulates the discharge of pollutants to ground water under the authority of the New Jersey Water Pollution Control Act (WPCA) N.J.S.A. 58:10A. The New Jersey Pollutant Discharge Elimination System (NJPDES) permit program regulations are contained in N.J.A.C. 7:14A.

NJPDES permits are required for discharges to ground water of both sanitary and industrial wastes. These permits, which limit the mass and/or concentration of pollutants discharged, are issued to sanitary and industrial facilities that have ongoing, operational discharges of wastewater to ground water. The purpose is to restrict the discharge of pollutants to

the ground waters of the state and protect the public health and the environment. Discharges from past activities may continue to be regulated under the Site Remediation Program or the Division of Solid and Hazardous waste.

In Tewksbury Township, there are five existing NJPDES discharges that are listed in **Table 5.7** and mapped in **Figure 5f**. GWQS (see **Section 5G**) Class II regulations apply to these discharges. The accompanying descriptions of the discharges are from applicable issues of the DEP Bulletin, the official publication of Public Notices of NJDEP actions.

Table 5.7: NJ Pollution Discharge Elimination System - Ground Water Discharges in Tewksbury Township

Facility Name Site Identification Number	Description from NJDEP Bulletin
CHRISTY PROPERTY - WASTEWATER FACILITIES NJ0138592 Lot 22, Block 44, Route 523 (Oldwick Road) Tewksbury Twp., NJ Hunterdon County	May 13, 2009: "The project consists of the following facilities: Alternative Living Units (1, 2 and 3 bedrooms), Senior Housing Units (5 bedrooms), Library, Volunteer Fire House with Banquest[sic] Hall and Historical Society House The facility generates a maximum quantity of 9,975 gpd of wastewater. The wastewater is treated to the Ground Water Quality Standards prior to discharge to a subsurface disposal field. The wastewater is discharged to two subsurface disposal beds providing a total of 20,000 ft2 of infiltrative area. The flow from the facility shall be limited to 9,975 gpd. Residuals generated in the treatment process shall be periodically removed from the primary settling tank to an approved residual management facility."(1) August 28, 2002: Identical notice to above. (2)
A M BEST CO INC NJ0134627 1 AM Best Road Tewksbury Twp., NJ Hunterdon County	July 22, 2009: "This is a renewal action which also authorizes an increase in the volume of wastewater discharged to the subsurface disposal beds. Sanitary wastewater is discharged to a Wastewater Treatment and Recycling System (WTRS) that discharges to subsurface disposal beds. Potable water softener backwash and boiler blow down water to the WTRS represents an additional discharge of 121 gpd. This permit action authorizes an increased loading rate to the disposal bed from 1 gpd/sq ft. to 2 gpd/sq.ft. The design flow of the WTRS is 8,221 gpd. The disposal field is comprised of two beds of laterals with a total of 3,825 square feet of disposal area. The discharge of wastewater to the onsite disposal field is limited to a flow volume of 7,500 gpd. The facility is an office complex that includes bathrooms. Sanitary waste generated by the facility is treated by the onsite WTRS. A portion of the wastewater is recycled back to the office complex to use in restrooms for non-potable toilet flushing. Any other portions of wastewater are discharged to a subsurface disposal field located onsite." (3) April 7, 2004: Similar to July 22, 2009 entry above, except "...The design flow of the facility is 3,825gpd." (4)
CROSSROADS AT OLDWICK NJ0104396 Crossroads at Oldwick Rt 523 Tewsksbury, NJ	May 13, 2009: "The project consists of a maximum of 75 single family dwelling units, treatment plant and subsurface disposal fields. The design flow for the facility, based upon N.J.A.C. 7:14A-23.3(a), is 22,500 gallons per day (75 3 bedroom or larger units @ 300 gpd/unit). The wastewater is treated to groundwater quality standards prior to disposal to subsurface disposal fields. The treated effluent will be discharged to two subsurface disposal beds providing a total of 49,600 ft2 of infiltrative area. Disposal area 1 shall provide a minimum of 39,600 ft2 of disposal area, and shall receive a maximum discharge of 15,000 gpd (maximum loading rate of 0.38 gpd/ft2). Disposal area 2 shall provide a minimum of 10,000 ft2 of disposal area, and shall receive a maximum discharge of 7,500 gpd (maximum loading rate of 0.75 gpd/ft2). The flow from the facility shall be limited to a maximum of 22,500 gpd. Residuals generated in the treatment process shall be periodically removed from the primary settling tank to an approved residual management facility." (5) July 14, 2004: "This permit was transferred from Toll Brothers to Applied Wastewater Management Inc effective 4/29/04."(6) February 13, 2002: The proposed project was expanded from the original proposal from 40 units

Facility Name Site Identification Number	Description from NJDEP Bulletin
	to a maximum of 75 single family dwelling units, otherwise, the same as May 13, 2009 entry, above.(7) November 27, 2002: "This permit is transferred from Whitehouse Partners to Toll Brothers Inc effective 1/1/2002."(8)
OLDWICK WATER POLLUTION CONT NJ0055956	2008: GW>20,000 0.03 mgd (9)
TEWKSBURY TWP ELEMENTARY SCHOOL NJ0139998 109 Fairmount Rd. Tewksbury Twp. Hunterdon County	November 21, 2007: This is a renewal permit action for Tewksbury Township Elementary School, with details unchanged from April 24, 2002 entry, below. (10) April 24, 2002: "The Tewksbury Township Elementary School is a proposed 63,000 square foot school which will serve a maximum population of 600 students, teachers and staff. The school will also have a cafeteria. The maximum daily volume of sanitary sewage generated shall be 9,000 gallons per day. The sanitary wastewater will be treated prior to disposal to a subsurface disposal field. The residual shall be periodically pumped from storage tanks for offsite disposal at an authorized residual management facility. The design volume of sanitary sewage for the proposed elementary school is 9,000 gallons per day. The sanitary sewage is treated by an onsite advanced wastewater treatment system and the effluent is discharged into a series of subsurface disposal beds. Up to 24,480 ft2 of disposal area is provided with a maximum loading rate of 0.368 gpd/ft2. There are three (3) 48' * 170' subsurface disposal beds proposed."(11)

Sources: NJDEP GIS layer NJPDESgwd.zip
(1) DEP Bulletin, Volume 33 Issue 9. May 13, 2009. NJDEP, Trenton, NJ.
(2) DEP Bulletin, Volume 26 Issue 16. August 28, 2002. NJDEP, Trenton, NJ.
(3) DEP Bulletin, Volume 33 Issue 14. July 22, 2009. NJDEP, Trenton, NJ.
(4) DEP Bulletin, Volume 28 Issue 7. April 7, 2004. NJDEP, Trenton, NJ.
(5) DEP Bulletin, Volume 33 Issue 9. May 13, 2009. NJDEP, Trenton, NJ.
(6) DEP Bulletin, Volume 28 Issue 13. July 14, 2004. NJDEP, Trenton, NJ.
(7) DEP Bulletin, Volume 26 Issue 20. November 27, 2002. NJDEP, Trenton, NJ.
(8) DEP Bulletin, Volume 26 Issue 3. February 13, 2002. NJDEP, Trenton, NJ.
(9) No DEP Bulletin reference found. Information is from the Highlands Water Protection and Planning Council, 2008 (Utility Capacity Technical Report)
(10) DEP Bulletin, Volume 31 Issue 21. November 21, 2007. NJDEP, Trenton, NJ.
(11) DEP Bulletin, Volume 26 Issue 8. April 24, 2002. NJDEP, Trenton, NJ.

I. Contaminated Ground Water Sites

The NJDEP Bureau of Planning and Systems compiled a list of Known Contaminated Sites (KCS). The Known Contaminated Sites List for New Jersey 2005 (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.) are those sites and properties within the state where contamination of soil or ground water has been identified or where there has been, or there is suspected to have been, a discharge of contamination. It is important to note that some of the cases listed may have been fully remediated and should no longer be considered contaminated sites. In addition, new contaminated sites may have been identified since the creation of this list and are not included here. For further information contact NJDEP's Site Remediation Program and Waste Management (SRWM) lead program, which are identified with each site listed in this data base.

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. The sites

included in this dataset are handled under various regulatory programs administered by the NJDEP's Site Remediation and Waste Management program, including the New Jersey Brownfield and Contaminated Site Remediation Act, Industrial Site Recovery Act, Solid Waste Management Act, Spill Compensation & Control Act, Underground Storage of Hazardous Substances Act, Water Pollution Control Act and the Federal Comprehensive Environmental Response, Compensation and Liability Act, Superfund Amendments and Reauthorization Act, and Resource Conservation and Recovery Act Corrective Action Program. A site can be regulated under more than one of these regulatory programs.

Within Tewksbury, there are 10 KCSs, none of them on the National Priorities (Superfund) List (see **Table 5.8** and **Figure 5f**).

The *Deed Notice Extent* GIS layer identifies those Known Contaminated Sites (KCS) or sites on Site Remediation Programs' (SRP) Comprehensive Site List (CSL) that have been assigned a Deed notice. A deed notice is defined in 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, a delineation of those restrictions, a description of all specific engineering or institutional controls at the property that exist and that shall be maintained in order to prevent exposure to contaminants remaining on the property, and the written consent to the notice by the owner of the property". Its purpose is to provide information and to help minimize any chance of exposure to contaminated soils. One Deed Notice Case (see **Table 5.8** and **Figure 5f**) is located within Tewksbury, on Burrell Road, where the contaminant of concern is listed as Total Petroleum Hydrocarbons. According to the GIS data, this case has been resolved to the extent that the remedial investigation is complete and all remedial solutions have been applied (NJDEP SRP, 2007).

Areas that are specified as having *Currently Known Extent* (CKE) of ground water pollution are geographically defined areas within which the local ground water resources are known to be compromised because the water quality exceeds drinking water and ground water quality standards for specific contaminants. The CKE areas are intended to provide information to the public about contaminated ground water areas in the state. Unless precautionary measures are taken to protect potable users, well installation should be avoided. This information is being made available so informed decisions can be made on well location, design, or treatment before wells are proposed, permitted, and installed (NJDEP SRP, 2007b).

One CKE extends from Washington Township (Morris County) over the northern boundary of Tewksbury (see **Table 5.8** and **Figure 5f**). It is known as the "Cleaveland Industrial Center." The contaminants include metals and Volatile Organic Compounds and Semi-Volatile Organic Compounds in the soil and ground water. According to the most recent Publicly Funded Cleanups Site Status Report (2003), "Cleaveland Industrial Center has a history of industrial operations dating back more than five decades. The U.S. government manufactured explosives at the site during the 1940s. The property was sold to a private company in 1947 and it has operated as an industrial park since the 1950s. A tenant that manufactured sodium and iodine salts reportedly discharged its process waste water directly onto the ground behind the complex. Another tenant, Lanterman Machine and Tools, Inc., allegedly discharged hazardous wastes into septic systems. Fabritex Mills abandoned approximately 1,000 containers of chemicals, including flammable solvents, caustics, dry chemicals and laboratory reagents, when it ceased operations at the site in 1986. During the 1980s sampling of private potable wells in the area revealed that 17 were contaminated with volatile organic compounds at levels exceeding New Jersey Drinking Water Standards. Point-of-Entry Treatment (POET) systems were installed on the wells with funds provided by NJDEP as an interim measure to supply potable water for the residents. A preliminary investigation by NJDEP indicated that contaminated ground water was

migrating from the site. USEPA implemented a removal action in 1991 to dispose of the chemicals left at the buildings formerly occupied by Fabritex Mills. Between 1993 and 1997 the Washington Township Municipal Utilities Authority used funds provided by NJDEP to extend public water lines to the residences with contaminated wells and approximately 170 additional properties with wells that were at risk of becoming contaminated. In 1999 NJDEP's Remedial Response Element began a Remedial Investigation and a Remedial Action Selection (RI/RAS) to delineate the contamination at the industrial park and off-site areas and evaluate cleanup alternatives. NJDEP implemented an Interim Remedial Measure (IRM) the following year to remove all of the abandoned above ground and underground storage tanks. The RI has revealed significant contamination in the on-site soil and on-site and off-site ground water. NJDEP expects to complete the RI/RAS in late 2004." (NJDEP SRWM, 2003).

The NJDEP Dataminer website reveals that there are 15 sites with regulated Underground Storage Tanks (UST) listed within Tewksbury. Only one of these continues to use the USTs (see **Table 5.8**), while the rest have been removed and are considered terminated.

Table 5.8: Contaminated Sites in Tewksbury Township

Site Identification Number	Name & Address	Status* Date	Lead Agency**	Remedial Level***
Known Contaminated Sites List (KCSL)				
255146	10 HOLLOW BROOK RD 07830	10/27/2005	BFO-N	C1
221182	2 FOX HILL RD 08858	3/10/2004	BFO-N	C2
261139	2 STRAWBERRY LN 08833	12/8/2005	BFO-N	C1
219130	23 BURRELL RD 08833 Deed Notice: Ongoing Date: 12/1/2004	12/6/2004	BOMM	B
263589	32 HUNTERS CIR 08858	9/27/2005	BFO-N	C1
131477	32 POTTERSTOWN RD 08858	3/11/2002	BFO-N	C2
G000011565	33 MATHESON RD 08858	2/10/1997	BFO-N	C2
G000062277	5A & 5B COLD SPRINGS RD 08858	5/2/2001	BFO-N	C2
261356	COKESBURY RD MVA 1014 CALIFON COKESBURY RD 08833	8/17/2005	BFO-N	B
009915	OLDWICK MATERIALS INC 126 ROCKAWAY RD 08858	6/3/2002	BNCM	C2
217910	ZION LUTHERAN CHURCH OF OLDWICK 56 OLD TURNPIKE RD 08858	12/18/2003	BFO-N	C1
KCSL Site Re-Evaluation Report August 2006◆				
G000023461	3 JOLIET STREET	Assigned to RPIU. Under Invest-igation		
005011	AMBEST COMPANY AMBEST RD	Assigned to Lead Bureau		
Deed Notice Extent				
00166654	Rambling Hills Farm 20 Burrell Road	12/1/2004	BFO-N	
Currently Known Extent (CKE)				
	Cleaveland Industrial Center			
Underground Storage Tanks (UST)				
015228	DELCYM INC T/A OLDWICK VILLAGE GARAGE 30 Old Turnpike	9/30/09		

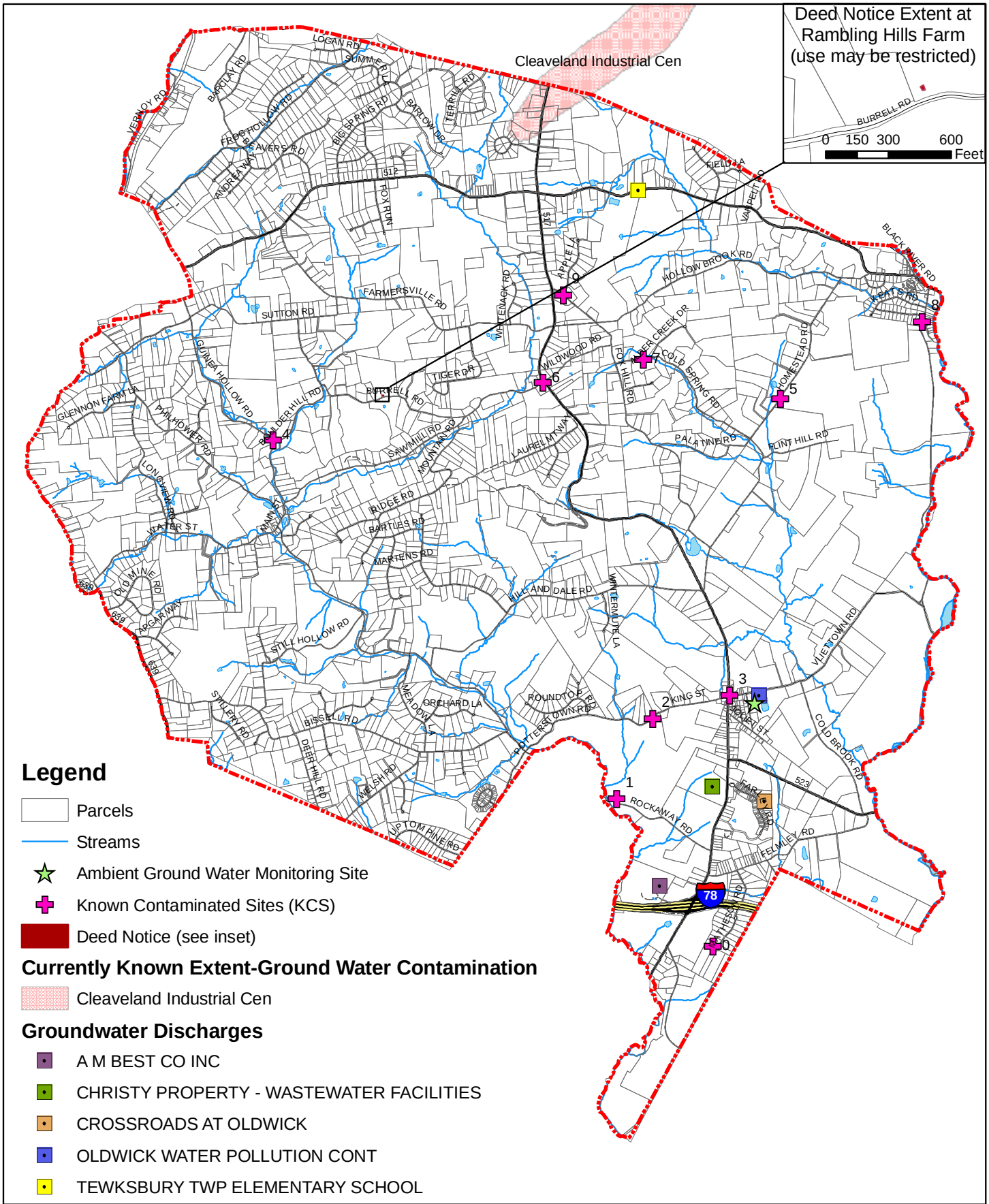
***STATUS – all sites in this list are Active:** This status is designated when a contaminated site is assigned to a remedial program and measures such as a preliminary assessment, remedial investigation or cleanup work is underway; **Status Date:** The date that the site was assigned to the contact bureau.

Lead Agency: **BFO-N = Bureau of Field Operations – Northern (973) 631-6401; BNCM = Bureau of Northern Case Management (formerly BEECRA) (609) 777-0899; BOMM = Bureau of Operation, Maintenance & Monitoring (609) 984-2990

***Remedial Level**: A: Emergency Action – stabilization; B: A single phase remedial action with a single contaminant affecting only the soil; C1: Remediation does not require a formal design. The source of the contamination is known or has been identified. There is a potential for ground water contamination; C2: Remediation requires a formal design. The source of the contamination is known OR the release has caused ground water contamination; C3: A multi-phased remediation action. Where the source of the contamination is either unknown or there is an uncontrolled discharge to Soil and/or ground water; D: A multi-phased remediation with multiple sources/releases to multiple media including ground water; U: not yet determined

◆These sites were removed from the *Known Contaminated Sites in New Jersey* (KCSNJ) report for reevaluation by the Site Remediation Program. These *pending* sites were a group of contaminated sites awaiting the execution of an oversight document, such as a Memorandum of Agreement or Administrative Consent Order, or the availability of resources for a publicly funded action prior to assignment to a specific remedial bureau.

Sources: KCSL: NJDEP SRWM GIS data, Feb. 2006; NJDEP SRWM, Spring 2006; NJDEP SRWM, 2007.
UST: NJDEP Dataminer website, 2008: http://datamine2.state.nj.us/DEP_OPRA/OpraMain/get_long_report?



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 5f: GW Discharges, Known Contaminated Sites, etc.

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

J. Ground Water Level Monitoring

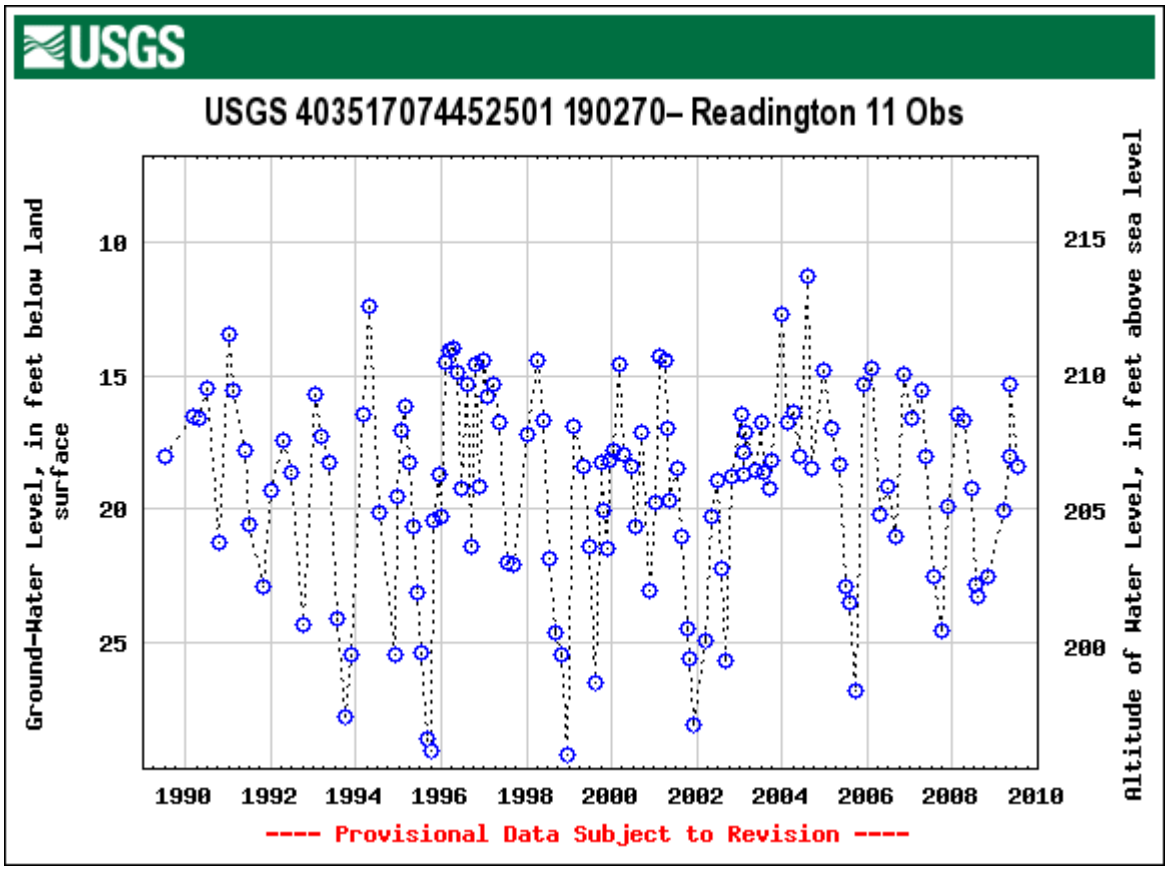
The *ground water level* is the distance from the land surface (i.e. top of well casing) to the water in a well. Ground water level monitoring is critical for determining the current state of the ground water, identifying trends and predicting ground water drought. In addition to drought, over-withdrawal 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, as well as causing a decrease in the baseflows of adjacent streams.

The Hunterdon County Master Plan of 1972 recommended that "a network of observation wells be established… several years prior to …development so that gradual changes from the natural environment will be recorded." (Elam and Popoff, 1972).

There are no wells monitored regularly for static water level within Tewksbury. However, the USGS maintains a nation-wide network of wells to monitor the effects of droughts and other climate variability on ground-water levels. One USGS monitoring well is located nearby in the Passaic aquifer in Readington; and one is located in the Precambrian aquifer near Chester, Morris County, although not the same geologic unit that occurs in Tewksbury. Descriptions of these sites are provided in **Table 5.9**, while the ground water level for the available period of record is shown in **Figure 5g**.

Table 5.9: USGS Ground Water Climate Response Network – wells currently monitored near Tewksbury

PASSAIC AQUIFER
Site Number: 403517074452501 - 190270--READINGTON SCHOOL 11 OBS **LOCATION:** Whitehouse Station, Hunterdon County, New Jersey , Hydrologic Unit 02030105 Latitude 40°35'17", Longitude 74°45'25" NAD27 **Well depth:** 101 feet **Hole depth:** 101 feet **Land surface altitude:** 224.99 feet above sea level NGVD29 Well completed in "Early Mesozoic basin aquifers" (N300ERLMZC) national aquifer. Well completed in "PASSAIC FORMATION" (227PSSC) local aquifer **Begin date (periodic record):** 07/14/1989 **Begin date (continuous record):** 04/25/1990 **Continuous record summary stats**: *Highest Water Level*: 8.74' *Mean*: 18.80' *Lowest Water Level*: 29.84'
PRECAMBRIAN AQUIFER
Site Number: 404934074400501 - 271190--BLACK RIVER 10 OBS **LOCATION:** near Chester, Morris County, New Jersey, Hydrologic Unit 02030105 Latitude 40°49'04", Longitude 74°40'53" NAD27 **Well depth**: 200 feet **Hole depth**: 200 feet **Land surface altitude**: 890 feet above sea level NGVD29 Well completed in "Piedmont and Blue Ridge crystalline-rock aquifers" (N400PDMBRX) national aquifer. Well completed in "PRECAMBRIAN ERATHEM" (400PCMB) local aquifer **Begin date (periodic record):** 10/05/1989 **Begin date (continuous record):** 05/21/1992 **Continuous record summary stats:** *Lowest Water Level*: 16.32' *Mean*: 8.29' *Highest Water Level*: 0.0'
Note: The above sites are maintained by USGS New Jersey Water Science Center. See **Figure 5g** for graphs of data from these sites. Source: USGS, 2009



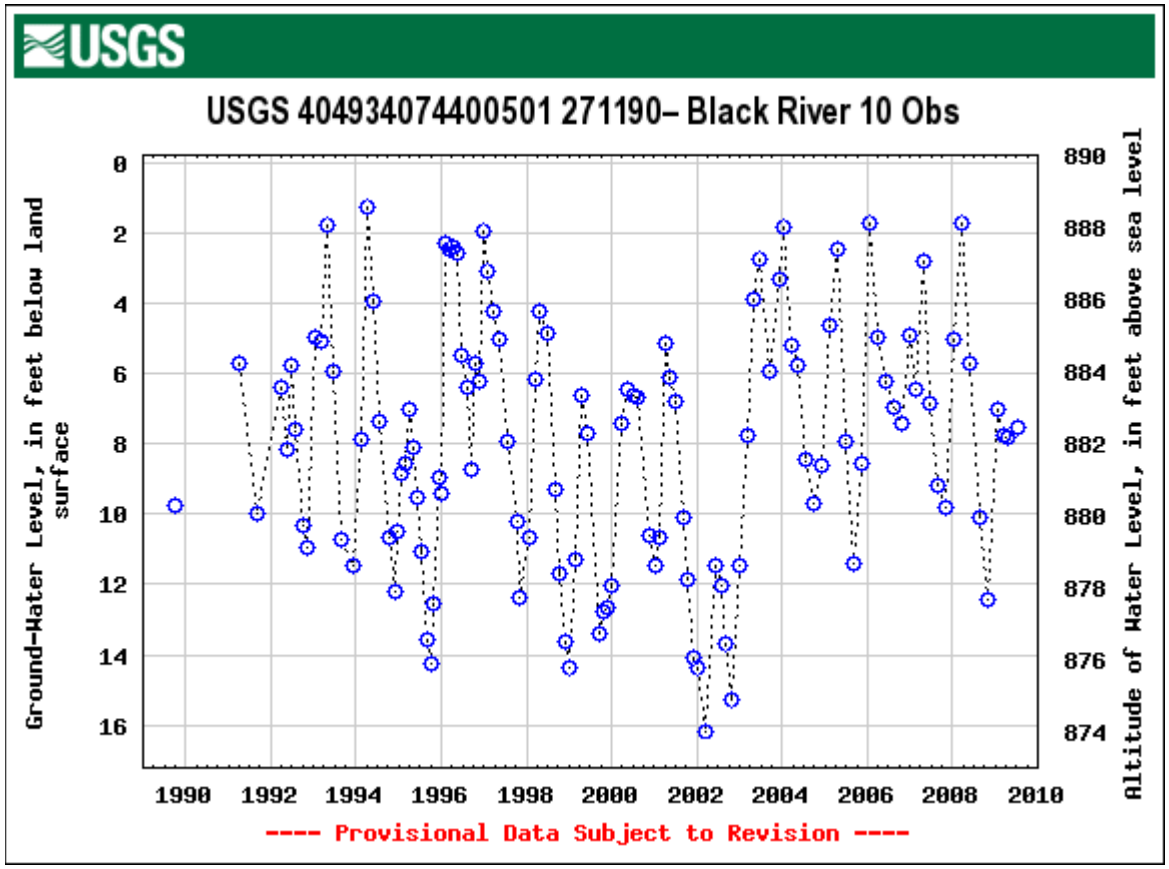


Figure 5g: Ground Water Level at Readington and Black River (Chester) Stations monitored by USGS Source: USGS, 2009

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Hunterdon County Well & Septic System Care: http://www.co.hunterdon.nj.us/health/wellguide.htm

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- Private Well Testing Act. 2002. N.J.A.C. 7:9E. http://www.state.nj.us/dep/pwta/
- Rules & Regulations (current & proposed): http://www.nj.gov/dep/rules/
- Surface & Ground Water Quality Standards and Assessment: http://www.state.nj.us/dep/wms/bwqsa/

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- Arsenic in NJ Ground Water: http://www.state.nj.us/dep/njgs/enviroed/infocirc/arsenic.pdf
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USGS - Water Resources of NJ: http://nj.usgs.gov/

6: SURFACE WATER

A. Watersheds

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. *Sub-watersheds* are those smaller drainage areas that make up a larger watershed. *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," and has established a watershed management approach (NJDEP, 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. More information concerning watershed management is presented in **Section 10C**.

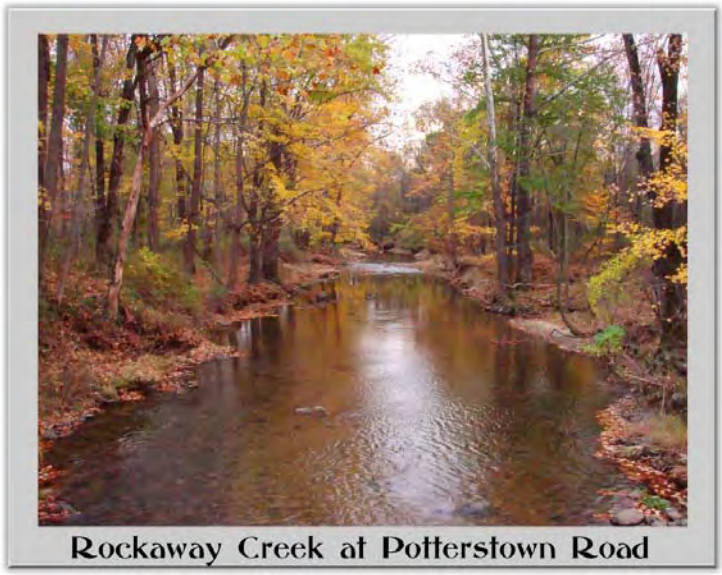

Rockaway Creek at Potterstown Road

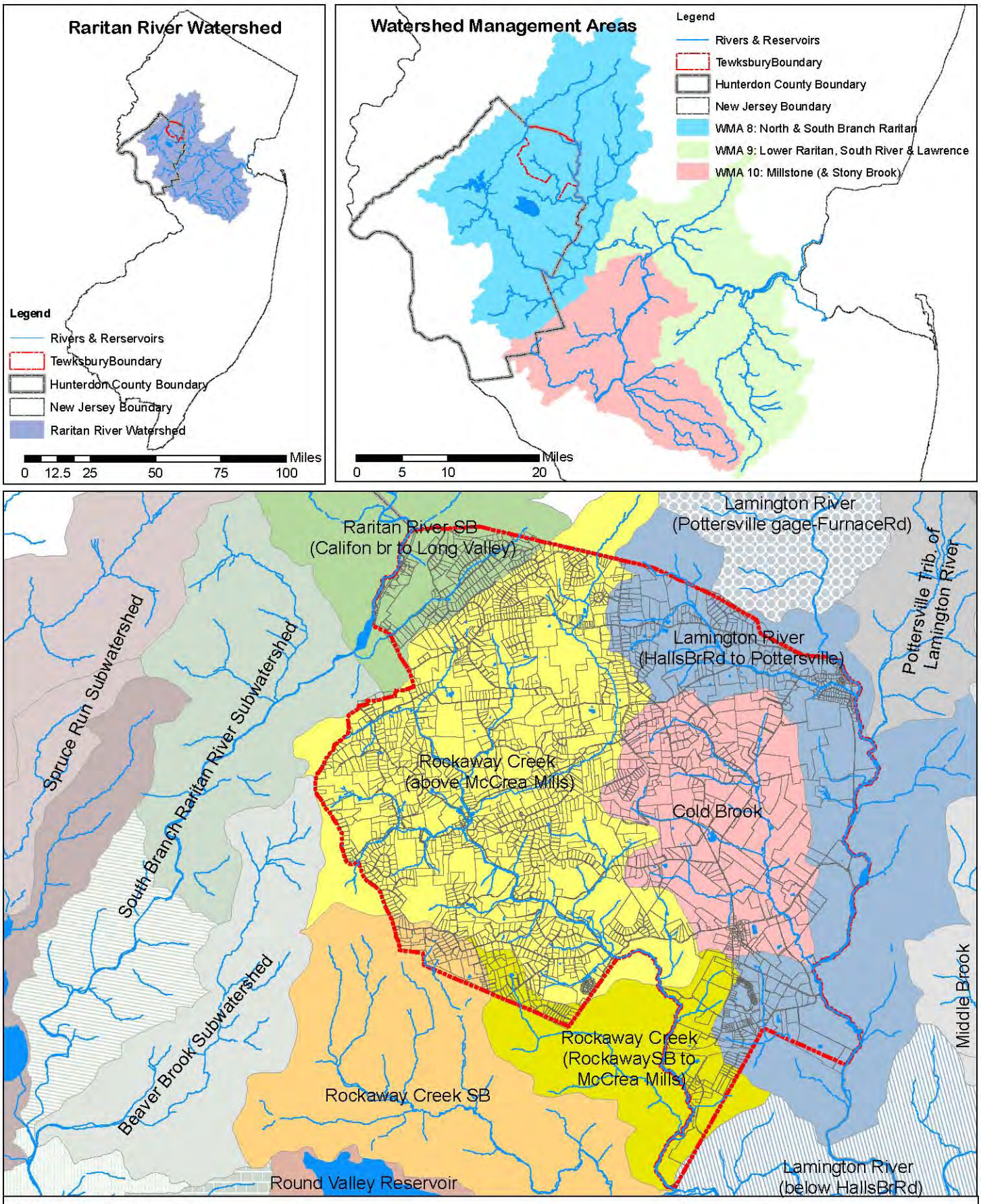
Figure 6a shows the watersheds, sub-watersheds and streams either within or partially within Tewksbury Township. The classification system used by the NJDEP assigns each watershed a *14-digit Hydrologic Unit Code (HUC14[15]).* The HUC14 is a hierarchical system where the first 4 digits (also known as a HUC4) refer to the major drainage basin. The land area of New Jersey that drains to the Atlantic Ocean is assigned a HUC4 of "0203." The Raritan River basin is assigned a HUC8 of "02030105." All of Tewksbury Township is within the Raritan River watershed, thus every sub-watershed within this basin has a HUC that starts with "02030105." **Table 6.1** lists the HUC14s for the subwatersheds within Tewksbury Township.

> "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)

When using the NJDEP's *Watershed Management Areas (WMA's)*, all of Tewksbury falls within WMA 8, which includes both the North and South Branches of the Raritan River (see top right inset in **Figure 6a**).

The northwestern corner of Tewksbury lies within the watershed of the South Branch Raritan River. The remainder of the township drains to the Lamington River, which forms Tewksbury's eastern border. The sub-watersheds of the Rockaway Creek and Cold Brook drain the central portion of the township and join with the Lamington River, which in turn joins to the North Branch Raritan River.

[15] The HUC14s have a minimum size of 3,000 acres, although some basins are defined with smaller areas. At other times, small subwatershed units are combined.



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 6a: Watersheds & Watershed Mgmt. Areas

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

Table 6.1: Hydrologic Unit Codes for Tewksbury's Subwatersheds

14-Digit Hydrologic Unit Code (HUC14)	Subwatershed Name
South Branch Raritan River Watershed	
02030105010060	Raritan River South Branch (Califon br to Long Valley)
North Branch Raritan River Watershed	
02030105050080	Rockaway Creek (above McCrea Mills)
02030105050090	Rockaway Creek (Rockaway South Branch to McCrea Mills)
02030105050100	Rockaway Creek South Branch
02030105050060	Cold Brook
02030105050070	Lamington River (Halls Bridge Road to Pottersville)
02030105050110	Lamington River (below Halls Bridge Road)
Source: NJGS, 2006	

B. Floodplains/Flood Prone Areas

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 defines these geographic areas based on studies of flood risk.

FEMA publishes *Flood Insurance Rate Maps* (FIRMs) that show the flood zone boundaries. FIRMs are the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). FEMA uses the FIRMs to produce the digital Q3 Flood Data, which are shown in **Figure 6b**. The Q3 data identify Special Flood Hazard Areas (SFHAs), however more detailed information may be obtained from the paper FIRM. SFHAs 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[16] (FEMA, 1996).

Flood Facts

- Floods are the #1 natural disaster in the United 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 (SFHA) or high-risk area and have a Federally backed mortgage, your mortgage lender requires you to have flood insurance.

(FEMA, 2008a)

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

Areas in *Zone X*, which includes the majority of Tewksbury Township, have low to moderate risk of flooding. They correspond to areas outside the 1% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1% annual chance stream flooding or where the contributing drainage area is less than 1

[16] 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).

square mile. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in this zone.

Zones with a high-risk of flooding, or SFHAs, 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 Tewksbury that participate in the NFIP, all homeowners in Zones A and AE are required to get flood insurance in order to get a loan from a federally regulated lender. These areas have a 26% chance of flooding over the life of a 30-year mortgage (FEMA, 2008b).

Floodplains in Tewksbury are shown in **Figure 6b**, based on FEMA determinations and also on soils that show evidence of flooding. Frequent flooding occurs in areas adjacent to the South Branch Raritan River, Rockaway Creek and Lamington River, and along many of the smaller tributaries to a lesser extent. The majority of the township is not subject to flooding, due to the township's hilly terrain and its location in or near the headwaters of its streams.

On the northwestern edge of the Township, the 1% annual chance floodplain of the South Branch of the Raritan River reaches approximately 200 to 650 feet wide on the Tewksbury side.

The Rockaway Creek comprises the majority of the floodplains as it bisects the Township. From the point where Rockaway Creek enters the township near Beacon Light Road south to Saw Mill Road, Rockaway Creek's floodplain averages less than 300 feet wide. Floodplains up to 900 feet can be found around Mountainville and along Rockaway Road from near Meadow Lane to the southeastern tip of the Township.

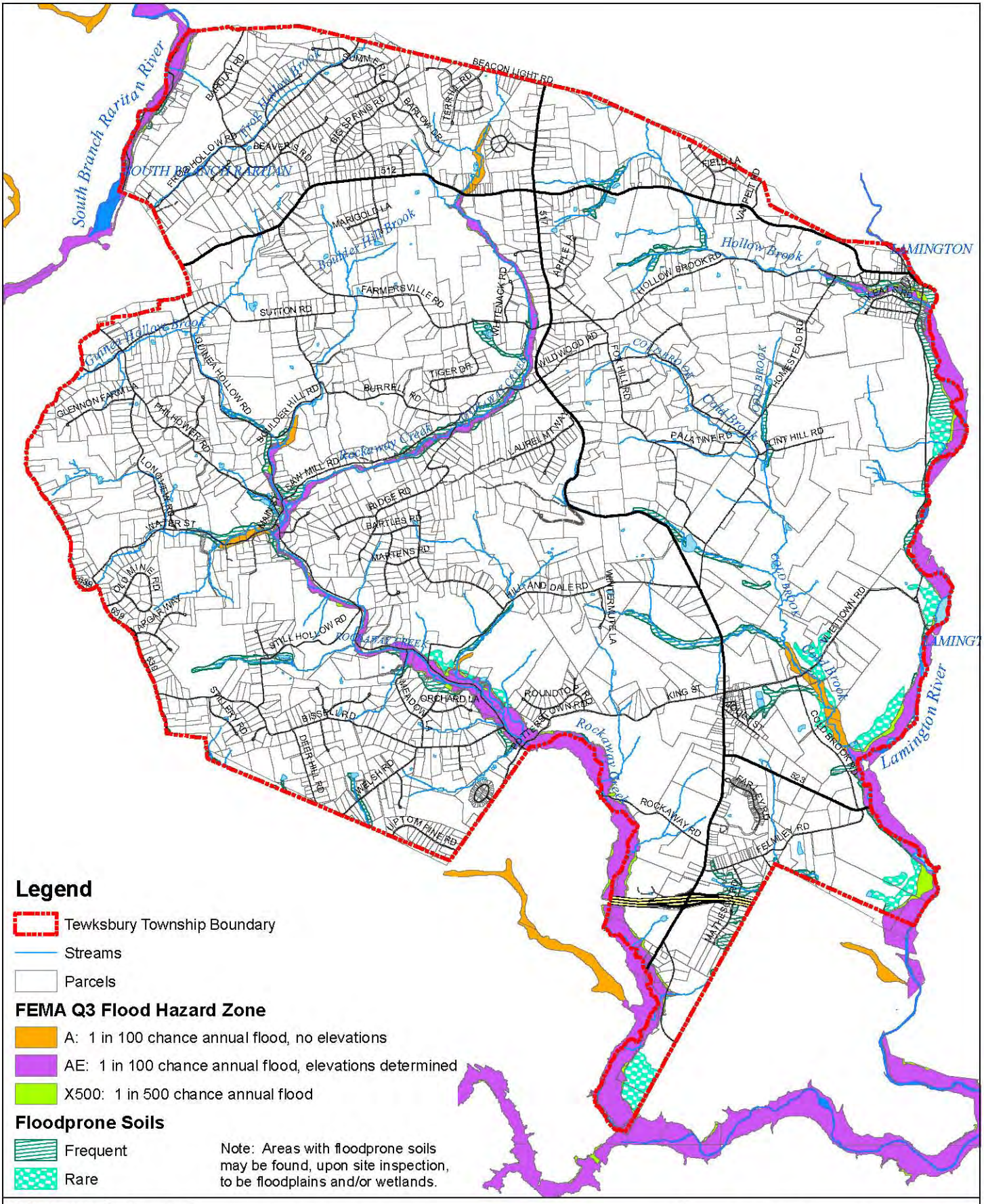
Cold Brook has minimal floodplains in its upper reaches, but its floodplain east of Oldwick to its confluence with the Lamington River ranges from about 200 to 500 feet wide. The Lamington River's floodplain marks the eastern edge of the Township, ranging for the most part from 500 to 700 feet wide, with a narrow point around the middle, and widening to 1000 feet at the southeastern corner of the Township.

Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures may include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances. Community involvement is an important element in making flood insurance available to home and businesses owners. 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. These efforts benefit downstream areas as well.

According to Tewksbury's Master Plan, "Development in the floodplains is essentially prohibited by state law and regulated by Tewksbury Ordinances. The floodplain is essentially a collector basin for flood water, and any development in that area would impede the plain's effectiveness in containing flood waters, as well as result in damage to properties adjacent to the floodplain" (Hintz, 2003).

C. Wetlands

A *wetland* is a transitional area between aquatic and terrestrial ecosystems. Wetlands are those areas that are inundated or saturated by surface water or ground water 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 types, which often show mottling) and hydrology (low spots or evidence of water) are evaluated. A *transition area*, or buffer, is an area of land adjacent to a



Data Sources: See Appendix B.
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Figure 6b: Floodplains

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

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 9B-3 in NJDEP Division of Land Use Management, 2003).

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.
- Wetlands provide high quality open space for recreation and tourism (NJDEP Land Use Regulation, 2006).

However, already over 54% of the total wetlands in the continental US have been lost, and an additional 200,000 acres disappear every year (NJDEP Land Use Regulation, 2006). 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.

A wetland in Tewksbury

New Jersey protects wetlands under the 1987 New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B 9B-3 in NJDEP Division of Land Use Management, 2003). This law requires NJDEP to regulate 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[17].

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

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 and those contiguous with FW-1, FW-2 Trout Production waters and their tributaries, and Category 1 classified streams (see **Section 6D**, below). A determination of threatened and endangered species habitat is provided by using the Landscape Project data (see **Section 7E**).

The wetlands shown in **Figure 6c** were determined by selecting all wetlands land use types from NJDEP's 2002 Land Use GIS data. Linear wetlands at least 10 feet in width were determined by NJDEP from the 1986 aerial photos. **Figure 6c** provides guidance on where wetlands are found in Tewksbury Township. This dataset is intended to serve as a resource for analysis rather than regulatory delineations. The maximum transition area widths of 150 feet are mapped in **Figure 6C**, because the GIS data does not distinguish wetland values. Since the majority of the wetlands in Tewksbury are adjacent to trout waters, C1[18] waters and/or threatened and endangered species habitat, the 150 foot buffer usually applies. However, the actual transition area width required by the NJDEP is determined in the LOI.

There are approximately 900 acres of wetlands within Tewksbury, or 3.6% of the township (NJDEP, 2007). There are several types of freshwater wetlands in Tewksbury Township, such as coniferous or deciduous wooded wetlands, scrub/shrub wetlands, and herbaceous wetlands and vernal pools (see **Sections 7A and 7B**).

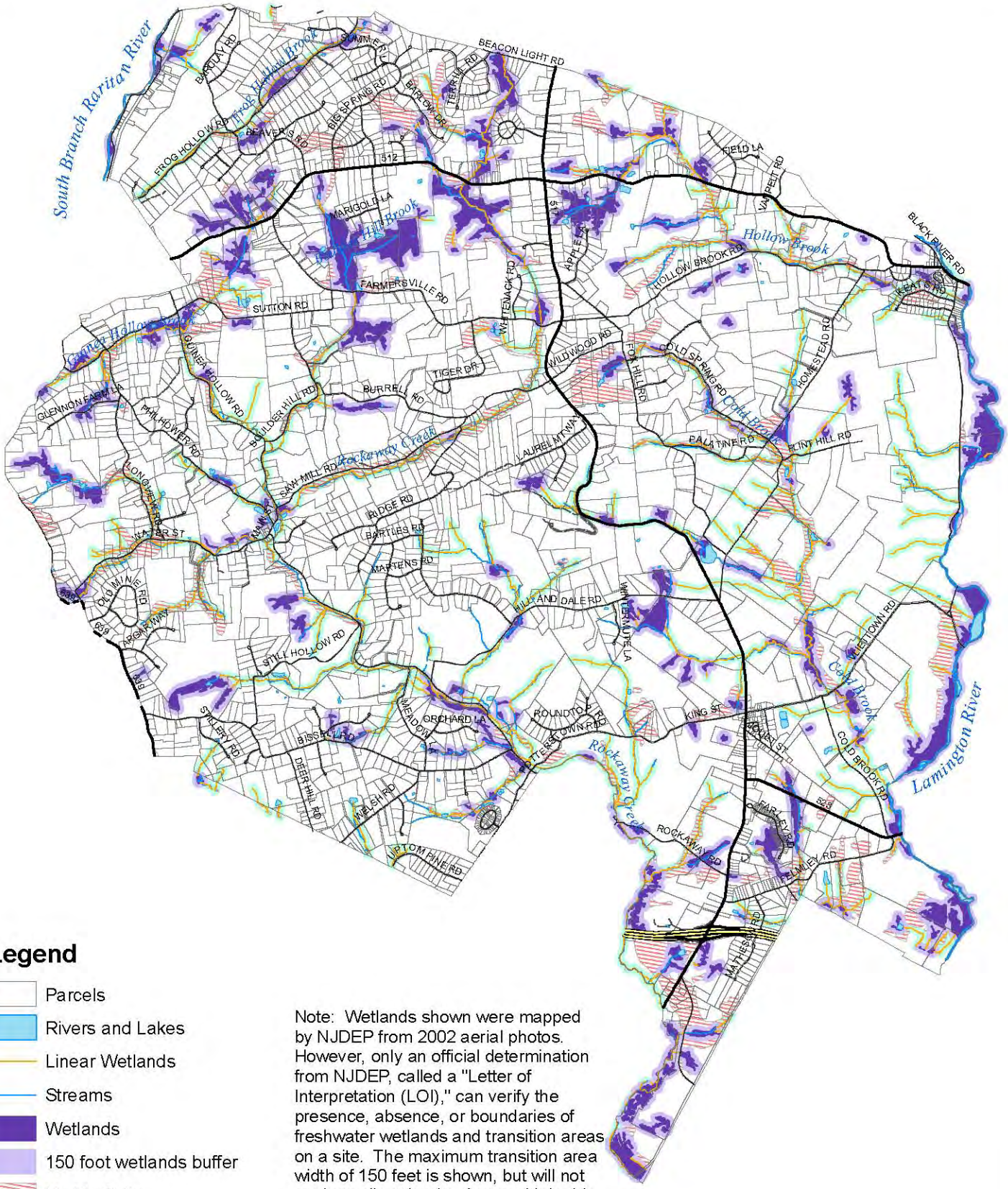
D. Surface Water Quality Standards

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 that are necessary to protect the State's waters. The SWQS operate in conformance with the Federal Water Pollution Control Act (33 U.S.C. 1313(c)), commonly known as the Clean Water Act (CWA), and the Federal Water Quality Standards Regulation at 40 CFR 131.

According to NJDEP, in its October 2006 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. In order to provide adequate, clean supplies of potable water, it is the policy of the State that all fresh waters be protected as potential sources of public water supply. Therefore, point and nonpoint sources of pollutants shall be regulated to attain compliance with the Surface Water Quality Standards human health criteria outside of regulatory mixing zones." (NJAC 7:9B-1.5)

[18] The 300 foot buffer surrounding Category 1 streams, which often exceeds the 150 foot wetlands buffer, is discussed in the next section.



Legend

- Parcels
- Rivers and Lakes
- Linear Wetlands
- Streams
- Wetlands
- 150 foot wetlands buffer
- Hydric Soils
- 150 foot linear wetlands buffer

Note: Wetlands shown were mapped by NJDEP from 2002 aerial photos. However, 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. The maximum transition area width of 150 feet is shown, but will not apply to all wetlands. Areas with hydric soils may be found, upon site inspection, to be wetlands.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 6c: Wetlands

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

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, agricultural and industrial supplies, and navigation. 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 6G**).

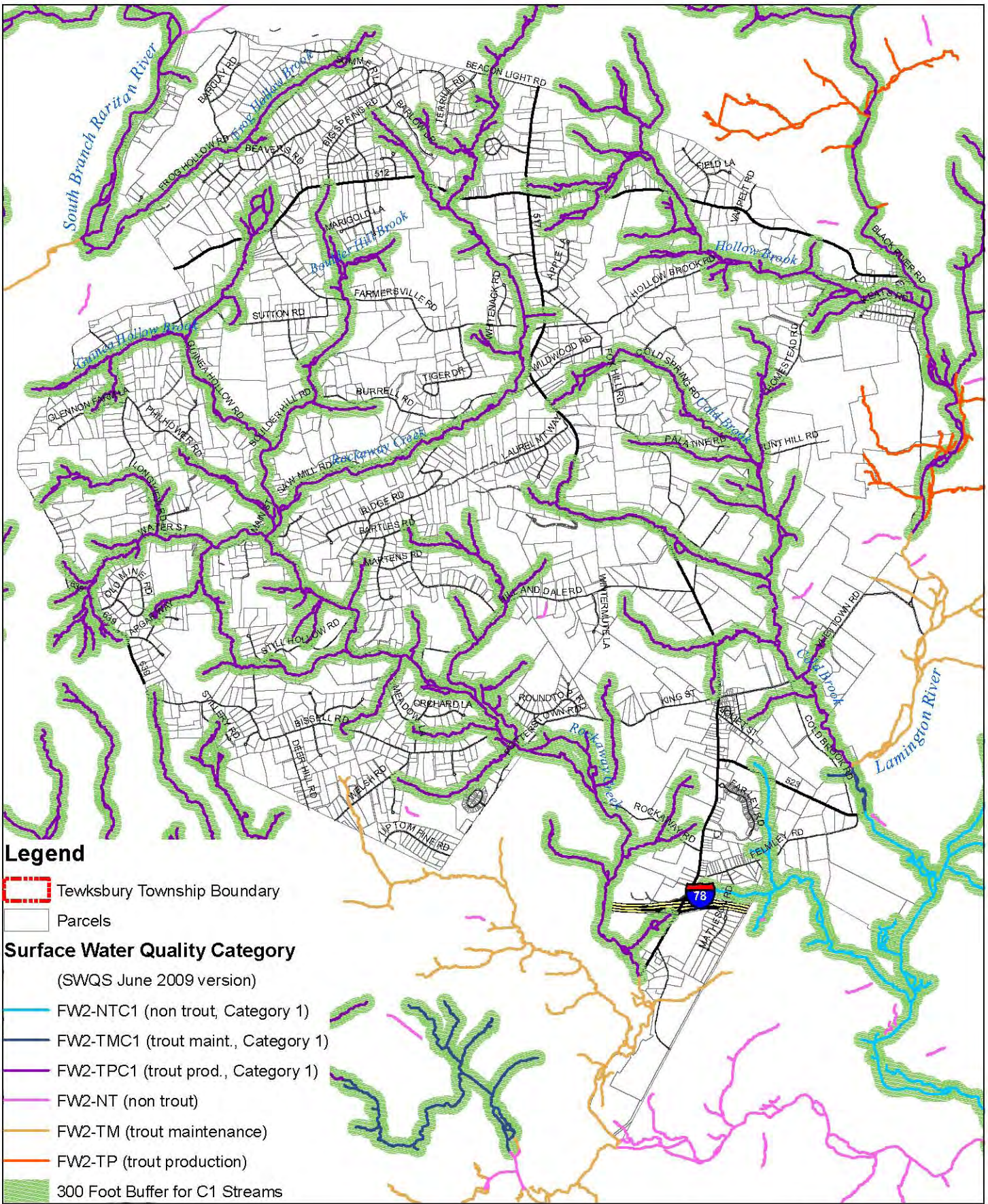
Table 6.2 describes the definitions of the categories, while **Figure 6d** illustrates the stream categories within Tewksbury. In **Figure 6d**, "category" is shown, which is a compendium of all surface water classification designations for a given water body. Category describes a stream's surface water 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).

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 (NJDEP Land Use Management, Water Monitoring and Standards, January, 2008).

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 February 2004 Stormwater Management rules, 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. Wetlands contiguous with C1 streams are considered Exceptional Value Wetlands, which receive a buffer width of 150 feet in conjunction with the 300 foot stream buffer.

Within Tewksbury, the streams designated as both trout production (TP) and Category 1 (C1) include the South Branch Raritan River, Rockaway Creek (except the portion in the southern end of the township), Cold Brook, and the upper reaches of the Lamington River (NJDEP Land Use Management, Water Monitoring and Standards, October 16, 2006). These streams within Tewksbury exhibit high ecological significance, importance for recreation and fishing, and value to the many communities in the Raritan Basin that depend upon surface waters for drinking water supplies.

Proposed in 2007 and adopted in 2008, the NJDEP upgraded lower section of the Lamington River from its confluence with Cold Brook to its confluence with the North Branch Raritan River, including all unnamed and unlisted tributaries, based on exceptional ecological significance. This portion of the Lamington River flows through Bedminster, Tewksbury and Readington Townships and contains intact riparian areas, good water quality, and abundance of host fishes. It provides one of most important habitats in the state for the brook floater, a state endangered mussel. Brook floaters prefer well-oxygenated, fast moving water and numerous riffle areas with rocky substrate, which are present in these waters. The creeper (a NJ



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

Figure 6d: Surface Water Quality Standards (SWQS)

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

Table 6.2: 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(h) Table 6, 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). In all FW1 waters the designated uses are: 1. Set aside for posterity to represent the natural aquatic environment and its associated biota; 2. Primary and secondary contact recreation; 3. Maintenance, migration and propagation of the natural and established aquatic biota; and 4. Any other reasonable uses.
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 and secondary contact recreation; 3. Industrial and agricultural water supply; 4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation, and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and 5. Any other reasonable uses.
Delaware River	The designated uses for the main-stem *Delaware River and Delaware Bay* are those contained in "Delaware River Basin Commission, Water Quality Regulations, Administrative Manual - Part III," Article 3, dated October 23, 1996, including all amendments and future supplements thereto.
Trout Water Status - this is for information only and does not affect the water quality criteria for those waters.	
TP	*Trout production waters* means waters designated at N.J.A.C. 7:9B-1.15(b) through (g) for use by trout for spawning or nursery purposes during their first summer.
TM	*Trout maintenance water*s means waters designated at N.J.A.C. 7:9B-1.15(b) through (g) 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-1.15(b) 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* are 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 significances) as designated in N.J.A.C. 7:9B-1.15(i). Waters classified as FW1 waters and Pinelands waters are Outstanding National Resource Waters.
Non-degradation	*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 in this subchapter. The quality of Nondegradation waters shall be maintained in their natural state (set aside for posterity) and shall not be subject to any manmade wastewater discharges. The Department shall not approve any activity which, alone or in combination with any other activities, might cause changes, other than toward natural water quality, in the existing surface water quality characteristics.
C1	*Category one waters* means those waters designated in the tables in N.J.A.C. 7:9B-1.15(c) through (h), designated 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 characteristics because of their clarity, color, scenic setting, other characteristics of aesthetic value, exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resource(s). Category One Waters shall be protected from any measurable changes (including calculable or predicted changes) to the existing water quality. Water quality characteristics that are generally worse than the water quality criteria, except as due to natural conditions, shall be improved to maintain or

Category	Definition
	provide for the designated uses where this can be accomplished without adverse impacts on organisms, communities or ecosystems of concern.
C2	*Category two waters* are 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). For Category Two Waters, water quality characteristics that are generally better than, or equal to, the water quality standards shall be maintained within a range of quality that shall protect the existing/designated uses, as determined by studies acceptable to the Department, relating existing/designated uses to water quality. Where such studies are not available or are inconclusive, water quality shall be protected from changes that might be detrimental to the attainment of the designated uses or maintenance of the existing uses. Water quality characteristics that are generally worse than the water quality criteria shall be improved to meet the water quality criteria.
Source: NJDEP Land Use Management, Water Monitoring and Standards, October 16, 2006	

special concern mussel) and the rapids clubtail (a NJ imperiled dragonfly) are also found in this stream segment (NJDEP Land Use Management, Water Monitoring and Standards, May 21, 2007(proposal); June 16, 2008(adoption)).

E. Total Maximum Daily Loads

When surface waters do not meet the New Jersey Surface Water Quality Standards, *Total Maximum Daily Loads* (TMDLs) must be developed, as specified under Section 303(d) of the Federal Clean Water Act. A TMDL identifies all the contributors to surface water quality impacts and sets goals for load reductions for specific pollutants in order to meet the Surface Water Quality Standards. Regulations concerning TMDLs are contained in EPA's Water Quality Planning and Management Regulations (40 CFR 130).

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) (NJDEP Division of Watershed Management, 2008). 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.

Waters requiring TMDLs are identified as sublist 5 in the Integrated List of Waterbodies that combines the 303d list of impaired waters and the surface water quality inventory report (305b), which NJDEP prepares every two years. After the Integrated List is approved, the NJDEP Division of Watershed Management 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.

A fecal coliform TMDL has been proposed, established, and approved for the Lamington River near Pottersville (along with 47 other streams in the Raritan Water Region) (NJDEP Division of Watershed Management, 2003).

The 2006 Integrated List, which summarizes whether or not stream water quality meets SWQS is shown in **Table 6.3**. **Table 6.4** displays information about the impaired waters within Tewksbury. For those streams not attaining compliance, TMDLs will be developed. All of the streams listed in **Table 6.4** are on the schedule to be completed within 2 years (NJDEP Water Monitoring and Standards, December 2006).

Table 6.3: 2006 Integrated List for Tewksbury's Streams

HUC14	Watershed	Sublist							
		Aquatic Life general	Aquatic Life trout	Primary contact recreation	Secondary contact recreation	Drinking Water supply	Ag. Water supply	Indust. Water supply	Fish cons-umption
02030105010060	Raritan R SB(Califon br to Long Valley)	5	5	4a	3	2	2	2	3
02030105050040	Lamington R(Pottersville gage-FurnaceRd)	2	2	4a	3	2	2	2	3
02030105050080	Rockaway Ck (above McCrea Mills)	2	2	3	3	3	3	3	3
02030105050090	Rockaway Ck (RockawaySB to McCrea Mills)	2	2	3	3	3	3	3	3
02030105050100	Rockaway Ck SB	5	5	3	3	2	2	2	3
02030105050060	Cold Brook	2	2	4a	3	3	3	3	3
02030105050070	Lamington R(HallsBrRd-Pottersville gage)	5	5	4a	3	2	2	2	3
02030105050110	Lamington R (below Halls Bridge Rd)	5	N/A	4a	3	2	2	2	3

The assessment units were placed on one of five sublists according to the following: (See Section 7 of the Integrated List Methods Document for more detail on the Sublists). N/A (not applicable) is used when the designated use does not apply to a particular assessment unit.
Sublist 1: There is sufficient data to assess all applicable designated uses for the waterbody and the assessment indicates full attainment for all designated uses.
Sublist 2: Waterbodies are placed on this sublist when an assessment for an individual designated use is complete and results for that assessment indicates full attainment but other designated uses are unassessed, assessed as non attain or have an approved TMDL. When all designated uses are assessed as full attain, these waterbodies will be moved to Sublist 1.
Sublist 3: Waterbodies are placed on this sublist when the designated use assessment indicated insufficient or no data to assess the designated use.
Sublist 4: The waterbody is impaired or threatened for one or more designated uses. There are three subcategories:
Sublist 4A. Waterbodies are placed on this sublist when the designated use is non-attain due to pollutants and a TMDL has been adopted in New Jersey Register and approved by the USEPA
Sublist 4B. Waterbodies are placed on this sublist when the designated use is non-attain due to pollutants and other enforceable pollution control requirements are reasonably expected to result in the conformance with the applicable water quality standard(s) in the near future.
Sublist 4C. Waterbodies are placed on this sublist when the designated use is non-attain and the impairment is not caused by a pollutant.
Sublist 5: Designated use assessment is complete and results for the assessment indicate non-attain.
(The individual pollutants causing the non attainment of the designated uses will be identified on the "303(d) List of Impaired Waterbodies by Parameter with Ranking". The Pollutant will be listed if known or “pollutant unknown” or “toxic unknown” will be used when the pollutant is not known.)

Source: NJDEP Water Monitoring and Standards, December 2006 (Appendix A-1)

F. Point Source Pollution

Point source pollution 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 SWQS NJAC 7:9B p.7).

Point source discharges are regulated by NJDEP under the New Jersey Pollutant Discharge Elimination System (NJPDES). There is only one such discharge existing within Tewksbury Township, two revoked discharges, and two discharges that have been transferred to the Bureau of Nonpoint Pollution Control (see **Table 6.5** and **Figure 6e**). The Pottersville Sewage Treatment Plant has a permitted capacity of 0.05 mgd (50,000 gallons per day).

Table 6.4: Tewksbury Streams on NJ 303(d) List of Impaired Waters

Assessment Unit ID (HUC14)	Assessment Unit Name (subwatershed name)	Parameter	Scheduled for Completion
02030105010060-01	Raritan R SB (Califon br to Long Valley)	Phosphorus	2006-2008
02030105010060-01	Raritan R SB (Califon br to Long Valley)	Temperature	2006-2008
02030105050100-01	Rockaway Ck SB	Phosphorus	2006-2008
02030105050100-01	Rockaway Ck SB	Temperature	2006-2008
02030105050070-01	Lamington R (HallsBrRd-Pottersville gage)	Phosphorus	2006-2008
02030105050070-01	Lamington R (HallsBrRd-Pottersville gage)	Temperature	2006-2008
02030105050110-01	Lamington R (below Halls Bridge Rd)	pH	2006-2008
02030105050110-01	Lamington R (below Halls Bridge Rd)	Phosphorus	2006-2008
Source: NJDEP Water Monitoring and Standards, December 2006 (Appendix B and Appendix D).			

Table 6.5: NJ Pollutant Discharge Elimination System (NJDPES) Surface Water Discharges

NJPDES ID. #	Facility Name	Status*	Discharge Type*	Receiving Waters
NJ0102563.001A	Bellemead Develop Corp - Route 78	R	MMI	Rockaway Creek
NJ0028452.001A	Am Best Company	R	MMI	Rockaway Creek N B via unnamed trib
NJ0002917.001A	Oldwick Materials Inc	X	RF	Rockaway Creek
NJ0002917.002A	Oldwick Materials Inc	X	RF	Rockaway Creek
NJ0022781.001A	Valley Rd Sewer Co - Pottersville STP	E	MMI	Lamington River
***Notes for Above Codes** (NJDEP's codes and definitions were used): *Status:* **E**=Existing in the Point Source Permitting Regions; **X**=Permits transferred to Bureau of Nonpoint Pollution Control; **R**=Revoked/Terminated - Pipe no longer permitted for discharge *Discharge type*: **MMI**= Municipal Minor - publicly owned sewage treatment plants which discharge less than 1 MGD; **RF**=not defined				
Source: NJDEP, Environmental Regulation, Division of Water Quality, November, 2007				

G. Nonpoint Source Pollution

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, biological, or radiological characteristic of water from what was or is the natural, pristine condition of such water. Nonpoint source pollution is directly associated with stormwater.

When water flows off impervious surfaces, such as buildings, homes, parking lots and roads and through storm drains and ditches, it is known as *stormwater*. 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.

The NJDEP's February 2004 stormwater management requirements (N.J.A.C. 7:8) established new performance standards for all major developments, requirements for best management practices (BMP), and establishment of buffer area protections for Category One waterways. The emphasis is on increasing ground water recharge and reducing nonpoint source pollution (NJDEP, 2004).

The purpose of the Municipal Stormwater Regulation Program is to ensure a consistent approach to stormwater management statewide, reduce costs for regulated entities, and allow for a simple process for requesting authorization. All municipalities within the State are assigned either Tier A (more developed or coastal) or Tier B (less developed and non-coastal; Tewksbury Township is Tier B). 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. In addition, NJPDES permits are required for public complexes and highway systems.

Many resources are available on the Internet (see **Internet Resources**), including a New Jersey Stormwater Best Management Practices Manual (April 2004), model ordinances and general educational materials. The BMP manual provides examples of ways to meet the standards contained in the rule. A program called New Jersey Conservation Reserve Enhancement Program (NJ-CREP) is designed to assist farmers in reducing nonpoint source pollution caused by agricultural water runoff sources.

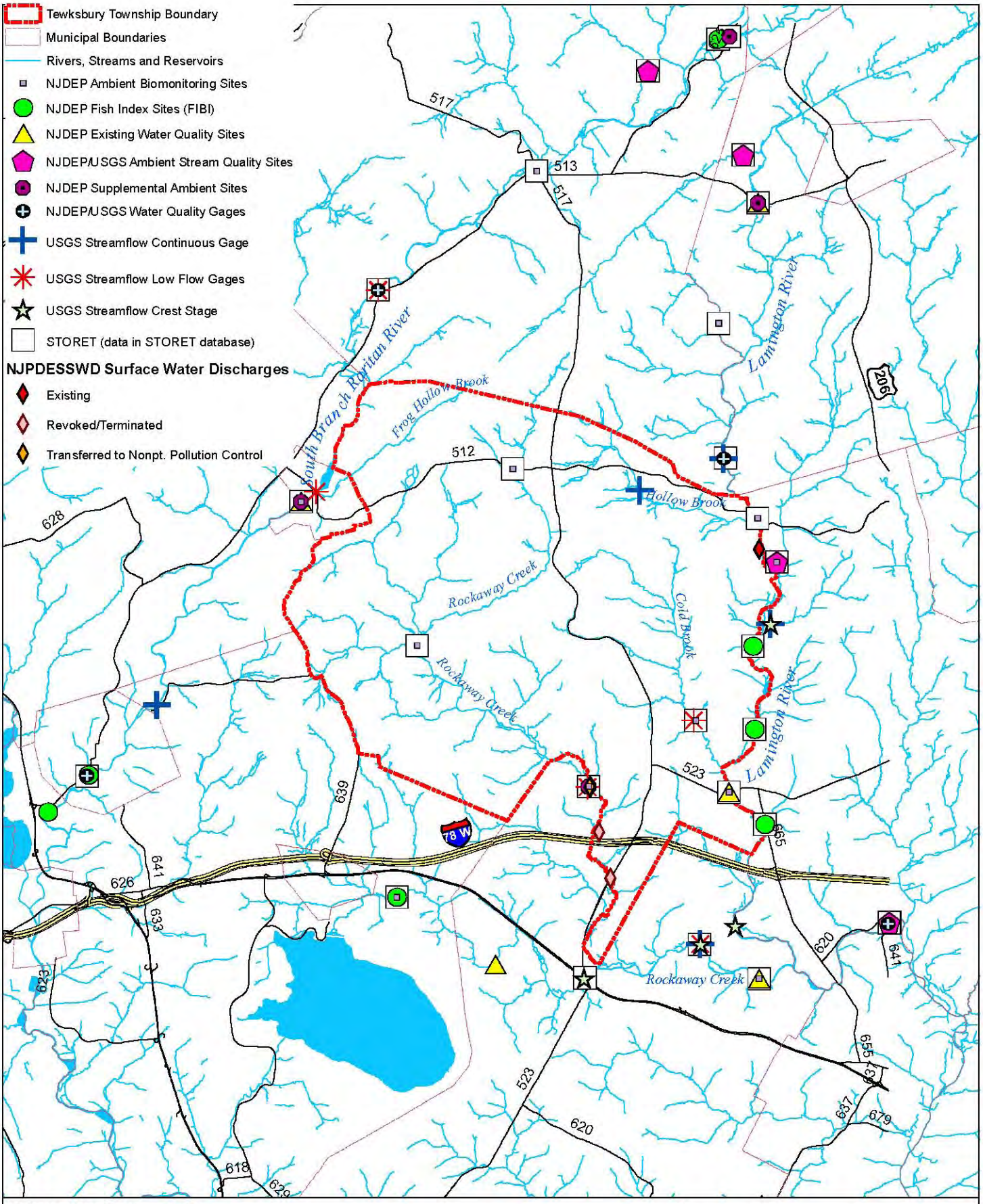
Tewksbury's Stormwater Management Plan was adopted in March 2005. A Stormwater Control Ordinance was adopted in February 2006. The Township will be requiring long-term operation and maintenance of all BMPs through the stormwater control ordinance. Written reminders will be issued to people responsible for BMPs to alert them to compliance obligations and inspections. In addition, requirements for labeling storm drains and for annual public education programs have been implemented (NJDEP Bureau of Nonpoint Pollution Control, 2008).

H. Surface Water Quality and Flow Monitoring

Surface water quality data have been collected at sites on several streams within Tewksbury Township by the NJDEP, USGS, and the Upper Raritan Watershed Association. Surface water monitoring sites are displayed on **Figure 6e**. The various monitoring programs are discussed below. A list of the sites sampled for each program is provided in **Table 6.6**. Sites located outside of Tewksbury are included because of the usefulness of knowing the water quality and stream flow entering and exiting the township.

Water Quality and Flow Sites and Programs

1. NJDEP Ambient Biomonitoring Network for New Jersey (AMNET): In 1992, NJDEP reactivated its Ambient Biomonitoring Network (AMNET) to support its Statewide Water Quality Inventory (305(b)), Impaired Waters (303(d)), and Watershed Programs. Under this program, sites in each of New Jersey's five Water Regions are sampled for benthic macroinvertebrates on a rotating schedule once every five years. The health of in-stream benthic macroinvertebrate communities are evaluated using the US Environmental Protection Agency's (USEPA) Rapid Bioassessment Protocol (RBP) 2. Benthic macroinvertebrates (bottom dwelling



Data Sources: See Appendix B.
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N

0 0.5 1 2 3 Miles

Figure 6e: Surface Water Points and Discharges

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

organisms visible to the naked eye) include insects, mollusks, and crustaceans. The various species of macroinvertebrates have a predictable tolerance (or intolerance) of pollution and/or habitat degradation. Since the macroinvertebrates must live for an extended time period in a relatively small area of stream bottom, they reflect a longer-term level of water quality than a single-grab sample of the water. A *New Jersey Impairment Score* is developed based on these results. In addition, *Stream Habitat Assessments* and limited physical and chemical water quality parameters are measured at each site. Data for the AMNET sites within Tewksbury are summarized in **Table 6.7**.

2. Fish Index of Biotic Integrity Stations: Three sampling sites are located on the Lamington River within Tewksbury Township. See **Table 7.4** for the results. Nearby sites outside of Tewksbury are shown on **Figure 6e**, including 3 sites on the South Branch Raritan River and one on the Rockaway Creek.

3. NJDEP Existing Water Quality Stations in New Jersey**:** These data represent sampling points for the EWQ (Existing Water Quality) project at NJDEP. The EWQ Network was designed to provide supplemental data for water quality for the entire state to support water management and monitoring activities within NJDEP, and to be a valuable layer for computerized cartographic products. There is one site on the Lamington River within Tewksbury.

4. NJDEP Ambient Stream Quality Monitoring Sites for New Jersey**:** These data represent ambient stream sites monitored cooperatively by the NJDEP and the USGS for water quality parameters. This network was established in 1976 to determine status and trends of ambient surface waters in New Jersey. The sampling frequency is four times per year. A wide range of conventional parameters, metals, pesticides and sediments are monitored in this program. Metals, pesticides and sediments are monitored on a reduced sampling frequency. Data is available from the following sources: 1) the USGS computerized data system, NWIS, 2) EPA's computerized data system, STORET or 3) USGS' annual reports "Water Resources Data-New Jersey". The 1997 network revision focused on supporting evolving water quality initiatives at NJDEP

5. NJDEP Ambient Supplemental Surface Water Monitoring: Water quality is measured at one site within Tewksbury on the North Branch of Rockaway Creek.

6. NJDEP/USGS Surface WQ Gage: This network is jointly funded by the USGS and the NJ Department of Environmental Protection. This program has no sites within Tewksbury, but measures water quality outside the township on the South Branch Raritan River and Lamington River.

7. USGS Continuous-Stream Flow Gaging: These sites are maintained by the United States Geological Survey (USGS), Water Resource Division (WRD). One site on the Lamington River a short distance north of Pottersville is monitored continuously for stream flow and this data is available in real-time on the internet.

8. USGS Stream Low Flow Gaging: No active low flow stream gaging sites are located within Tewksbury, but one nearby site is located in Califon on the South Branch of the Raritan River.

9. USGS Stream Crest Gaging: There are three USGS Stream Crest Gages located near Tewksbury, where gage height is measured (relative height of water level; not actual flow volume).

10. The Upper Raritan Watershed Association (URWA): In 1999, with funding provided by Merck & Co., Inc., URWA and the Tewksbury and Readington Township Environmental Commissions developed a water study of Rockaway Creek and its tributaries. Chemical and benthic macroinvertebrate sampling was done on a quarterly basis at 16 sites for several years. The macroinvertebrate and habitat scoring continues using trained volunteers as water stewards.

Table 6.6: Surface Water Monitoring Stations (shown on Figure 6e)

Program Name	Station ID	Name	Municipality	Type of Data Collected
1. NJDEP Ambient Biomonitoring Network	AN0315*	S Br Raritan R at route 517	Washington Twp.	Macro-invertebrates and Habitat
	AN0316*	S Br Raritan R dwnstr of Rt 512	Califon Boro	
	AN0369*	Rockaway Ck at Island Rd	Readington Twp.	
	AN0367*	Rockaway Ck S Br at Windy Acres Farm	Clinton Twp.	
	AN0364*	Rockaway Ck N Br at Rt 512	Tewksbury Twp.	
	AN0365*	Rockaway Ck N Br at Rockaway Rd	Tewksbury Twp.	
	AN0366*	Rockaway Ck N Br at Rockaway Rd	Tewksbury Twp.	
	AN0359*	Trout Bk at Hacklebarney Rd	Washington Twp.	
	AN0360*	Lamington R at Rt 512	Tewksbury Twp.	
	AN0361*	Unnamed Trib to Lamington R at Black R Rd	Bedminster Twp.	
	AN0362*	Cold Bk at Vliettown Rd	Tewksbury Twp.	
	AN0363*	Lamington R at Rt 523	Tewksbury Twp.	
2. Fish Index of Biotic Integrity (FIBI)	FIBI037*	Drakes Brook at Old RR off N. 4 Bridges Rd	Washington Twp	Fish populations and habitat
	FIBI086	Raritan River SB at Gray Rock Rd	Clinton Twp.	
	FIBI088	Raritan River SB (above Spruce Run) at Arch St	High Bridge Boro	
	FIBI073	Rockaway River S Br at Windy Acres	Clinton Twp.	
	FIBI078*	Lamington River at Rattlesnake Bridge Rd	Bedminster Twp.	
	FIBI032*	Lamington River at Black River Rd	Bedminster Twp.	
	FIBI054*	Lamington River at McCann Mill Rd	Tewksbury Twp.	
3. NJDEP Existing Water Quality Sites	AN0316*	Raritan R S Br downstream of Rt 512	Califon Boro	Water quality
	AN0369*	Rockaway Ck at Island Rd	Readington Twp	
	01399650	Rockaway Ck S Br on Mtn. Rd near Potterstown	Clinton Twp.	
	AN0358*	Lamington R at Rt 24 (Cooper Mill Park)	Chester Twp.	
	AN0363*	Lamington R at Route 523 (Lamington Rd)	Tewksbury Twp	
4. NJDEP/USGS Ambient Stream Quality Monitoring Sites for NJ	01396219	Stony Bk at Fariview Ave at Naughright (trib. of S Br Rar)	Washington Twp	conventional parameters, metals, pesticides, sediments, flow
	01399295	Tanners Bk at Chester Twp	Chester Twp.	
	01399520	Herzog Bk at Pottersville (trip of Lam.Riv)	Bedminster Twp.	
	01399780*	Lamington River at Burnt Mills	Bedminster Twp.	
5. NJDEP Supplemental Ambient Surface Water Monitoring Network	01396180	Drakes Brook on Bartley Long Valley Rd	Washington Twp.	conventional parameters, metals, pesticides, sediments
	01396350*	Raritan River S Br on Raritan River Rd	Califon Boro	
	01399570*	Rockaway Ck N Br on Rockaway Rd.	Tewksbury Twp.	
	01399320*	Lamington River on Route 24 (Cooper Mill Park)	Chester Twp.	
6. NJDEP/USGS Surface Water Quality Gage	01396280*	Raritan River SB at Middle Valley, NJ	Washington Twp.	stream flow
	01396535*	Raritan River SB at Arch St at High Bridge, NJ	High Bridge Boro	
	01399780*	Lamington River at Burnt Mills	Bedminster Twp.	
	01399500*	Lamington (Black) River near Pottersville, NJ	Chester Twp.	
7. USGS Continuous Stream flow Gage Station	01396500	Raritan River S Br near High Bridge (active)	Clinton Twp.	stream flow
	01399700*	Rockaway Creek at Whitehouse (discontinued)	Readington Twp.	
	01399500*	Lamington (Black) River near Pottersville (active)	Washington Twp.	
	01399525	Axle Brook near Pottersville (discontinued)	Bedminster Twp.	
	01399510	Upper Cold Brook near Pottersville (discontinued)	Tewksbury Twp.	
8. USGS Low Flow Gage Sites	01396280*	Raritan River SB at Middle Valley, NJ (inactive)	Washington Twp	stream flow with gage height
	01396350*	Raritan River SB at Califon, NJ (active)	Califon Boro	
	01399570*	Rockaway Creek at McCrea Mills, NJ (inactive)	Tewksbury Twp.	
	01399700*	Rockaway Creek at Whitehouse, NJ (inactive)	Readington Twp.	
	01399540	Cold Brook at Oldwick, NJ (inactive)	Tewksbury Twp.	
9. USGS Stream Crest Gaging	01399690	Rockaway Ck SB at Whitehouse (discontinued)	Readington Twp.	stream flow measured
	01399700*	Rockaway Ck at Whitehouse (active)	Readington Twp.	

Program Name	Station ID	Name	Municipality	Type of Data Collected
Station	01399550	Lamington R near Whitehouse (active)	Readington Twp.	occasionally
	01399525	Axle Brook near Pottersville (active)	Bedminster Twp.	
10. URWA Upper Raritan Watershed Association (not shown on Figure 6e)	1	Unnamed Trib, Farmersville	Tewksbury Twp.	benthic macro-invertebrates
	2	Unnamed Trib, Mountainville (Guinea Hollow Rd)	Tewksbury Twp.	
	3	Unnamed Trib, Mountainville (Water St)	Tewksbury Twp.	
	4	Unnamed Trib, Mountainville	Tewksbury Twp.	
	5	N Br Rockaway Ck, Rockaway Road at Bissell Road	Tewksbury Twp.	
	6	N Br Rockaway Ck, Whittemore property, Oldwick	Tewksbury Twp.	
	7	N Br Rockaway Ck, West of Rt 523, Whitehouse Station	Tewksbury Twp.	
Notes: When sites are identified as inactive or discontinued, they are listed in light gray. *Data is stored in STORET, the US Environmental Protection Agency's water quality storage and retrieval database.				
Sources: GIS data files				

Macroinvertebrate and habitat scores and ratings are summarized in **Table 6.7** for 6 sites monitored by the NJDEP and for 7 sites sampled within Tewksbury Township by URWA volunteers. Based on these results, NJDEP may determine that additional water quality sampling is warranted. Nearly all of these sites had non-impaired macroinvertebrate populations and optimal or suboptimal habitat ratings.

Table 6.7: Macroinvertebrate and Habitat Scores for Sites in Tewksbury

Site Code	Site Name	Para-meter*	Year Sampled by NJDEP								
			1994	1999	2001	2002	2003	2004◆	2005	2006	2007
AN0364	Rockaway Ck N Br at Rt 512	NJIS	30-N	30-N	--	--	--	85.2-E	--	--	--
		Habitat	--	100-M	--	--	--	154-S	--	--	--
AN0365	Rockaway Ck N Br at Rockaway Rd	NJIS	27-N	30-N	--	--	--	82.1-E	--	--	--
		Habitat	--	133-S	--	--	--	144-S	--	--	--
AN0366	Rockaway Ck N Br, Taylor's Mill Rd	NJIS	27-N	30-N	--	--	--	79.94-E	--	--	--
		Habitat	--	137-S	--	--	--	180-O	--	--	--
AN0360	Lamington R at Rt 512	NJIS	27-N	30-N	--	--	--	85.35-E	--	--	--
		Habitat	--	183-O	--	--	--	157-S	--	--	--
AN0362	Cold Bk at Vliettown Rd	NJIS	30-N	30-N	--	--	--	61.67-G	--	--	--
		Habitat	--	181-O	--	--	--	137-S	--	--	--
AN0363	Lamington R at Rt 523	NJIS	27-N	30-N	--	--	--	76.88-E	--	--	--
		Habitat	--	178-O	--	--	--	156-S	--	--	--
Site Code	Site Name	Para-meter*	Year Sampled by URWA Volunteers								
			1999	2000	2001	2002	2003	2004	2005	2006	2007
URWA1	Unnamed Trib, Farmersville	NJIS	21-M	24-N	30-N	30-N	27-N	27-N	24-N	30-N	30-N
		Habitat	165-O	--	--	--	--	149-S	--	149-S	149-S
URWA2	Unnamed Trib, Mountainville	NJIS	30-N	30-N	30-N	24-N	30-N	30-N	21-M	30-N	30-N
		Habitat	170-O	--	--	--	--	174	--	149	174
URWA3	Unnamed Trib, Mountainville (Water St)	NJIS	27-N	30-N	27-N	30-N	27-N	21-M	21-M	30-N	30-N
		Habitat	158	--	--	--	--	163	--	163	163
URWA4	Unnamed Trib, Mountainville	NJIS	30-N	30-N	30-N	30-N	24-N	--	--	30-N	--
		Habitat	170-O	--	--	--	--	--	--	163	182
URWA5	N Br Rockaway Ck, Bissell Road	NJIS	30-N	21-M	30-N	30-N	21-M	24-N	30-N	30-N	30-N
		Habitat	164-O	--	--	--	--	158-S	--	158-S	158-S
URWA6	N Br Rockaway Ck, Whittemore	NJIS	30-N	21-M	30-N	30-N	24-N	24-N	30-N	27-N	30-N
		Habitat	160-O	--	--	--	--	164-O	--	164-O	164-O
URWA7	N Br Rockaway Ck, W of Rte 523	NJIS	30-N	30-N	30-N	30-N	24-N	30-N	30-N	--	30-N
		Habitat	140-S	--	--	--	--	144-S	--	--	144-S

*NJIS (New Jersey Impairment Score): A composite of 5 scores based on family level taxonomy.
N=Non-impaired: score of 24 to 30; benthic community comparable to other undisturbed streams within the region; community characterized by a maximum taxa richness, balanced taxa groups, and good representation of intolerant individuals. M=Moderately Impaired: score of 9 to 21; macroinvertebrate richness reduced, in particular, EPT taxa; reduced community balance and number of intolerant taxa. S= Severely Impaired: score of 0 to 9; benthic community drastically different from those in less impaired situations; macroinvertebrates dominated by few taxa, but with many individuals; only intolerant individuals present.

HABITAT SCORES: O=OPTIMAL= 160 – 200; S=SUB-OPTIMAL=110 – 159; M=MARGINAL= 60 – 109; P=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).

◆In 2004, new indices were developed, based on genus level taxonomy. The index used in this area is the High Gradient Macroinvertebrate Index (HGMI). These new indices replace the NJIS and offer a greater level of resolution using four levels of assessment; E=excellent, G=good, F=fair, and P=poor.

Source: NJDEP BFBM, 2008; URWA, 2008

I. 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 *fish consumption advisories* as a guide to limit the human health effects of consuming these fish and the pollutants they contain. This information is intended to help individuals make an informed choice on the number of meals of fish to consume. The 2006 fish consumption advisories for fish caught anywhere in the state are listed in **Table 6.8** (no fish tissue sampling sites are located within Tewksbury). See the **Internet References** for more information, such as fish preparation guidelines and annual updates.

Table 6.8: 2009 Fish Consumption Advisories

LOCATION	SPECIES	ADVISORY/PROHIBITION	
		General Population [1] Range of Recommended Meal Frequency	High-Risk Individuals [2]
		DO NOT EAT MORE THAN:	DO NOT EAT MORE THAN:
New Jersey Statewide – All water bodies except those listed below	Trout (brown, brook, rainbow)	One meal per week	One meal per week
	Largemouth bass		One meal per month
	Smallmouth Bass		
	Chain Pickerel		
	Yellow bullhead	No restrictions	One meal per month
	Brown Bullhead		
	Sunfish [3]		One meal per week
Lamington River at Lamington (Hunterdon-Somerset Co.)	American Eel	One meal per week	One meal per month
	Brown Trout	No restrictions	One meal per week
	Redbreast Sunfish		

LOCATION	SPECIES	ADVISORY/PROHIBITION	
		General Population [1] Range of Recommended Meal Frequency	High-Risk Individuals [2]
		DO NOT EAT MORE THAN:	DO NOT EAT MORE THAN:
	Smallmouth Bass		
Raritan River - South Branch at High Bridge (Hunterdon Co.)	American Eel	One meal per month	Do not eat
	Redbreast Sunfish	No restrictions	One meal per week
Raritan River – South Branch at Long Valley (Clairmont Reach; Morris Co.)	Brown Trout	No restrictions	One meal per week
Raritan River – North Branch at Branchburg (Somerset Co.)	American Eel	One meal per week	One meal per month
	Yellow Bullhead		
	Smallmouth Bass	No restrictions	
	Redbreast Sunfish		One meal per week

[1] 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, grilling, and steaming). See web site for full description. 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.
[3] Sunfish includes bluegill, pumpkinseed, and redbreast sunfish.

Source: NJDEP Division of Science and Research, 2009

References: Surface Water

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NJDEP Land Use Management, Water Monitoring and Standards. May 21, 2007. Surface Water Quality Standards Proposed Amendments to N.J.A.C. 7:9B-1.4 and 1.15. 86 pages. [Proposal of Lamington River upgrade] http://www.nj.gov/dep/rules/proposals/052107b.pdf

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Internet Resources: Surface Water

General Water Resources Protection:
Home*A*Syst: Evaluate your home and property for pollution and health risks (USDA): http://www.nj.nrcs.usda.gov/partnerships/homeasyst/

Farm*A*Syst: Tools to help farmers better manage their operation to avoid environmental problems (USDA) http://www.nj.nrcs.usda.gov/partnerships/farmasyst/

SEEDS: The NJ Environmental Education Directory Website: http://www.state.nj.us/dep/seeds/index.html

Basic Watershed Information (Division of Watershed Management): http://www.state.nj.us/dep/watershedmgt/basicinfo2.htm

The Clean Water Book: Choices for Watershed Protection: http://www.state.nj.us/dep/watershedmgt/cleanwaterbook/waterbook_tble.htm

Water Quality Fact Sheets and Bulletins (NJ Agricultural Experiment Station Rutgers Cooperative Research & Extension): http://www.rcre.rutgers.edu/pubs/subcategory.asp?cat=6&sub=50

Floodplains:
Flood Hazard Area Program (NJDEP Land Use Regulation) http://www.state.nj.us/dep/landuse/se/se.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.state.nj.us/dep/landuse/fww/fww.html

Freshwater Wetlands Program: Before You Buy – Before You Build presentation http://www.state.nj.us/dep/enforcement/wetland-training/ontheroad/

Stream Encroachment Program (NJDEP Land Use Regulation): http://www.state.nj.us/dep/landuse/se/se.html

Non-Point Source Pollution / Stormwater:
NJDEP Municipal stormwater regulation program: http://www.state.nj.us/dep/dwq/msrp_home.htm

NJ Conservation Reserve Enhancement Program (NJ-CREP): http://www.state.nj.us/dep/watershedmgt/crep.htm
NJDEP Division of Watershed Management – Stormwater: http://www.state.nj.us/dep/watershedmgt/stormwater.htm

NJDEP's Stormwater Website: http://www.njstormwater.org/

Model stormwater control ordinance: http://www.state.nj.us/dep/watershedmgt/DOCS/pdfs/ModelSWOrdinance2.pdf

NJ Stormwater Best Management Practices Manual (April 2004): http://www.njstormwater.org/tier_A/bmp_manual.htm

Riparian Buffer Conservation Zone Model Ordinances:
http://www.state.nj.us/dep/watershedmgt/DOCS/pdfs/StreamBufferOrdinance.pdf

USEPA Nonpoint Source Pollution http://www.epa.gov/OWOW/NPS/

Surface Water Quality and Flow:
USEPA STORET Database: http://www.epa.gov/storet

NJDEP Water Monitoring Management: http://www.state.nj.us/dep/wms//

New Jersey Water Supply Authority: http://www.njwsa.org/

Raritan Basin Watershed Management Project: http://www.raritanbasin.org

Real-Time Flow Data for USGS 01399500 Lamington (Black) River near Pottersville NJ:
http://waterdata.usgs.gov/nwis/uv?01399500

NJDEP Regulations:
NJ Office of Legal Affairs Environmental statutes (NJSA) and regulations (NJAC):
http://www.state.nj.us/dep/legal/nj_env_law.htm

NJDEP Rule proposals http://www.state.nj.us/dep/rules

Information about C1 classification of streams (NJDEP, Water Monitoring and Standards)
http://www.nj.gov/dep/cleanwater/c1rule.html

Total Maximum Daily Load (TMDL) (NJDEP) http://www.nj.gov/dep/watershedmgt/tmdl.htm

NJDEP stormwater rule: http://www.njstormwater.org/

NJDEP Land Use Regulation Program – Freshwater Wetlands Protection Act (July 1998)
http://www.state.nj.us/dep/landuse/13_9b.pdf

NJDEP Land Use Regulation Program – Flood Hazard Control Act (July 1998)
http://www.state.nj.us/dep/landuse/58_16a.pdf

NJDEP Land Use Regulation Program – Wetlands, Stream Encroachment & Flood Hazard Laws (NJSA) & Regulations (NJAC) Web Page: http://www.state.nj.us/dep/landuse/njsa_njac.html

Fish Advisories & Guides:
NJ Division of Science & Research Fish Advisories Home Page: http://www.state.nj.us/dep/dsr/njmainfish.htm

Fish Smart Eat Smart: http://www.state.nj.us/dep/dsr/fishsmart.pdf

Phone Contacts:
NJ Drought Hotline: 1-800-448-7379

NJ Environmental Incident Hotline (hazardous spill, fire, explosion, illegal dumping, wildlife problem):
1-877-WARNDEP / 1-877-927-6337 (toll-free, 24 hours)

NJDEP Land Use Enforcement: 1-609-292-1240

NJDEP Land Use Regulation (stream encroachment), Hunterdon County: 1-609-984-0194

NJDEP Land Use Regulation (wetlands), if you want to build near suspected wetlands, call and ask for the Letter of Interpretation (LOI) information and application package: 1-609-292-0060

NJDEP Land Use Regulation (wetlands), Hunterdon County: 1-609-777-0454

7: BIOLOGICAL RESOURCES

A. Dominant Vegetation (Land Cover)

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 exotic species (e.g. the hemlock wooly adelgid, an insect that causes the decline and death of hemlock trees) and exotic diseases, overpopulations of deer and geese, and pollution.

The 2002 Land Use/Land Cover (LU/LC) data layer was directly digitized from the 2002 digital color infrared orthophotography (shown in **Figure 1b**) of New Jersey with a 1 foot pixel resolution by a contractor of NJDEP. The classification system used was a modified Anderson Classification System that provided the parameters for proper and consistent coding of the LU/LC feature classes and subclasses. It should be noted that 1) changes since 2002 are not shown, and 2) the method is not 100% accurate. The land cover classifications are shown in **Figures 7a and 7b**. The land cover types found in Tewksbury Township are listed in **Table 7.1** (NJDEP, 2007).

A deciduous forest in Tewksbury

The largest portion of land in Tewksbury Township is deciduous forest greater than 50% crown closure[19] (37% of the township), followed by agricultural cropland and pastureland (24%), and then rural residential, single unit (15%). Together, these top three land uses make up 76% of the township (NJDEP, 2007).

Table 7.1: 2002 Land Use/Land Cover (Anderson Classification) in Tewksbury Township

Code	Description	ACRES*	%
1110	RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING	23.08	0.09%
1120	RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	33.61	0.13%
1130	RESIDENTIAL, SINGLE UNIT, LOW DENSITY	173.14	0.69%
1140	RESIDENTIAL, RURAL, SINGLE UNIT	3862.48	15.31%
1200	COMMERCIAL/SERVICES	70.00	0.28%
1400	TRANSPORTATION/COMMUNICATION/UTILITIES	4.17	0.02%
1410	MAJOR ROADWAY	29.46	0.12%
1419	BRIDGE OVER WATER	0.54	0.00%
1462	UPLAND RIGHTS-OF-WAY DEVELOPED	2.14	0.01%
1463	UPLAND RIGHTS-OF-WAY UNDEVELOPED	152.11	0.60%
1499	STORMWATER BASIN	8.62	0.03%
1700	OTHER URBAN OR BUILT-UP LAND	294.85	1.17%
1710	CEMETERY	20.09	0.08%

[19] Crown closure is the percentage of a forest area occupied by the vertical projections of tree crowns. Crown closure percentages provide a reasonable estimate of stand density (USGS, 2007).

Code	Description	ACRES*	%
1750	MANAGED WETLAND IN MAINTAINED LAWN GREENSPACE	2.41	0.01%
1800	RECREATIONAL LAND	42.66	0.17%
1804	ATHLETIC FIELDS (SCHOOLS)	17.34	0.07%
1850	MANAGED WETLAND IN BUILT-UP MAINTAINED REC AREA	0.89	0.00%
1000 series	**All 1000 Series Urban Land Uses (including residential, commercial, etc.)**	**4737.61**	**18.78%**
2100	CROPLAND AND PASTURELAND	5938.81	23.55%
2140	AGRICULTURAL WETLANDS (MODIFIED)	102.42	0.41%
2150	FORMER AGRICULTURAL WETLAND (BECOMING SHRUBBY, NOT BUILT-UP)	27.47	0.11%
2200	ORCHARDS/VINEYARDS/NURSERIES/HORTICULTURAL AREAS	206.38	0.82%
2400	OTHER AGRICULTURE	459.17	1.82%
2000 series	**All 2000 Series Agricultural Land Uses**	**6734.25**	**26.70%**
4110	DECIDUOUS FOREST (10-50% CROWN CLOSURE)	1097.13	4.35%
4120	DECIDUOUS FOREST (>50% CROWN CLOSURE)	9436.33	37.41%
4210	CONIFEROUS FOREST (10-50% CROWN CLOSURE)	46.61	0.18%
4220	CONIFEROUS FOREST (>50% CROWN CLOSURE)	112.50	0.45%
4230	PLANTATION	85.72	0.34%
4311	MIXED FOREST (>50% CONIFEROUS WITH 10-50% CROWN CLOSURE)	33.22	0.13%
4312	MIXED FOREST (>50% CONIFEROUS WITH >50% CROWN CLOSURE)	170.17	0.67%
4321	MIXED FOREST (>50% DECIDUOUS WITH 10-50% CROWN CLOSURE)	61.48	0.24%
4322	MIXED FOREST (>50% DECIDUOUS WITH >50% CROWN CLOSURE)	97.22	0.39%
4410	OLD FIELD (< 25% BRUSH COVERED)	380.70	1.51%
4420	DECIDUOUS BRUSH/SHRUBLAND	85.07	0.34%
4430	CONIFEROUS BRUSH/SHRUBLAND	299.21	1.19%
4440	MIXED DECIDUOUS/CONIFEROUS BRUSH/SHRUBLAND	671.65	2.66%
4000 series	**All 4000 Series Forested Land Uses** (excludes wooded wetlands)	**12577.02**	**49.86%**
5100	STREAMS AND CANALS	122.98	0.49%
5200	NATURAL LAKES	1.38	0.01%
5300	ARTIFICIAL LAKES	71.04	0.28%
5000 series	**All 5000 Series Water Land Uses**	**195.40**	**0.77%**
6210	DECIDUOUS WOODED WETLANDS	849.87	3.37%
6220	CONIFEROUS WOODED WETLANDS	1.25	0.00%
6231	DECIDUOUS SCRUB/SHRUB WETLANDS	5.59	0.02%
6232	CONIFEROUS SCRUB/SHRUB WETLANDS	4.19	0.02%
6233	MIXED SCRUB/SHRUB WETLANDS (DECIDUOUS DOM.)	17.41	0.07%
6234	MIXED SCRUB/SHRUB WETLANDS (CONIFEROUS DOM.)	5.83	0.02%
6240	HERBACEOUS WETLANDS	12.47	0.05%
6241	PHRAGMITES DOMINATE INTERIOR WETLANDS	1.52	0.01%
6252	MIXED WOODED WETLANDS (CONIFEROUS DOM.)	3.95	0.02%
6000 series	**All 6000 Series Wetlands Land Uses**	**902.09**	**3.58%**
7300	EXTRACTIVE MINING	57.76	0.23%
7500	TRANSITIONAL AREAS**	18.15	0.07%
7000 series	**All 7000 Series Barren Land Uses**	**75.92**	**0.30%**
	All Land Uses	**25222.29**	**100.00%**

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

** *Transitional Areas* encompass lands on which site preparation for a variety of development types has begun, i.e. areas under construction (USGS, 2007).

Source: NJDEP, 2007 (GIS data 2002 Land use/Land Cover); see USGS 2007 for definitions of land uses

See next page for legend.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 7a: Land Cover from 2002 Aerial Photos

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

Legend

Parcels

Roads

INTERSTATE
STATE ROUTE
600 SERIES
500 SERIES
LOCAL
PRIVATE

2002 Land Cover - Urban Lands

1110 - Residential (High Density or Multiple Dwelling)
1120 - Residential (Single Unit, Medium Density)
1130 - Residential, single unit, low density
1140 - Residential, rural, single unit
1200 - Commericial and services
1400 - Transportation/Communications/Utiltities
1410 - Major Roadway
1419 - Bridge Over Water
1462 - Upland Rights-of-Way, Developed
1463 - Upland Rights-of-Way, Undeveloped
1499 - Stormwater Basin
1700 - Other Urban or Built-up Land
1710 - Cemetery
1750 - Managed Wetland, in Maintained Lawn Green space
1800 - Recreational Land
1804 - Athletic Fields (schools)
1850 - Managed Wetland, in Built-up Maintained Rec Area

2002 Land Cover - Forest

4110 - Decidious Forest (10-50% Crown Closure)
4120 - Deciduous Forest (>50% Crown Closure)
4210 - Coniferious Forest (10-50% Crown Closure)
4220 - Coniferous Forest (>50% Crown Closure)
4230 - Plantation
4311 - Mixed Forest (>50% Coniferous with 10-50% Crown Closure)
4312 - Mixed Forest (>50% Coniferous with >50% Crown Closure)
4321 - Mixed Forest (>50% Deciduous with 10-50% Crown Closure)
4322 - Mixed Forest (>50% Deciduous with >50% Crown Closure)
4410 - Old Field (< 25% Brush Covered)
4420 - Deciduous Brush/Shrubland
4430 - Coniferous Brush/Shrubland
4440 - Mixed Deciduous/Coniferous Brush/Shrubland

2002 Land Cover - Water

5100 - Streams and Canals
5200 - Natural Lakes
5300 - Artificial Lakes

2002 Land Cover - Wetlands

6210 - Deciduous Wooded Wetlands
6220 - Coniferous Wooded Wetlands
6231 - Deciduous Scrub/Shrub Wetlands
6232 - Coniferous Scrub/Shrub Wetlands
6233 - Mixed Scrub/Shrub Wetlands (Deciduous Dom.)
6234 - Mixed Scrub/Shrub Wetlands (Coniferous Dom.)
6240 - Herbaceous Wetlands (Non-Tidal)
6241 - Phragmites Dominate Interior Wetlands
6251 - Mixed Forested Wetlands (Deciduous Dom.)
6252 - Mixed Forested Wetlands (Coniferous Dom.)

2002 Land Cover - Barren Lands

7300 - Extractive Mining
7500 - Transitional Areas (sites under construction)

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
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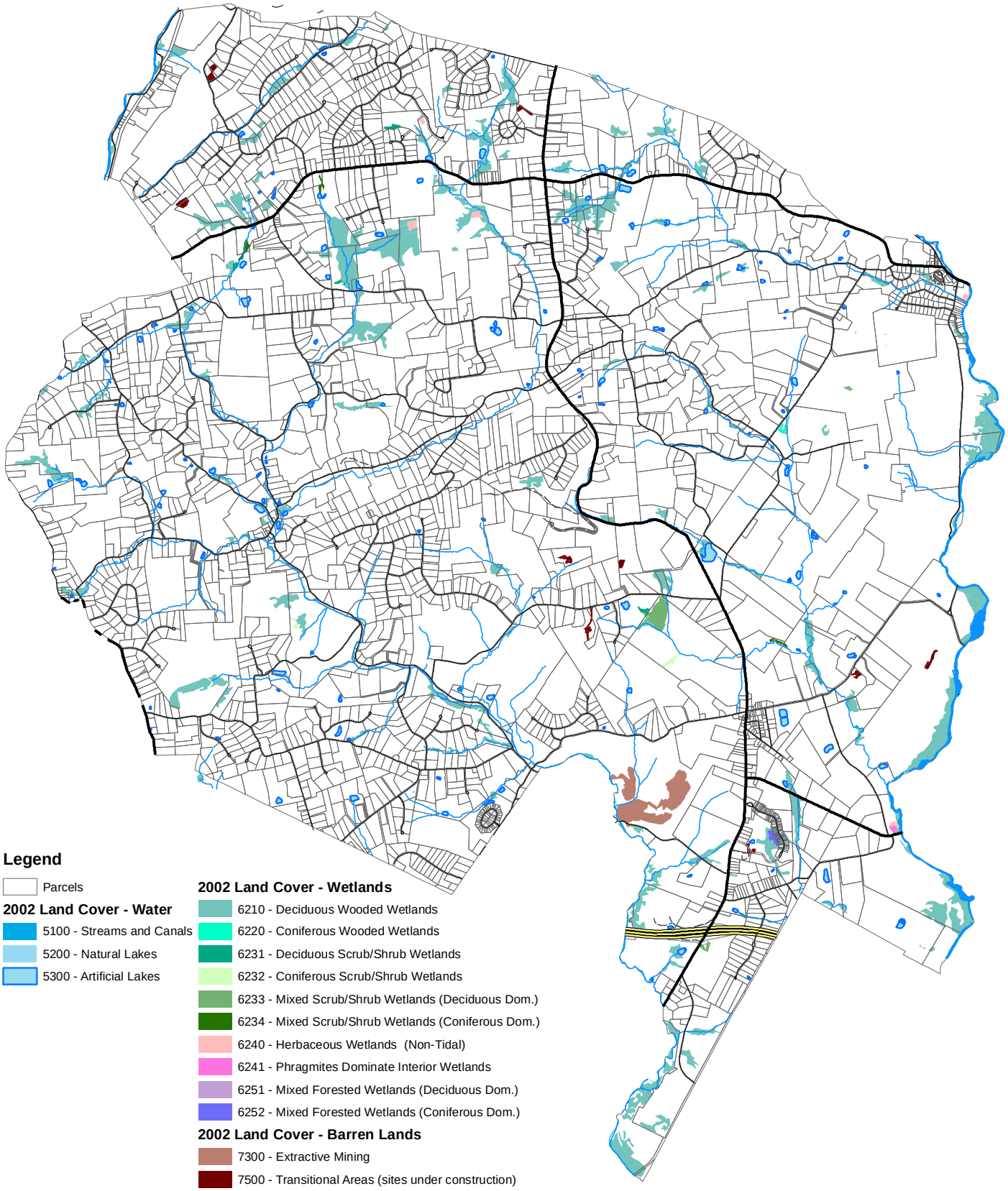
N

0 0.25 0.5 1 1.5 Miles

Figure 7a: Land Cover from 2002 Aerial Photos (legend)

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
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N

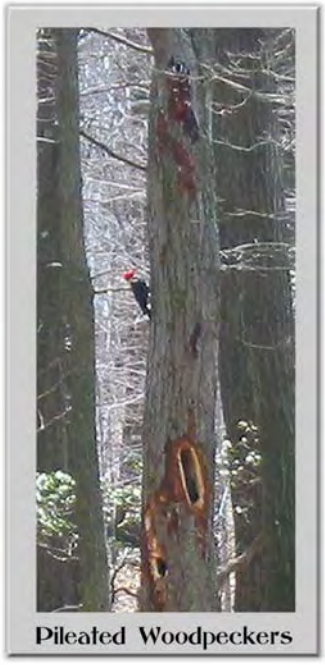
0 0.25 0.5 1 1.5 Miles

Figure 7b: Land Cover from 2002 Aerial Photos
(Land Cover Types Water, Wetlands & Barren Land)

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

In 2003, Tewksbury developed a five year Community Forestry Management Plan in accordance with the NJ Shade Tree and Community Forestry Act, P.L. 1996, Chapter 135, to guide the township in its efforts to create, protect, sustain, and manage a healthy tree resource (ForesTree Consultants, 2003).

According to the report, only about 30% of the Highlands forests have ever been cleared for agriculture. However, most likely all forests were cut for timber by the late 1800's and then again as the trees reached marketable size. Currently, Tewksbury's Highlands region contains excellent second growth forest of oak, ash, tulip poplar, red maple, and hickory. Generally, ash and red maples occupy the riparian zones, tulip poplar and ash occupy the mid-slopes and oaks occur in increasing amounts as elevations increase and moisture decreases. Older stands contain increasing numbers of sugar maple and some beech. Notable tulip poplar stands now occupy some old fields and previously clear-cut areas. When forests in the Highlands are left uncut, the trend will be towards more oak, beech, hickory and sugar maple (ForesTree Consultants, 2003).


Pileated Woodpeckers

Nearly all Piedmont forests were cleared for agriculture or heavily grazed by livestock. A large part is still in use as cropland, grazing, or orchards. Where forests have re-generated, these second growth forests consist mainly of eastern red cedar and ash. As succession of former old fields continues, the red cedar stands will slowly but surely give way to the ash and eventually to mixed oaks and hickories. Wooded wetlands and riparian zones are dominated by elm, ash, and red maple with associated species such as sycamore and some walnut. An interesting and scattered population of Virginia pine (*Pinus virginiana*, also called Jersey pine) is found in the southernmost portion of the Township (ForesTree Consultants, 2003). In Tewksbury, the species is near the northern limit of its range. Virginia pine is usually found as a pioneer species on old fields, burned areas, or other disturbed sites (USFS, 1990).

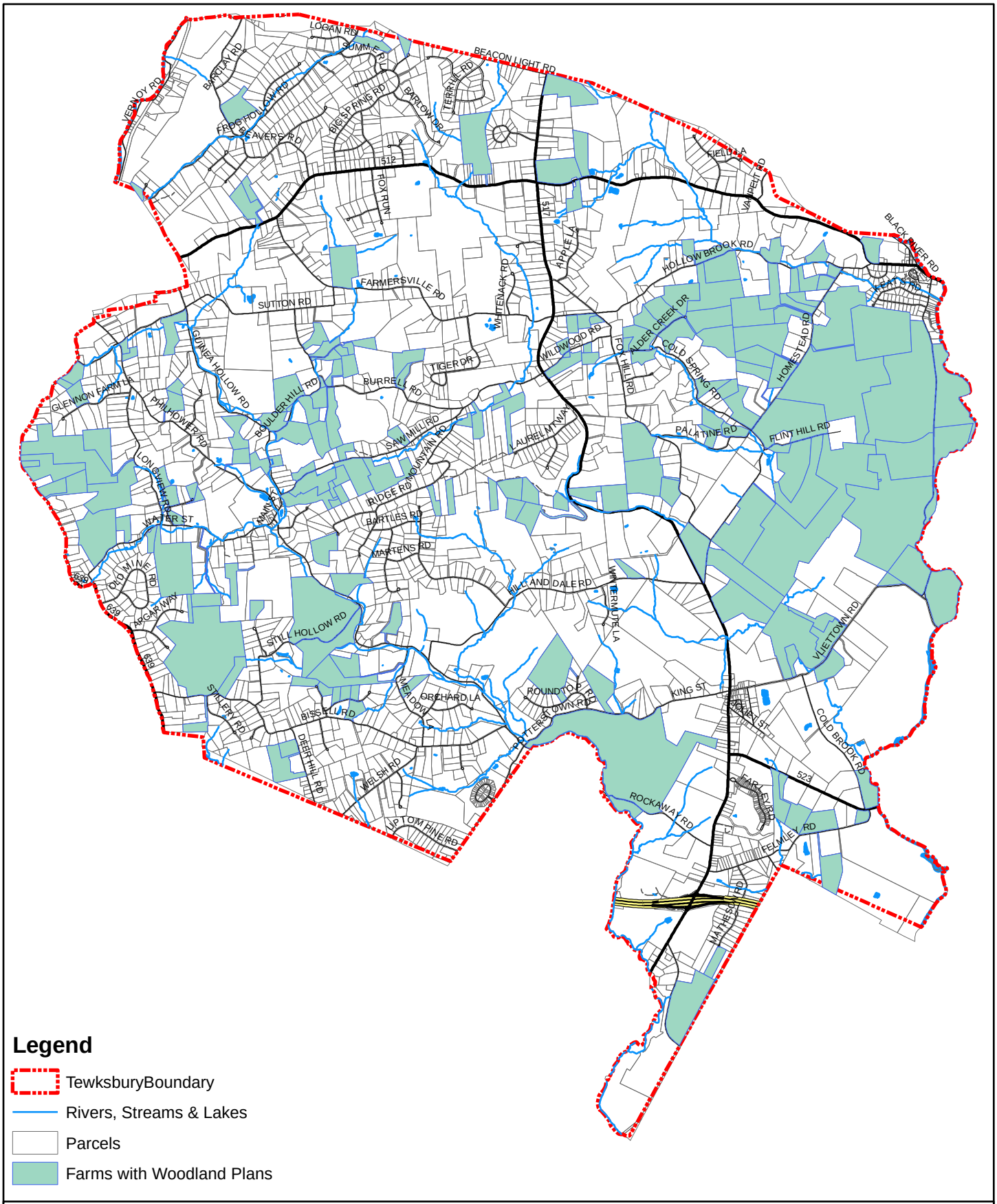
No serious insect or disease problems were noted in the report, with the exception of Dutch elm disease, which is resulting in elm mortality. Some tulip poplar mortality was attributed to the 1999 drought. Tewksbury's forests are at a low risk for forest fire (slightly higher risk in the Piedmont section of the township) due to the interspersion of streams and the excellent soils that support the rapid conversion of the annual leaf fall. Deer browsing (discussed further in **Section 7.B**) and invasive exotic plants (see **Section 7.F**) affect the future forest condition (ForesTree Consultants, 2003).

Various forest types and many tree species can be viewed at the township's Pascal Park. A Tree Trail brochure was developed by the township for educational purposes (ForesTree Consultants, 2003).

Woodland Management Plans (WMP) are required for some woodland owners under the Farmland Assessment Act of 1964, which provides farmland tax status to owners of farmlands. The NJ Forest Service reviews the plans and inspects the woodlands every 3 years. This program aids in the proper management of private forests, helping to eliminate excessive and unnecessary cutting of one of the state's valuable natural resources, while enhancing the benefits of woodlands, such as improved water and air quality and wildlife habitat (NJDEP, 2005). Farms with woodland management plans are shown in **Figure 7c**.

B. Wildlife

New Jersey hosts 325 bird species, 90 mammal species, 79 reptile and amphibian species and over 400 species of fish. Per square mile, New Jersey has the greatest wildlife diversity of



Legend

- TewksburyBoundary
- Rivers, Streams & Lakes
- Parcels
- Farms with Woodland Plans

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
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N

0 0.25 0.5 1 1.5 Miles

Figure 7c: Farms with Woodland Management Plans

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

any state in the nation, according to the NJ Division of Fish and Wildlife. New Jersey's geographic position where northern ecosystems reach their southern limit and where southern ecosystems reach their northern limit provides a wide variety of habitats including mountains, valleys, rolling hills, wetlands, pinelands, beaches, estuaries and rivers (NJDEP, 2005).


Eastern milk snake

The NJDEP website offers checklists for the birds, mammals, reptiles and amphibians of New Jersey, noting the status of each (e.g. common or rare) (see **Internet Resources**). A variety of plant and animal species enjoy Tewksbury Township's diversity of habitat types, although a catalogue of those specifically found within the boundaries of Tewksbury has never been done.

A few species of interest are discussed below.

White-tailed Deer

The largest herbivore living wild in New Jersey is the white-tailed deer (*Odocoileus virginianus*). 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. Fawns weigh approximately 7½ pounds at birth (which usually occurs between May and the first two weeks of June) while adult females average 100 pounds and adult males average 150 pounds (Burnett, No Date).

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 of over 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).


White-tailed Deer

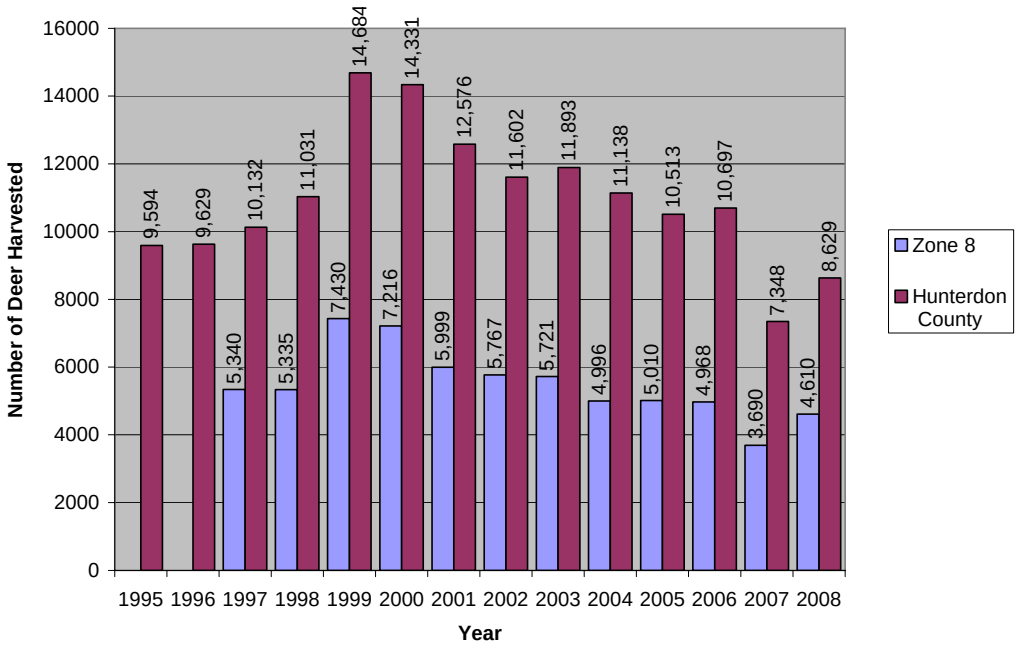
For comparison, NJDEP's hunting figures[20] for Hunterdon County show that an average for the period 1995-2006 of 27 deer per square mile are *taken* by hunters each year (see **Table 7.2**), therefore populations are well over the ecological carrying capacity. For the past twelve years, Hunterdon County has experienced the highest deer harvest in the state (nearly double the harvest of the next highest, Sussex County).

Deer Management Zone 8, which encompasses Tewksbury Township, had the highest harvest rates in the county for 9 out of the past 10 years. The presence of a number of Wildlife Management Areas that are open to public hunting in Zone 8, including Cold Brook, in Tewksbury, and Allamuchy, Hacklebarney and Voorhees State Parks, among others that are not located in Tewksbury, contribute to the high deer harvest numbers (NJ Division of Fish and Wildlife, 2008). The 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

[20] Deer harvest figures reflect numbers of hunters, availability of land on which to hunt, changes in hunting regulations, as well as other factors, so are not a direct measure of deer population.

plants and animals dependent on the forest); and the potential for reduced deer health due to inadequate nutrition and the spread of disease (Bowman's Hill, 2004; Honachevsky, 2000; Latham et al, 2005; Native Plant Society, 2004; Sauer, 1998). Despite all this, deer remain a natural part of the ecosystem and are not solely responsible for diversity loss and habitat degradation.

Table 7.2: Deer Hunting Harvest 1995 - 2008



Source: NJ Division of Fish and Wildlife, 2008

Many people still enjoy seeing deer, and many also gain satisfaction from hunting deer. Deer hunting contributes to the economy, as well, as deer hunters in New Jersey spend more than 100 million dollars each year as they enjoy in excess of 1.6 million recreation-days hunting deer (NJ Division of Fish and Wildlife, 2008).

Black Bear

Black bears, the largest land mammals in the state, are occasionally seen in Tewksbury Township. They are most frequently seen during the breeding season of June and July, when the males travel extensively in search of females. Black bears are omnivorous in food preferences, consuming a range of foods from skunk cabbage, berries, nuts, insects, small mammals, road-kill and human garbage. They are sometimes responsible for damage to bird feeders, beehives, sweet corn, livestock, garbage, etc. Black bears that are fed, unintentionally or intentionally, can become dangerous and may have to be destroyed (NJ Division of Fish and Wildlife, 2007).


Black Bear

The Division of Fish and Wildlife offers information and techniques for damage and nuisance prevention (see **Internet Resources**).

Coyotes

The population of eastern coyotes was reduced to 100 in the state in 1975, but has rebounded to the current population of 3,000. The coyote is the largest wild canine found in NJ, primarily nocturnal, but sometimes seen during the day, and extremely wary of humans. The coyote closely resembles a small German shepherd, except that its snout is longer and its tail is bushier, black-tipped, and held horizontally or lower. They are not pack animals, although the young may remain with the parents for 1½ years. Coyotes are opportunistic predators, feeding on small animals, carrion, insects, fruit and other vegetable matter. They occasionally kill and eat small livestock (e.g. chickens, sheep) and pets, and raid garbage. Sightings alone should not cause alarm but are a signal to take measures to make a property less hospitable to the coyotes and to safeguard children, pets and livestock (McBride, 2007).

Northern Copperhead

The copperhead is the only venomous snake found in Tewksbury Township. It is considered a species of special concern due to its rarity in NJ. The copperhead, as its name suggests, is a red-brown color with darker crossbands and a shovel-shaped head. It is distinguished from the northern water snake by the fact that the crossbands are hourglass shaped on the copperhead (i.e. narrower in the center of the back, wider on the sides). This snake prefers rocky wooded uplands and wooded wetlands and may be found hiding in rotting woodpiles or on the leafy forest floor. **Don't handle these snakes and don't approach them. They'll leave you alone if you leave them alone** (Schwartz & Golden, 2002)**.**

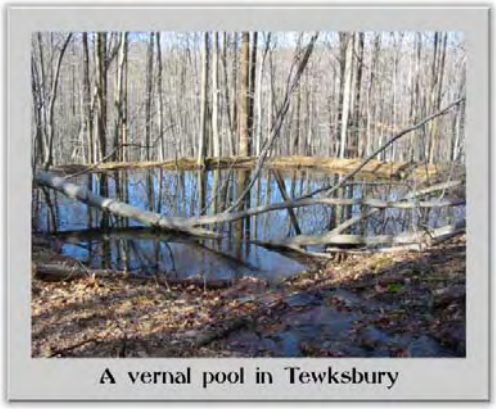
Wildlife of Vernal Pools

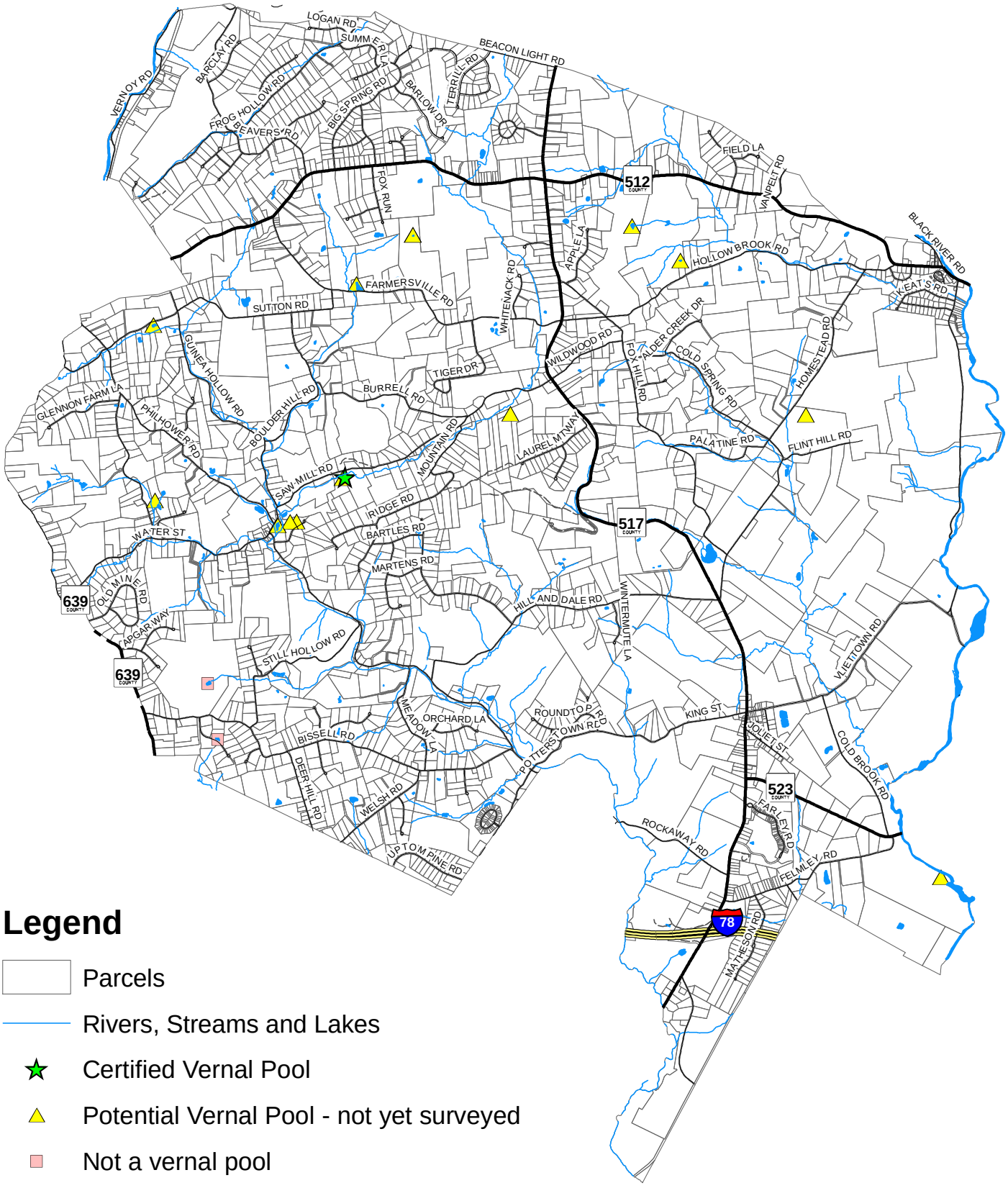
Vernal pools are defined as confined depressions, either natural or man-made, that maintain ponded water for part of the year, have no permanent outflow, and are devoid of breeding fish populations. These temporary wetlands provide habitat to many species of amphibians, several of which breed exclusively in vernal pools, as well as a multitude of insects, reptiles, plants, and other wildlife (see **Table 7.3**).


A newly emergent gray treefrog

The NJ Freshwater Wetlands Protection Act (adopted in 1989) did little to protect vernal pools because wetlands less than one acre in size were exempt from regulatory protection. Most vernal pools in NJ are less than 1/4 acre; therefore vernal pools could be filled, drained, or modified with a general permit. The loss of this critical habitat put the species that depend on vernal pools at risk. The NJDEP approved new regulations in September 2001, providing protection for vernal pools.

NJDEP Division of Fish and Wildlife, Nongame Species Program directs the Vernal Pool Project, which is an effort to map and survey the vernal pools throughout the state. Because of the ephemeral nature and small size of vernal pools, the program recruits volunteers to visit possible vernal pools and confirm, or "certify," whether the sites fulfill the regulatory definition. The state identified 17 potential vernal pools within Tewksbury, 4 of which have been certified, 2 have been investigated and found not to be vernal pools, while the remaining 11 have not yet been surveyed (see **Figure 7d**).


A vernal pool in Tewksbury



Legend

- Parcels
- Rivers, Streams and Lakes
- Certified Vernal Pool
- Potential Vernal Pool - not yet surveyed
- Not a vernal pool

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 7d: Vernal Pools and Potential Vernal Pools

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

Table 7.3: Vernal Pool Amphibians and Reptiles

Obligate Vernal Pool Breeding Amphibians	Facultative Vernal Pool Breeding Amphibians	Reptiles that Inhabit Vernal Pools on a Seasonal Basis
Marbled salamander *Special Concern* Spotted salamander Jefferson salamander *Special Concern* Wood frog Blue-spotted salamander *ENDANGERED* Eastern tiger salamander *ENDANGERED* Eastern spadefoot toad	Green frog Bullfrog Pickerel frog Southern leopard frog Carpenter frog *Special Concern* Northern spring peeper Northern cricket frog New Jersey chorus frog Upland chorus frog Northern gray treefrog Southern gray treefrog *ENDANGERED* Pine barrens treefrog *ENDANGERED* Four-toed salamander Long-tailed salamander *THREATENED*	Wood turtle *THREATENED* Spotted turtle *Special Concern* Mud turtle Eastern painted turtle Common snapping turtle (These reptiles visit vernal pools primarily to eat the eggs and larvae of amphibians.)
Note: Species in black are either known to occur in Tewksbury Township or their ranges include Hunterdon County; species in grey have ranges that do not include Hunterdon County, therefore it would be unlikely to find them in Tewksbury.		
Sources: Tesauro, no date; Kenney et al, no date; Schwartz and Golden, 2002; N.J.A.C 7:7A, Appendix 1.		

Fish & Wildlife of Aquatic Habitats

A NJDEP program called *Integrated Biological Aquatics Assessment* combines various studies in an evaluation of the ecological health of aquatic habitats. Beginning in 2000, the Endangered and Nongame Species Program conducted surveys for freshwater mussels, dragonflies and damselflies (*Odonata*) and stream-associated reptiles and amphibians (often grouped under the term "herptiles") at selected Ambient Biomonitoring Network (AMNET; see Section 6H) sites, in addition to stream habitat assessments. Assessments of fish assemblages are a useful environmental indicator to adequately evaluate biological integrity and protect surface water quality. The USEPA's Rapid Bioassessment Protocol V method is used for these assessments, with some modifications for regional conditions (NJ Department of Fish and Wildlife, 2000).

These efforts have identified 12 native freshwater mussel species, 9 of which are listed as endangered, threatened or special concern; 172 Odonata species, of which 43 are considered rare; and 72 herptile species, 17 of which are listed as endangered or threatened.

The Bureau of Freshwater Fisheries evaluates fish populations with its Fish Index of Biotic Integrity (IBI), which uses fish populations as an indicator of stream water quality. Three IBI sampling sites are located within Tewksbury Township on the Lamington River, and another four sites are located nearby on the South Branch of the Raritan River. "Good" IBI ratings were determined for all these sites, except one site on the South Branch of the Raritan River (at Arch Street in High Bridge), which was rated "excellent." A list of fish species found at the sites on the Lamington River in Tewksbury may be found in Table 7.4 (NJ Division of Fish and Wildlife, April 2004, July 2005 and January 2008).

Recreational fishing often focuses on trout, smallmouth and largemouth bass, pickerel and eel. Public fishing access is available on the South Branch Raritan River on the northwestern boundary of the township. Trout are stocked on the South Branch Raritan, Rockaway Creek and Lamington River (NJ Fish and Wildlife, no date and 2008). See Section 6J for Fish Consumption Advisories.

Table 7.4 List of Fishes Collected During Index of Biotic Integrity Sampling of Lamington River in Tewksbury Township (listed in order of abundance)

COMMON NAME	SCIENTIFIC NAME	# FOUND	SIZE RANGE (INCHES)
FIBI054: Lamington River at McCann Mill Road (most recent sampling date 08-02-2002)			
Blacknose dace	*Rhinichthys atratulus*	195	
Common shiner	*Luxilus cornutus*	148	
White sucker *	*Catostomus commersoni*	117	
Longnose dace	*Rhinichthys cataractae*	112	
Tesselated darter	*Etheostoma olmstedi*	95	
Satinfin shiner	*Cyprinella analostana*	46	
Fallfish	*Semotilus corporalis*	37	
Spottail Shiner	*Notropis hudsonius*	24	
American eel*	*Anguilla rostrata*	22	
Brown Trout*	*Salmo trutta*	14	3.0-11.4
Redbreast sunfish*	*Lepomis auritus*	13	2.2-5.3
American brook lamprey	*Lampetra appendix*	8	
Swallowtail shiner	*Notropis procne*	7	
Redfin pickerel	*Esox americanus americanus*	3	4.3-4.7
Creek Chub	*Semotilus atromaculatus*	2	
Bluespotted Sunfish	*Enneacanthus gloriosus*	1	
Pumpkinseed sunfish*	*Lepomis gibbosus*	1	3.0
Number of Fish Species: 17	**Number of Fish:** 845	**Nearby AMNET Water Quality Rating:** FIBI054 is 2.23 mi downstream ofAN0360 [No AMNET rating]	
FIBI Score: 40	**FIBI Rating:** Good	**Habitat Score:** 175	**Habitat Rating:** optimal
FIBI032: Lamington River at Black River Road (most recent sampling date 7-11-2006)			
Shield Darter	*Percina peltata*	63	
American eel	*Anguilla rostrata*	52	
Tesselated darter	*Etheostoma olmstedi*	51	
Longnose dace	*Rhinichthys cataractae*	45	
Margined Madtom	*Noturus insignis*	27	
Bluegill sunfish	*Lepomis macrochirus*	26	1.6-3.1
White sucker	*Catostomus commersoni*	26	
American brook lamprey	*Lampetra appendix*	23	
Spottail Shiner	*Notropis hudsonius*	19	
Pumpkinseed sunfish	*Lepomis gibbosus*	16	2.2-3.5
Common shiner	*Luxilus cornutus*	15	
Redbreast sunfish	*Lepomis auritus*	9	
Swallowtail shiner	*Notropis procne*	7	
Banded killifish	*Fundulus diaphanus*	5	
Redfin pickerel	*Esox americanus americanus*	5	3.3-4.2
Fallfish	*Semotilus corporalis*	5	
Satinfin shiner	*Cyprinella analostana*	5	
Green sunfish	*Lepomis cyanellus*	3	2.2-2.8
Eastern mudminnow	*Umbra pygmaea*	2	
Smallmouth bass	*Micropterus dolomieu*	2	
Blacknose dace	*Rhinichthys atratulus*	2	
Largemouth bass	*Micropterus salmoides*	1	2.2
Rock bass	*Ambloplites rupestris*	1	4.4
Number of Fish Species: 23	**Number of Fish:** 410	**Nearby AMNET Water Quality Rating:** FIBI032 is 1.2mi upstream AN0363 1994 – Non-impaired 1999 – Non-impaired 2004 – Non-impaired	
FIBI Score: 2001: 44 2006: 40	**FIBI Rating:** 2001: Good 2006: Good	**Habitat Score:** 148	**Habitat Rating:** sub-optimal

COMMON NAME	SCIENTIFIC NAME	# FOUND	SIZE RANGE (INCHES)
FIBI078: Lamington River at Rattlesnake Bridge Road (most recent sampling date 7-29-2003)			
Common shiner	*Luxilus cornutus*	35	
American eel	*Anguilla rostrata*	26	
Tesselated darter	*Etheostoma olmstedi*	25	
White sucker	*Catostomus commersoni*	18	
Banded killifish	*Fundulus diaphanus*	14	
Bluegill sunfish	*Lepomis macrochirus*	13	2.4 - 3.3
Redbreast sunfish	*Lepomis auritus*	11	3.3 – 4.7
Blacknose dace	*Rhinichthys atratulus*	8	
Swallowtail shiner	*Notropis procne*	8	
Pumpkinseed sunfish	*Lepomis gibbosus*	5	2.2 - 4.7
Redfin pickerel	*Esox americanus americanus*	5	3.1 - 7.9
Spotfin shiner	*Cyprinella spiloptera*	4	
Green sunfish	*Lepomis cyanellus*	4	3.5 - 4.3
Sea lamprey	*Petromyzon marinus*	3	
Longnose dace	*Rhinichthys cataractae*	3	
Fallfish	*Semotilus corporalis*	2	
Spottail shiner	*Notropis hudsonius*	1	
Rock bass	*Ambloplites rupestris*	1	3.3
Smallmouth bass	*Micropterus dolomieu*	1	2.0
American brook lamprey	*Lampetra appendix*	1	
Number of Fish Species: 20	**Number of Fish:** 188	**Nearby AMNET Water Quality Rating:** FIBI078 is 4 mi downstream of AN0363 Round 1 – Non-impaired Round 2 – Non-impaired Round 3 – Non-impaired	
FIBI Score: 40	**FIBI Rating:** Good	**Habitat Score:** 139	**Habitat Rating:** sub-optimal
* Regulated as a fishable species under current New Jersey Fish and Wildlife codes			
Sources: NJ Division of Fish and Wildlife, April 2004; NJ Division of Fish and Wildlife, July 2005; NJ Division of Fish and Wildlife, January 2008			

C. Endangered, Threatened and Special Concern Animal Species

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.

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 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 73 species currently listed as endangered or threatened, plus another 57

species of special concern. **Table 7.5** presents the definitions used by NJDEP in describing the status of 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. A reporting form is available on the Internet, and is included in **Appendix C**. For state-wide species lists, see **Internet Resources**.

A search of NJDEP Division of Parks and Forestry *Natural Heritage Database* in November 2007 revealed the documented presence of 20 endangered, threatened and special concern animals in Tewksbury Township (see **Tables 7.5** for code definitions and **Table 7.6** for list; see **Section 7E** for rare plants)**.** These include 5 endangered species (bobcat, bald eagle, bog turtle, brook floater and red-shouldered hawk), meaning that they likely need management action to avoid extinction within New Jersey. There are 6 threatened species, which are vulnerable and could become endangered, including 5 birds (barred owl, bobolink, Cooper's hawk, grasshopper sparrow, savannah sparrow) and one reptile (wood turtle). Special concern species, which warrant concern due to evidence of decline or vulnerability, include 3 birds (eastern meadowlark, great blue heron and veery), 2 reptiles (box turtle and northern copperhead snake) and 2 amphibians of special concern due to declining populations (Jefferson salamander and northern spring salamander). In addition, there is one endangered invertebrate found within the township (the brook floater, a mussel) and one special concern invertebrate (the creeper mussel).

The bog turtle and small whorled pogonia (a plant) are also listed as threatened on the Federal endangered species list. Federal cost-sharing programs, which provide funding for habitat management and improvement, may be available for private landowners having bog turtles on their land (NJDEP, bog turtle fact sheet, no date).

Fact sheets, including photos, for many of the endangered, threatened and rare animals listed below are presented in **Appendix C**. **Appendix C** also includes a list of Hunterdon County rare species and natural communities. The species found in other locations within the county also have potential to be present in Tewksbury if suitable habitat is present within the township.

Table 7.5: Definitions of Species Status

STATE STATUS	STATE STATUS DEFINITIONS
E	*Endangered* applies to a species whose prospects for survival within the state are in immediate danger due to one or several factors, such as loss or degradation of habitat, over-exploitation, predation, competition, disease or environmental pollution, etc. An endangered species likely requires immediate action to avoid extinction within NJ.
T	*Threatened* applies to species that may become Endangered if conditions surrounding it begin to or continue to deteriorate. Thus, a Threatened species is one that is already vulnerable as a result of, for example, small population size, restricted range, narrow habitat affinities, significant population decline, etc.
SC	*Special Concern* applies to 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.
D	*Declining* species applies to a species that has exhibited a continued decline in population numbers over the years.
S	*Stable* (or increasing) applies to species that appear to be secure in NJ and not in danger of falling into any of the preceding categories in the near future.
U	*Undetermined* refers to a species about which there is not enough information available to determine the status.
FEDERAL STATUS	**FEDERAL STATUS DEFINITIONS**
LE	Taxa formally listed as *endangered*.
LT	Taxa formally listed as *threatened*.
STATE RANK	**STATE ELEMENT RANK DEFINITIONS**

STATE STATUS	STATE STATUS DEFINITIONS
S1	*Critically imperiled in New Jersey* because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Species ranked S1 are often restricted to specialized habitats and/or restricted to an extremely small (3%) geographical area of the state. Also included are species 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 species 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 species may have been more frequent, but now, largely through habitat destruction, are known from fewer extant occurrences. The S2 rank also includes species which occur in habitats restricted to 10 % of the total state area.
S3	*Rare in state* with 21 to 100 occurrences (plant species in this category have only 21 to 50 occurrences). Includes species which are widely distributed in the state but often occurring in small populations, and also in habitats which may be common or widespread. Species having a moderately restricted distribution (but greater than 10%) in New Jersey, but are locally abundant, are also included. Species ranked S3 are not yet imperiled in state but may soon be if additional populations are destroyed.
S4	Apparently secure in the state, with many occurrences.
S5	Demonstrably secure in state and essentially ineradicable under present conditions.
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.
REGIONAL STATUS	**REGIONAL STATUS CODES FOR PLANTS AND ECOLOGICAL COMMUNITIES**
LP	Indicates 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 NJ Pinelands Comprehensive Management Plan.
HL	Indicates taxa or ecological communities protected by the *Highlands Water Protection and Planning Act* within the jurisdiction of the Highlands Preservation Area.
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.
GNR	Species has not yet been ranked
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).	
Sources: NJ Division of Fish and Wildlife, 2005: http://www.njfishandwildlife.com/spclspp.htm and http://www.nj.gov/dep/parksandforests/natural/heritage/spplant_ap1.html	

The New Jersey Endangered Species Conservation Act was signed into law on Dec.14, 1973, preceding the federal Endangered Species Act by two weeks. According to NJDEP then Commissioner Bradley Campbell (Bean, 2003), these regulations have done a good job of protecting listed species that occur in wetlands and in the Pinelands area, but have often failed to protect species found elsewhere. Critical habitat regulations (under development) will use the state's Landscape Project (see **Figures 7d through 7f**) to also protect upland habitats.

NJDEP provided additional protection of threatened and endangered species by designating waters that provide critical habitat for endangered species as Category One (C1) waters (see **Figure 6d**). Rare, threatened and endangered species are often very sensitive to pollution and habitat disturbances, therefore should benefit from the C1 regulations aimed to establish stream buffers and maintain water quality.

Table 7.6: Animal Species Presently Recorded in the Natural Heritage Database for Tewksbury Township

Common Name	Scientific Name	Federal Status	State Status	Global Rank	State Rank	Habitat
Vertebrates, mammals:						
bobcat*	*Lynx rufus*		E	G5	S1	Variable, but prefer forested habitats that provide dense understory and are not highly suburbanized
Vertebrates, birds:						
bald eagle (foraging area) *	*Haliaeetus leucocephalus*	Delisted June 2007 (was LT)	E	G4	S1B.S1N	Large perch trees near a body of water
barred owl*	*Strix varia*		T/T	G5	S2B.S2N	Woodlands, wooded wetlands
bobolink*	*Dolichonyx oryzivorus*		T/SC	G5	S2B.S3N	Large hayfields, pastures
Cooper's hawk*	*Accipiter cooperii*		T/S	G5	S2B.S4N	Mixed riparian or wetland forests; avg. 0.3 miles away from nearest house
eastern meadowlark	*Sturnella magna*		SC/SC	G5	S3B.S3N	fields, meadows, prairies
grasshopper sparrow*	*Ammodramus savannarum*		T/SC	G5	S2B.S3N	Grasslands, hayfields, prairies
great blue heron	*Ardea herodias*		SC/S	G5	S3B.S4N	Wetlands, shores
Kentucky warbler	*Oporornis formosus*		SC/SC	G5	S3B.S3N	Woodland undergrowth
red-shouldered hawk*	*Buteo lineatus*		E/T	G5	S1B.S2N	Woodlands, wooded wetlands
savannah sparrow*	*Passerculus sandwichensis*		T/T	G5	S2B.S4N	Open fields, meadows, shores
veery	*Catharus fuscescens*		S/S	G5	S3B	Damp deciduous woods
Vertebrates, reptiles:						
bog turtle*	*Glyptemys muhlenbergii*	LT	E	G3	S1	Calcareous fens, sphagnum bogs, wet meadows
eastern box turtle*	*Terrapene carolina carolina*		SC	G5T5	S3	Woods & meadows
northern copperhead snake*	*Agkistrodon contortrix contortrix*		SC	G5T5	S3	Rocky wooded uplands, wooded wetlands, rotting woodpiles, leaf litter
wood turtle*	*Glyptemys insculpta*		T	G4	S2	Clean streams & undisturbed uplands
Vertebrates, amphibians:						
Jefferson salamander*	*Ambystoma jeffersonianum*		D	G4	S3	Breed in woodland vernal pools; live underground in upland deciduous forests
northern spring salamander*	*Gyrinophilus p. porphyriticus*		D	G5T5	S3	Cool mountain streams & shaded seepages
Invertebrate:						
brook floater*	*Alasmidonta varicosa*		E	G3	SI	on rock and gravel substrates in rapids and riffles of small streams
creeper or squawfoot mussel	*Strophitus undulatus*		SC	G5	S3	substrate is varied and can consist of mud, sand, or gravel

* = fact sheets for species marked with an * are included in **Appendix C**.
Note: For status and rank definitions, refer to **Table 7.5**.

Sources: NJDEP ONLM, November 2007; NJDEP ONLM fact sheets; Schwartz, 2002; Peterson, 1980

D. The Landscape Project

The Landscape Project 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 land owners for planning, open space acquisition, and land-use regulation (Niles et al, 2004).

The NJDEP, Division of Fish and Wildlife, Endangered and Nongame Species Program is responsible for the Landscape Project Version 3.0, which was released to the public in May 2008. It was created by intersecting endangered, threatened and rare species data with the NJDEP 2002 aerial-photo based Land Use/Land Cover GIS layer to delineate potential rare species habitat within the Highlands Region. In contrast to previous versions, the data was not separated into five general habitat types (forest, forested wetland, grassland, emergent wetland and beach), but retained the 69 unique LU/LC classes that are found within the Highlands Extended Boundary. These were then used to assign habitat value for each individual species. The resulting data layers identify, delineate and rank critical habitat based on the conservation status of species present (see **Table 7.7** for rank definitions). The same methodology will be applied to the rest of the state in the future. **Figure 7e** illustrates the Landscape Project Version 3.0. Approximately half of Tewksbury Township is comprised of habitat for state endangered species (rank 4).

The Highlands Council used the Landscape Project Version 3.0 data to develop a Highlands Conservation Rank, which is based upon how critical the Highlands Region is to the continued existence of the species within the state (see **Appendix E.2**) (Highlands Water Protection and Planning Council, 2007).

The Landscape Project GIS data may be related to a database of species in order to identify the species of concern in a particular patch.

Grassland Habitat: Tewksbury Township is home to three species of state threatened grassland birds: the Savannah sparrow, the grasshopper sparrow, and the bobolink. Habitat for these birds is ranked 3 (Winkler et al, 2008). The Master Plan states that the grasshopper sparrow was found in only one location in the township (near Bissell Road), but cautions that recent development in the area may have destroyed their habitat and thus these birds (Hintz, 2003). Just south of Route 78, bobolinks were recently observed displaying breeding behavior (Wander Ecological Consultants, 2006).

Forest Habitat: A broad swath of rank 4 forest habitat extends across the center of Tewksbury. This area is habitat to the state endangered bobcat, as well as priority bird and herptile species. The state endangered red-shouldered hawk and the state threatened barred owl are found in the rank 4 forests, while the barred owl and herptile priority species are also found in the rank 3 forests.

Wetland Habitat: Habitat for the federally threatened species, the bog turtle (rank 5), is located on the northern edge of the township, in the headwaters of the Rockaway Creek near Dege Farm Road. Habitats for the red-shouldered hawk, barred owl and bog turtle exist in patches along the Lamington River on the eastern edge of the township.

For some species, additional specific mapping protocols were developed in the Landscape Version 2.1. The wood turtle and the bald eagle nesting site models were incorporated into Version 3.0, however the bald eagle foraging model remains a stand-alone GIS layers that was not used to value habitat patches (Winkler, 2008). While the bald eagle is listed as present in Tewksbury, the Landscape Project methodology for bald eagle foraging area does not identify any such habitat within Tewksbury.

Table 7.7: Landscape Project Habitat Rank Definitions

Rank	Definition	Approximate Percent of Tewksbury
0	Rank 0 is assigned to species-specific patches that do not contain any species occurrences and do not meet any habitat-specific suitability requirements.	26%
1	**Suitable Habitat** – Rank 1 is assigned to species-specific 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.	9%
2	**Special Concern** – Rank 2 is assigned to species-specific patches containing one or more occurrences of species considered to be species of special concern (this rank represents "rare species" of wildlife as defined in the Highlands Water Protection and Planning Act Rules).	1%
3	**State Threatened** – Rank 3 is assigned to species-specific patches containing one or more occurrences of State threatened species.	13%
4	**State Endangered** – Rank 4 is assigned to species-specific patches with one or more occurrences of State endangered species.	49%
5	**Federally Listed** – Rank 5 is assigned to species-specific patches containing one or more occurrences of wildlife listed as endangered and threatened pursuant to the Federal Endangered Species Act of 1973.	1%
Sources: Winkler et al, 2008		

E. Endangered, Threatened & Special Concern Plants

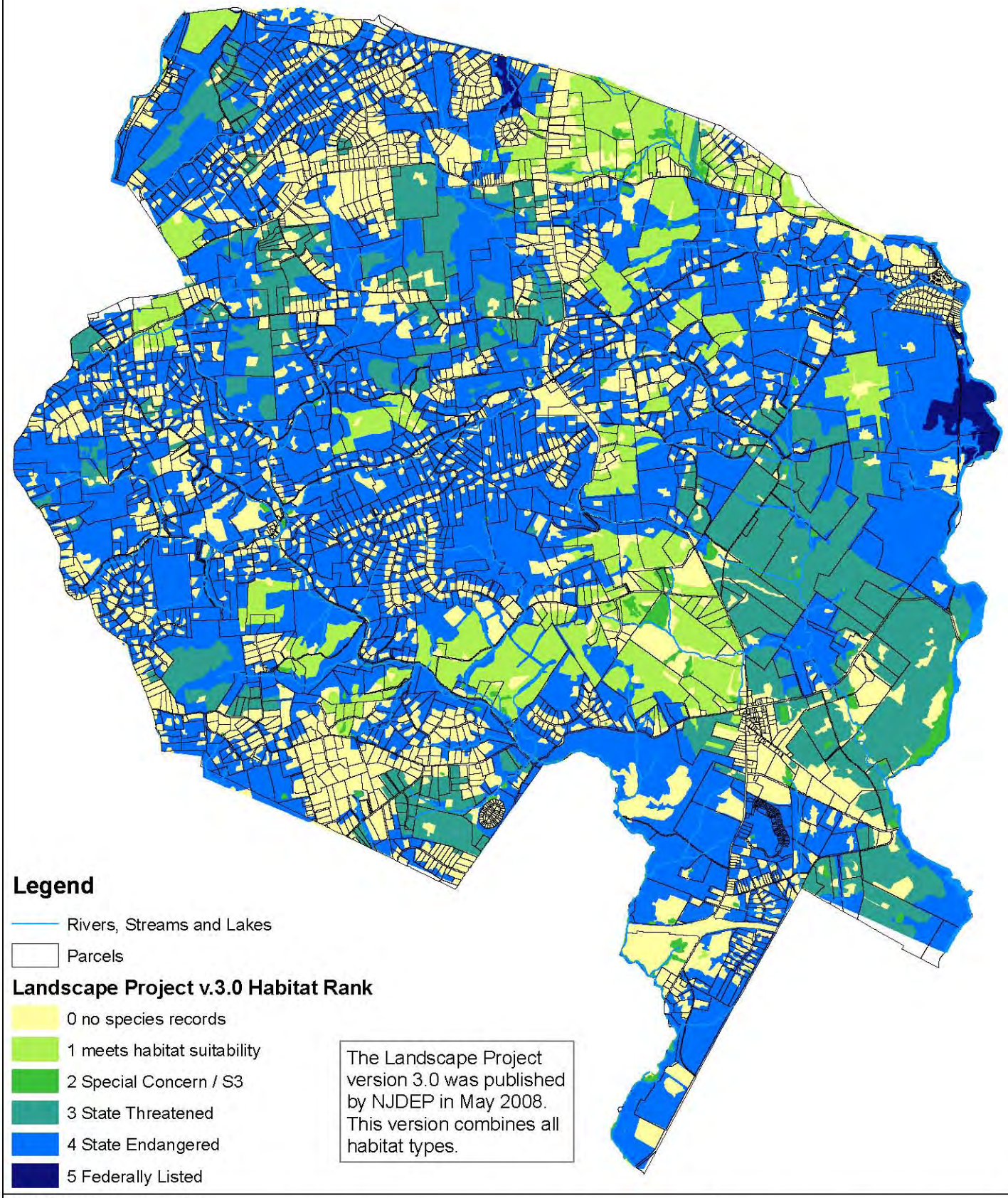
A search of NJDEP Division of Parks and Forestry *Natural Heritage Database* in November 2007 revealed the documented presence of 5 special concern plants in Tewksbury Township (see **Tables 7.5** for code definitions and **Table 7.8** for list**).** These include 2 endangered vascular plants, 2 imperiled vascular plants and one rare plant. No lists are available for non-vascular plants.

Natural Heritage Priority Sites represent some of the best remaining habitat for rare species and exemplary natural communities in the state. They have been identified through the Natural Heritage Database by the NJDEP Office of Natural Lands Management (ONLM) as areas critically important for preservation of New Jersey's biological diversity. The database provides detailed, up-to-date information on rare plant species and natural communities for planners, developers, and conservation agencies for use in resource management, environmental impact assessment, and both public and private land protection efforts. According to the ONLM, if these sites become degraded or destroyed, we may lose some of the unique components of our natural heritage.

Within Tewksbury Township, there are two Natural Heritage Priority Sites (see **Figure 7f**). **Table 7.9** provides descriptions of the sites. One is ranked[21] **B4** (moderate significance**)** and one is ranked **B5** (general biodiversity significance).

These Natural Heritage Priority Sites are considered some of the best and most viable occurrences of endangered and threatened plant species and natural communities, but they do not cover all known habitats for endangered and threatened plant species in Tewksbury Township. Information on whether or not endangered or threatened species have been documented on a specific piece of land can be obtained by requesting a search of the Natural Heritage Database

[21]Biodiversity Significance Ranks are as follows: **B1** – Outstanding significance; **B2** – Very high significance; **B3** – High significance; **B4** – Moderate significance (such as a viable occurrence of a globally rare element, a good occurrence of any natural community, a good or excellent occurrence or only viable state occurrence of an element that is critically imperiled in the State, an excellent occurrence of an element that is imperiled in the State, or a concentration (4+) of good occurrences of elements that are imperiled in the State or excellent occurrences of elements that are rare in the State); **B5** – Of general biodiversity interest or open space.



Legend

- Rivers, Streams and Lakes
- Parcels

Landscape Project v.3.0 Habitat Rank

- 0 no species records
- 1 meets habitat suitability
- 2 Special Concern / S3
- 3 State Threatened
- 4 State Endangered
- 5 Federally Listed

The Landscape Project version 3.0 was published by NJDEP in May 2008. This version combines all habitat types.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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Figure 7e: Landscape Project - Version 3.0 Highlands

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

Table 7.8: Plant Species Presently Recorded in the Natural Heritage Database for Tewksbury Township

Common Name	Scientific Name	Federal Status	Regional Status	State Status	Global Rank	State Rank	Last Observed	Description
Frank's sedge	*Carex frankii*		HL		G5	S3	1985	Sedge family. Edges of wet woods, seasonally wet meadows. Obligate wetlands species. A "grass-like" plant.
Lobed spleenwort	*Asplenium pinnatifidum*		LP, HL	E	G4	S1	1985	Spleenwort family (Fern division). Cliffs, ledges, and boulders of sandstone and other acidic rocks. Stems short-creeping to erect, frequently branched.
Shining Ladies'-tresses	*Spiranthes lucida*		HL		G5	S2		Orchis family. Moist places. Small flowers in 4-10" spike, leaves lance shaped & shining.
Small whorled pogonia	*Isotria medeoloides*	LT	LP, HL	E	G2	S1	1964	Orchis family. Dry or moist woods. Single flower in late spring or early summer above whorl of 5 elliptical leaves.
Thread-leaf water buttercup	*Ranunculus trichophyllus var.*		HL		G5T5	S2	1970	Buttercup family. Ponds and streams. Aquatic plant with finely divided leaves and white flowers just above the water surface.
Note: For status and rank definitions, refer to **Table 7.5.**								
Sources: NJDEP ONLM, 2007; Newcomb, 1977; Intermountain Herbarium Server; Flora of North America								

from the Office of Natural Lands Management. In addition, some areas have never been surveyed, but may also contain endangered or threatened species.

The ONLM has also developed the *Natural Heritage Grid Map* (see **Figure 7f**), which provides a general representation of the locations of rare plant species and natural communities as of 2004, 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 species of concern are listed in **Table 7.10**. The map identifies potentially sensitive areas, and indicates where custom database searches are needed for land use decision-making. The Grid Map does not include habitat for animal species, and not all areas have been surveyed.

Table 7.9: Natural Heritage Priority Sites Descriptions

Site Name: Hell Mountain	**Site Code: S.USNJHP1 * 269**
Location: Tewksbury Township, Hunterdon County **Description:** Steep sloped rocky mountain. **Boundary Justification:** Includes the mountain slope that is habitat for endangered plant species, as well as buffer. **Biodiversity Rank:** Biodiversity Significance B4V1 (moderate significance) **Comments:** This is the only documented occurrence for a plant species that is critically endangered in the state.	
Site Name: Vernoy	**Site Code: S.USNJHP1 * 173**
Location: Tewksbury Township, Hunterdon County **Description:** Wooded floodplain along the South Branch of the Raritan River. **Boundary Justification:** Boundary encompasses extent of floodplain forest habitat. **Biodiversity Rank:** Biodiversity Significance B5V5 (general biodiversity significance) **Comments:** This site contains a good occurrence of a state rare plant species.	
Source: NJDEP ONLM, March 2007	

Table 7.10: Natural Heritage Grid Descriptions

Grid Id. #	Precision	Class	Species Name	State Rank
6349	M&S	Vascular plant	Thread-leaf water buttercup	S2
		Vascular plant	Frank's sedge	S3
6350	M	Vascular plant	Thread-leaf water buttercup	S2
6549	M	Vascular plant	Thread-leaf water buttercup	S2
6550	M	Vascular plant	Thread-leaf water buttercup	S2
6746	S	Data sensitive	DATA SENSITIVE SPECIES OR NATURAL COMMUNITY	
7147	S	Data sensitive	DATA SENSITIVE SPECIES OR NATURAL COMMUNITY	
Note: For state rank definitions, refer to **Table 7.5**. For more information about the species, see **Table 7.8.**				
Source: NJDEP ONLM, February 2004				

F. Invasive Exotic Species

Exotic species (also called alien or introduced species) are a threat to natural areas. Exotic species are those that have been introduced by people to an area 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); thus, they are not part of the original natural community.

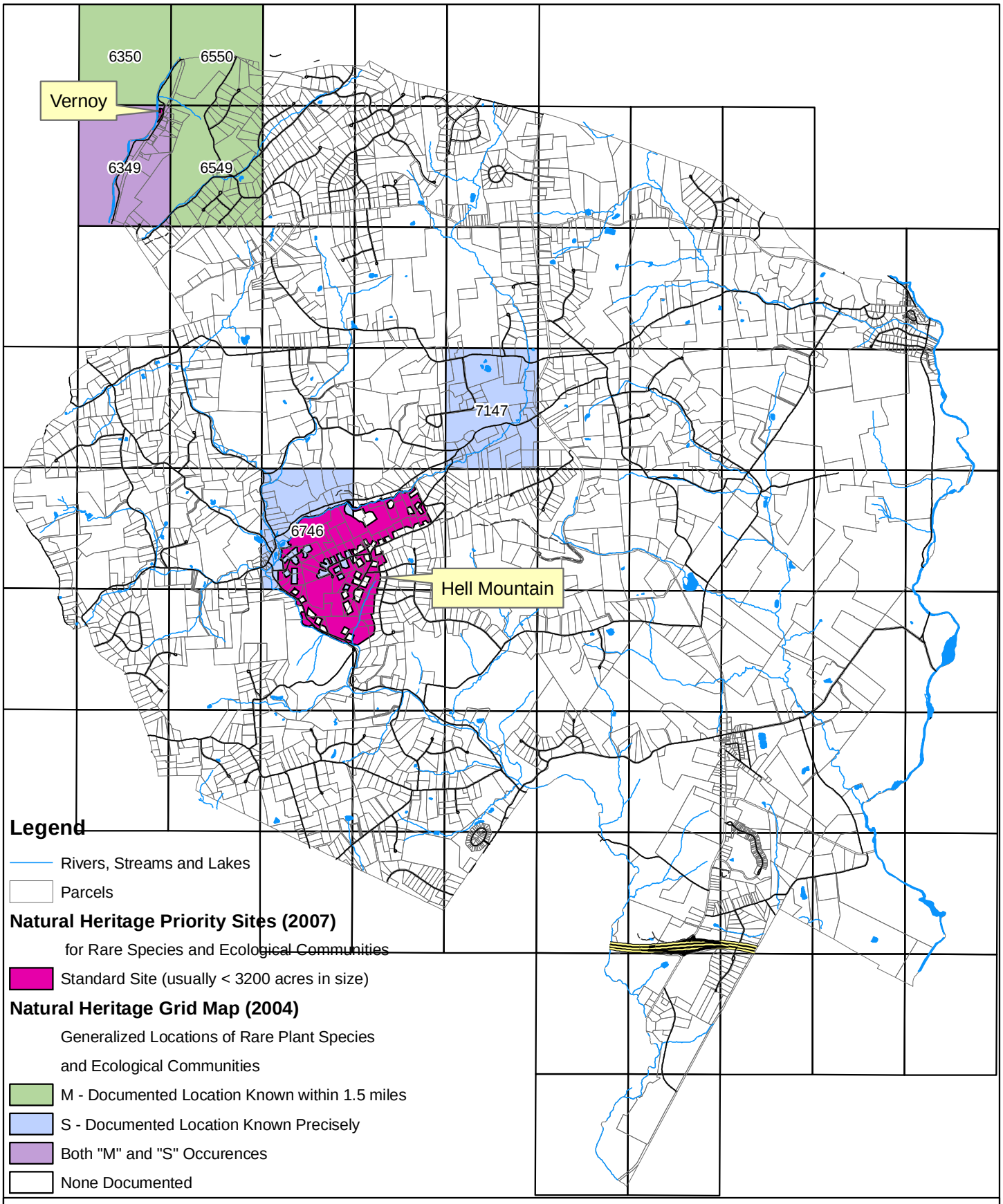
Some exotic species cannot compete against native species and never cause problems. However, some species adapt well to their new environment and proliferate. They compete with native species for space, nutrients and light, and can result in the local elimination of native species. The new environment may harbor no natural population controls, such as insects to eat the invading plant and thereby control its population. Some of the most problematic invasive exotic species in Tewksbury Township include barberry, stiltgrass, autumn olive and multifora rose (see **Table 7.11**). According to Robichaud and Anderson, "…as many as 25 percent of the plant species now present in New Jersey are exotic plants."

Native plants can be susceptible to exotic diseases, which they have not evolved resistance to. The chestnut blight fungus was an accidental introduction that destroyed all mature chestnut trees, once one of the dominant trees in the New Jersey landscape. Another introduced fungus, Dutch elm disease, destroyed the American elm.

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. Several introduced insects, which are impacting the woodlands of Tewksbury Township, include the hemlock wooly adelgid, gypsy moth, and pine looper (NJ Forest Service, 2007). They weaken their host trees to diseases carried by the insect pests, or other environmental stresses, which increase mortality after successive years of infestation.

A Tewksbury forest with a dense understory of the invasive exotic plant, Japanese barberry.

The Tewksbury Community Forestry Management Plan (2003) noted that invasive non-native plants such as multiflora rose, autumn olive and barberry are most evident



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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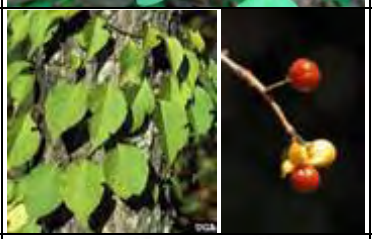
Figure 7f: Natural Heritage Priority Sites & Grid Map

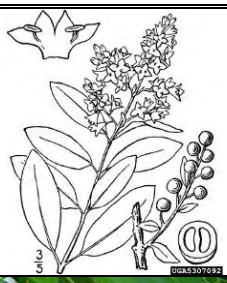
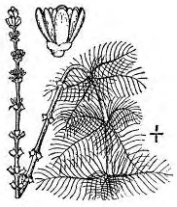
Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

near roadsides or recently disturbed sites. Abandoned fields are quickly colonized by dense stands of mutilfora rose and autumn olive. These areas are slow to become reforested. In contrast, interior forests, as little as 50' from the road edge, contain few invasive non-native species (ForesTree Consultants, 2003).

Table 7.11: Invasive Exotic Plants

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 Administration, Bugwood.org
Ailanthus altissima	tree of heaven	Aggressive in disturbed areas, crowding out native plants.		Britton and Brown, 1913, Vol. 2: 446.
Alliaria petiolata	garlic mustard	Aggressive in shady habitats, crowding out native plants.		Deborah J. Kratzer
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
Celastrus orbiculatus	Oriental bittersweet	The vine twines around surrounding plants, impeding sap flow. Also makes host plants too heavy, increasing wind, snow & ice damage.		James H. Miller, USDA Forest Service, Bugwood.org
Centaurea biebersteinii	spotted knapweed	Outcompetes & replaces native plants. Resistant to herbivores. Can increase erosion by displacing native root systems with its taproot.		Britton and Brown, 1913. Vol. 3: 558.

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Cirsium arvense	Canada thistle	Competes with crops and degrades pastures (inedible to livestock).		Deborah J. Kratzer
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
Elaeagnus umbellate	autumn olive	Sprouts vigorously in disturbed areas, produces shade, preventing sprouting of native trees.		Deborah J. Kratzer
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	Chinese bush-clover	Can form dense stands in meadows, open woodlands, and wetland borders that crowd out native species and disrupt succession. Unpalatable to native wildlife.		James H. Miller, USDA Forest Service, Bugwood.org

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Ligustrum vulgare	common privet	Crowds out more desirable native plants.		USDA PLANTS Database, Bugwood.org
Lonicera japonica Thunberg	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.		Chuck Bargeron, University of Georgia, 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.

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Miscanthus sinensis	Chinese silver grass	Escapes from ornamental plantings and can form large clumps along disturbed areas, crowding out native vegetation. It is also extremely flammable and increases fire risks where it grows.		James H. Miller, USDA Forest Service, Bugwood.org
Polygonum cuspidatum	Japanese knotweed	Spreads aggressively in disturbed, sunny areas, especially river banks and wetlands, crowding out native plants.		Tom Heutte, USDA Forest Service, Bugwood.org
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
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
Vinca minor	periwinkle	Spreads in shady forests, crowding out native plants.		Jil M. Swearingen, USDI National Park Service, Bugwood.org

Sources: Snyder & Sylan, 2004; Swearagain et al., 2002; Courtney, 1997; Center for Invasive Species and Ecosystem Health, 2009; Britton and Brown, 1913; Mohlenbrock , 1995

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Flora of North America (search As: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=200004154

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http://www.state.nj.us/dep/parksandforests/forest/njfs_forest_health.html

Native Plants: Bowman's Hill Wildflower Preserve: http://www.bhwp.org

Natural Heritage Program (NJDEP Division of Parks and Forestry):
http://www.state.nj.us/dep/parksandforests/natural/heritage/index.html

Wildlife
Bear Information (NJDEP F&W): http://www.njfishandwildlife.com/bearinfo.htm

Checklists for birds, mammals, reptiles and amphibians of New Jersey, with status (e.g. common or rare) (NJDEP):
http://www.state.nj.us/dep/fgw/chklists.htm

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Vernal Pools (NJDEP): http://www.njfishandwildlife.com/ensp/vernalpool.htm

Fish Index of Biotic Integrity (Bureau of Freshwater Fisheries):
http://www.state.nj.us/dep/wms/bfbm/downloads.html#fish

Fish Fact Sheets: http://www.state.nj.us/dep/fgw/fishfact.htm

Integrated Biological Aquatics Assessment http://www.state.nj.us/dep/fgw/ensp/ibaa03.htm

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Cornel Lab of Ornithology, All About Birds: http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/

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NJDEP Endangered and Nongame Species Program Home Page: http://www.state.nj.us/dep/fgw/ensphome.htm

NJDEP Landscape Project Home Page (wildlife habitat): http://www.njfishandwildlife.com/ensp/landscape/

Species Reporting Form: http://www.njfishandwildlife.com/ensp/rprtform.htm

Protecting Habitats
Landscape Project (NJDEP, Division of Fish Wildlife): http://www.njfishandwildlife.com/ensp/landscape/

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- Wildlife Habitat Incentive Program (WHIP): http://www.njfishandwildlife.com/artwhip06.htm
- Landowner Incentive Program (LIP) Grants: http://www.njfishandwildlife.com/ensp/lip_prog.htm

Backyard Habitats & Conservation
- National Audubon Society: http://www.audubon.org/bird/at_home/
- New Jersey Audubon Society: http://www.njaudubon.org/Education/BackyardHabitat/
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Home Page: http://www.state.nj.us/dep/parksandforests/natural/heritage/index.html

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Plants Database (NRCS): http://plants.usda.gov

8: OPEN SPACE AND FARMLAND

A. Funding Sources & Tools

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.

In 1997, Tewksbury Township residents approved the establishment of a 3 cent tax for every $100 assessed value, and in 1999, residents approved an increase to 5 cents to provide a stable source of funding for open space and farmland preservation (Hintz, 2003).

Farmland in Tewksbury

In 1999, Hunterdon County residents approved a five-year tax to fund an Open Space, Recreation, Farmland and Historic Preservation Trust Fund, which was renewed in 2004 for another 5 years. In 2008, residents approved a tax without a sunset clause, and expanded the purposes to include protecting drinking water sources and water quality, preserving open space, natural areas, farmland and historic sites, to acquire, develop, improve and maintain county and municipal lands for recreation and conservation purposes, and to preserve historic structures, facilities, sites, areas, or objects, or for the payment of debt service or indebtedness issued or incurred by the County for any of these purposes. The Board of Chosen Freeholders is authorized to determine the annual tax levy, which has been a 3 cent tax per $100 valuation since its inception (Hunterdon County, 2009).

The Garden State Preservation Trust Act provides state funds for land acquisition and park development through the Green Acres program and funding for farmland preservation through the State Agriculture Development Committee (SADC). Various programs under the SADC include Purchase of Development Rights, Fee Simple (outright purchase), the Eight Year Program, and the Planning Incentive Grant (PIG). To participate in the Eight Year Program, landowners agree to deed-restrict their farms solely to agricultural use for a period of eight years. In return, they receive certain benefits and increase their score when applying to other programs. The PIG program seeks to preserve reasonably contiguous farms. In order to participate, a township must 1) identify a reasonably contiguous project area; 2) demonstrate a commitment to funding; 3) have an Agricultural Advisory Committee appointed by the mayor; and 4) adopt a Farmland Preservation Element of the municipal master plan.

Farmland owners may wish to pursue various programs through the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), which either rents or buys easements or cost-shares habitat restoration and conservation measures.

These include the Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentives Program (WHIP) (see **Internet Resources**).

Private land trusts working to preserve land in Tewksbury Township include the Tewksbury Land Trust, Upper Raritan Watershed Association, New Jersey Conservation Foundation, Hunterdon Land Trust Alliance and the New Jersey Natural Lands Trust. These organizations 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**).

B. 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 biking/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 it 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, 2005).

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 farmland preservation, private land trusts, and conservation easements to meet the Township's open space, farmland and recreation goals (Howe, 1989).

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).

Columbia Trail is a greenway created from a former rail line. Approximately 1¼ miles of Columbia Trail (which is considered part of Hunterdon County's South Branch Reservation park) traverses the northwest corner of Tewksbury Township. The trail is available for hiking, biking and cross-country skiing, extending from its start in High Bridge, through Tewksbury, and continuing northeast into Morris County, where it will connect with the Highlands Trail (Cooper, 2009). The trail traverses both deciduous and coniferous forests, and parallels the South Branch Raritan River. These habitats provide a corridor for the movement and observation of wildlife, and breeding habitat for herptiles (Hunterdon County website, 2008).

C. Open Space

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;
- maintain water quality and groundwater recharge areas;
- protect sensitive environmental features;
- protect historic areas;
- maintain biodiversity;
- minimize erosion or damage from flooding;
- maintain rural character (ANJEC, no date).

An updated inventory of the preserved open space properties is presented in **Table 8.1** and **Figure 8a**. Using the acreage figures in the GIS data files[22], a total of 2,255 acres have been preserved as open space in Tewksbury Township, which is approximately 11% of the township. The following paragraphs describe some of these preserved properties.

Cold Brook Preserve on Route 517 is a 287-acre Hunterdon County Park, consisting of rolling fields and old pastures. The historical use of the property for farming is maintained by leasing the farm fields to a local farmer, in keeping with a management plan. Trails are available for hiking, horseback riding and mountain biking. Varied habitats, which include old fence rows, meadows, wooded areas, and the edge habitat between them, provide opportunities for wildlife watching (Hunterdon County website, 2008).


Whittemore Wildlife Sanctuary

The Whittemore Wildlife Sanctuary is a 180-acre property located on Rockaway Road owned by the township. The park is dedicated to environmental education. The park's trails are available for hiking, dog walking and horseback riding. These trails traverse mainly wooded areas with wetlands, ravines and hilly terrain. The Rockaway River flows along the southern border of the property (Tewksbury Township website, 2008).

A 10-acre property on Palatine Road, known as the Whitman property was preserved by a partnership of the New Jersey Conservation Foundation (NJCF), Tewksbury Land Trust and Green Acres. It includes a section of the Cold Brook Stream, open space and woodlands with trees that are over 200 years old (NJCF Annual Report, 2005). A 40 acre tract on Fox Hill Road, known as the Lance Preserve, was another property preserved by a coalition including the Tewksbury Land Trust, NJCF, Lamington Conservancy, Hunterdon County and Tewksbury Township (Teasdale, 2009).

A number of properties preserved by the Upper Raritan Watershed Association (URWA) include Hollow Brook Preserve, a 21-acre property that consists of forested wetlands, with many springs and the headwaters of the Hollow Brook flowing through it; Fox Hill Preserve, 50 acres of fields and woodlands with a broad valley view of farm lands and forest, which is traversed by a trail; and the Dinner Pot Natural Area, a 12-acre property that consists of steep slopes, wet springs and seeps, and an unnamed tributary to trout-production waters. Due to the extreme

[22] "Acres" is usually from the GIS data, and may not reflect actual acreage. In some cases, only a portion of the acreage of a property is preserved, but the full acreage is listed.

environmental constraints of the site, there are no maintained trails on this site, but it provides a scenic view from Route 517 (Upper Raritan Watershed Association website, 2008).

Properties with conservation easements are shown on **Figure 8b**. These properties, or portions of them, are restricted in some way, but are not open to the public. Boundaries of the actual easement are not shown on the map.

Table 8.1: Preserved Open Space[23]

BLOCK	LOT	FACILITY	USE	OWNERSHIP	ACRES
County Parkland (279.51 acres)					
2	2	South Branch River Reservation	Recreation/Conservation	Fee Simple	2.58
2	4	South Branch River Reservation	Recreation/Conservation	Fee Simple	0.50
2	5	South Branch River Reservation	Recreation/Conservation	Fee Simple	2.77
2	100	Columbia Trail	Recreation/Conservation	Fee Simple	2.51
3	100	Columbia Trail	Recreation/Conservation	Fee Simple	5.01
3	101	Columbia Trail	Recreation/Conservation	Fee Simple	6.96
16.03	1	Columbia Trail	Recreation/Conservation	Fee Simple	4.80
21	3	South Branch River Reservation	Recreation/Conservation	Fee Simple	9.61
23	26	Adjacent to Cold Brook Preserve	Recreation/Conservation	Partial Easement	30.80
23	28	Adjacent to Cold Brook Preserve	Recreation/Conservation	Partial Easement	21.70
38	7	Cold Brook Preserve	Recreation/Conservation	Partial Easement	1.60
38	8	Cold Brook Preserve	Recreation/Conservation	Partial Easement	178.98
38	8.3	Cold Brook Preserve	Recreation/Conservation	Partial Easement	11.70
Municipal Parks and Open Space (1038.33 acres)					
6.04	1.01	Property on Dege Farm Road	open space for cluster	Fee Simple	33.83
6.04	1.24	Property on Coddington Lane	open space for cluster	Fee Simple	37.95
6.04	23.2	Property on Pace Farm Road	Recreation/Conservation	Fee Simple	21.21
7	2	Pottersville Reservoir Park	Recreation/Conservation	Fee Simple	6.60
7	4.01	Fairmount North	Recreation/Conservation	Fee Simple	15.12
7	13	Pottersville Reservoir Park	Recreation/Conservation	Fee Simple	82.02
7	13.03	Pottersville Reservoir Park	Recreation/Conservation	Fee Simple	37.65
7	23	Fairmount North	Recreation/Conservation	Fee Simple	56.99
14	21	Christie Hoffman Park	Recreation/Conservation	Fee Simple	162.15
14	21.01	Christie Hoffman Park	Recreation/Conservation	Fee Simple	4.93
14	21.02	Christie Hoffman Park	Recreation/Conservation	Fee Simple	19.44
15	9.05	Property on Tiger Dr (narrow strip on east side adjacent to road)		Fee Simple	0.30
15	18.01	Property on Farmersville Road (near Sawmill School)	Recreation/Conservation	Fee Simple	15.80
16	6	Pascal Farm Park	Passive Rec/Conservation	Fee Simple	136.64
16	6.01	Pascal Farm Park	Passive Rec/Conservation	Fee Simple	7.26
16	27	Pascal Farm Park	Passive Rec/Conservation	Fee Simple	1.11
23	8.41	Property on Homestead Road	Recreation/Conservation		13.29
23	26.02	Property on Vliettown Road	sewage disposal		14.29
27	104	Hell Mountain Preserve	Recreation/Conservation		10.41
27	108	Hell Mountain Preserve	Recreation/Conservation		2.21
27	115	Hell Mountain Preserve	Recreation/Conservation		94.26
29	18	Cold Brook, Property on Cold Spring Rd			1.10
34	8	Rockaway Creek, on Rockaway Road	Recreation/Conservation	Fee Simple	4.93
42	2	Property on Vliettown Road	sewage disposal		23.37

[23] Some properties or portions of properties are not open to the public.

BLOCK	LOT	FACILITY	USE	OWNERSHIP	ACRES
44	12	Oldwick Fields	Recreation/Conservation	Fee Simple	11.77
44	23	Whittemore Wildlife Sanctuary	Recreation/Conservation	Fee Simple	73.93
45.01	1	Crossroads Open Space	Recreation/Conservation	Fee Simple	31.35
45.02	49	Crossroads Open Space	Recreation/Conservation	Fee Simple	7.44
46	20	Whittemore Wildlife Sanctuary	Recreation/Conservation		89.28
46	20.01	Whittemore Wildlife Sanctuary	Recreation/Conservation		15.31
49	5.02	Rockaway Creek, Property on Oldwick Rd			3.55
51	11	Rockaway Creek Access, Sawmill Rd			0.30
51	19	Rockaway Creek Access, Sawmill Rd			2.56
Non-profit and Private Conservation Lands (312.83 acres)					
6.04	4.01	Fairmount Church	Non-profit/private		0.85
6.04	5.01	Fairmount Church	Non-profit/private		1.42
6.04	6	Fairmount Church	Non-profit/private		2.22
6.04	6.01	Fairmount Church	Non-profit/private		3.02
6.04	41.03	Fox Fell Homeowners Association	Non-profit/private	Homeowners Association	15.53
15	9.15	Open Space lot for Highland Farms	Non-profit/private	Homeowners Association	7.02
15	13	Tewksbury Land Trust, Sawmill Rd (Sawmill School)			48.54
15	21.02	Open Space lot for Highland Farms	Non-profit/private	Homeowners Association	11.79
16	1	Fairmount Church	Non-profit/private		1.31
16	2.02	Fairmount Church	Non-profit/private		2.95
16	14	Hollow Brook Preserve			27.60
16	26	Hollow Brook Preserve	Recreation/Conservation	Fee Simple	21.24
27	71		Non-profit/private		52.48
28	13.01	Property on Old Turnpike Rd (Rt 517)	Recreation/Conservation	Fee Simple	11.78
28	27	Property on Fox Hill Road	Non-profit/private	Tewksbury Land Trust	35.33
29	10.04	Black River Greenway, Palatine Rd	Non-profit	Fee Simple	10.97
30	3	Cold Brook Natural Area (property on Palatine Rd)	Non-profit	Fee Simple	44.42
30	5	Cold Brook Natural Area (property on Fox Hill Rd)	Non-profit	Fee Simple	14.36
Conservation Easements (624.47 acres)					
6.04	7.2		Non-profit/private	Easement	26.83
14	14	Property on Farmersville Rd	Recreation/Conservation	Partial Easement	6.70
14	14.01	Property on Farmersville Rd	Recreation/Conservation	Partial Easement	3.20
14	15	Tewksbury Land Trust, Farmersville Rd	Farm Conservation Area	Easement	77.96
14	22	Property on Farmersville Rd	Agriculture	Easement	6.38
15	3	Open Space lot for Fern Valley	Non-profit	Easement	8.31
15	20	Property on Farmersville Rd	Agriculture	Easement	27.64
23	26		Non-profit	Easement	48.21
23	28		Non-profit	Easement	32.45
28	14	Property on Old Turnpike Rd (Rt 517)-URWA	Recreation/Conservation	Partial Easement	42.19
32	22.01				72.98
37	5.15	Bissell Run Homeowners			3.29

BLOCK	LOT	FACILITY	USE	OWNERSHIP	ACRES
		Association			
37.03	5.08	Bissell Run Homeowners Association			9.27
37.03	5.24				1.86
38	8.03		Non-profit	Easement	11.74
38	11		Non-profit	Easement	23.18
38	16.14		Non-profit	Easement	53.72
45.01	35			Easement	1.13
45.02	50	Private easement (front of lot)		Easement	3.67
46	17.01	easement-Readington Twp.		Easement	3.13
48	4	Property on Felmley Rd & Rt 523	Non-profit	Easement	159.79
48	4.01	Property on Felmley Rd & Rt 523	Recreation/Conservation	Easement	0.85
				Total (excluding farmland):	**2,255.15**

Notes:

Area is usually from the GIS data, and may not reflect tax map acreage.
There are no state or federally owned open space properties within Tewksbury.
Acreage usually reflects area of entire parcel: conservation easement may apply to only a portion of this area in many cases.
See **Table 8.2** for preserved farmland.

Sources: Hunterdon County GIS data; NJDEP Green Acres website; and Highlands Water Protection and Planning Council, January 2008; Tewksbury Land Use Office.

D. Farmland

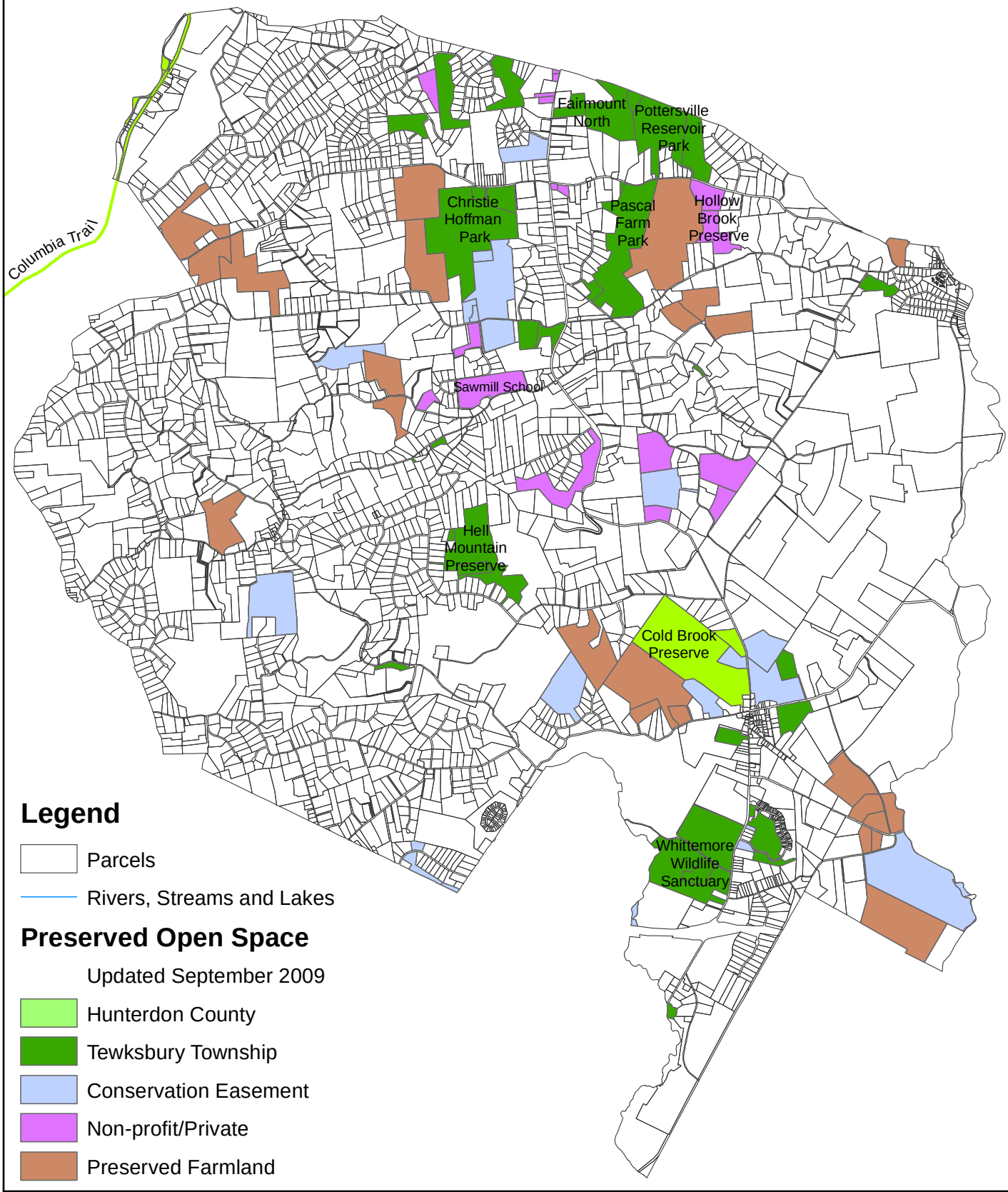
Preservation of farmland is recognized as a priority at the national, state, county and local levels. Through various public forums and opinion surveys, Hunterdon County residents have clearly stated their desire to preserve the County's rural character (Hunterdon County website, 2005). In Tewksbury, "The principal pursuit of the Township is and always has been agriculture" (Hintz, 2003).

Agriculture is an important sector of the economy, while offering a quality of life and rural atmosphere that most residents value. Farms require less governmental services than residential development, thereby stabilizing property taxes. Agriculture also maintains clean air by generating little traffic, provides fresh local produce, and offers attractive vistas. Farmland, which typically has minimal impervious surfaces, provides ground water recharge areas. Preservation of farmland allows agriculture to exist as a viable and beneficial industry now and into the future. Efforts to preserve farmland are important because the land that is best for development is typically prime farmland. Once developed, farmland is lost and is a non-renewable resource (Hunterdon County Website, 2005).


Farmland in Tewksbury

The goal of the township's Farmland Preservation Plan Element (FPPE), which is part of the 2003 Tewksbury Master Plan, is to

> "Preserve farmland and encourage its continued use recognizing it as an important component of the economy of the township, county and the state, and that agricultural lands are an irreplaceable natural resource and a key element of Tewksbury's rural character (Hintz, 2003)."



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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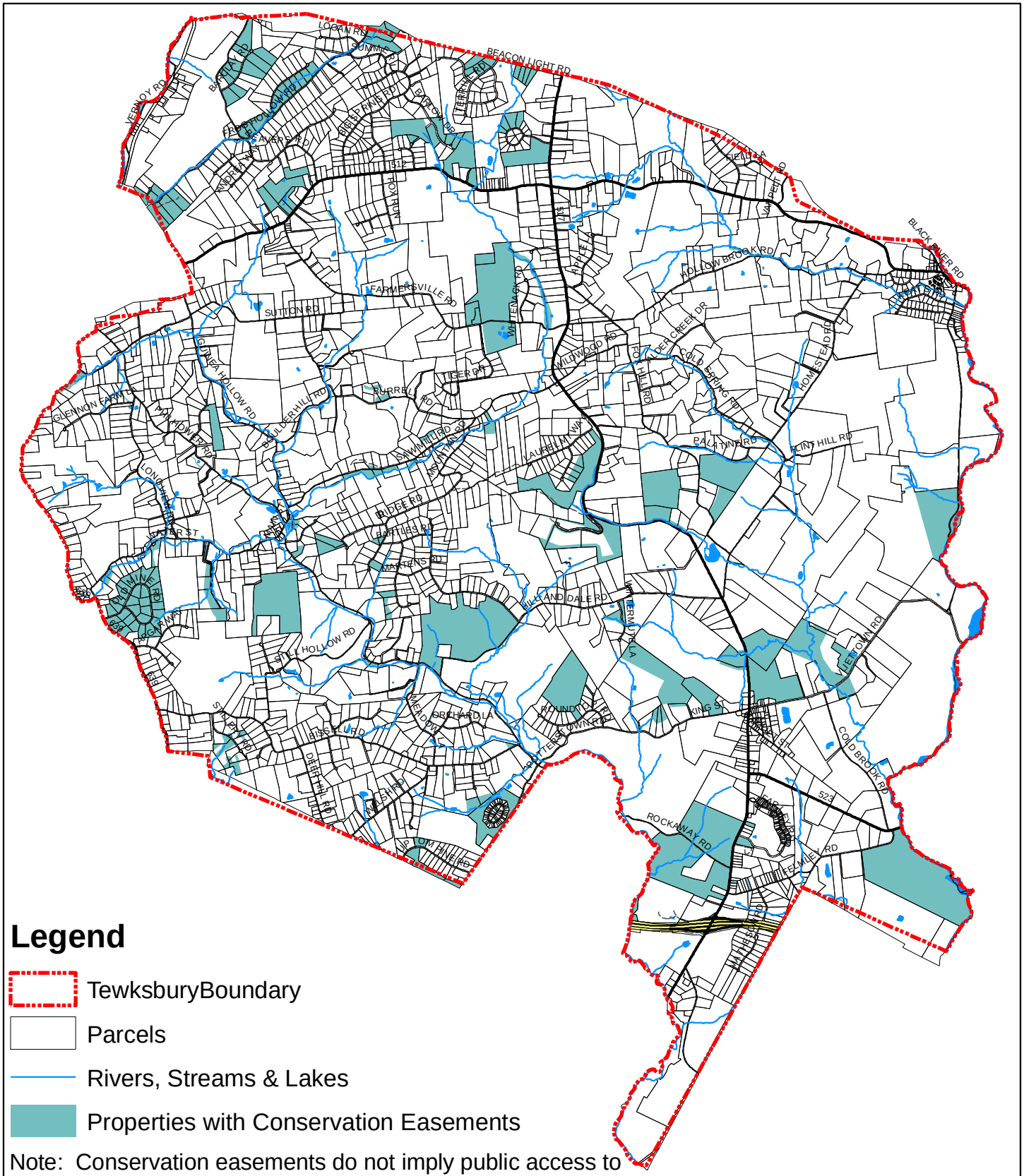
0 0.25 0.5 1 1.5 Miles

Figure 8a: Preserved Open Space

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services



Legend

- TewksburyBoundary
- Parcels
- Rivers, Streams & Lakes
- Properties with Conservation Easements

Note: Conservation easements do not imply public access to these properties. In addition, the easement may not apply to an entire parcel. The boundaries of actual easements are not shown.

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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Figure 8b: Properties with Easements

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

As required by the Municipal Land Use Law and in order to apply for the Planning Incentive Grant (PIG), the FPPE includes an inventory of farm properties (Hintz, 20003, p.79), details of municipal support for agriculture, and a plan for preserving farmland (Hintz, 2003, pp.181-209). The FPPE also discusses the history of agriculture in Tewksbury Township, importance of farmland preservation, agricultural preservation goals and policies, prior farmland preservation efforts in the township and presents information on the types and classes of agricultural soils in the township.

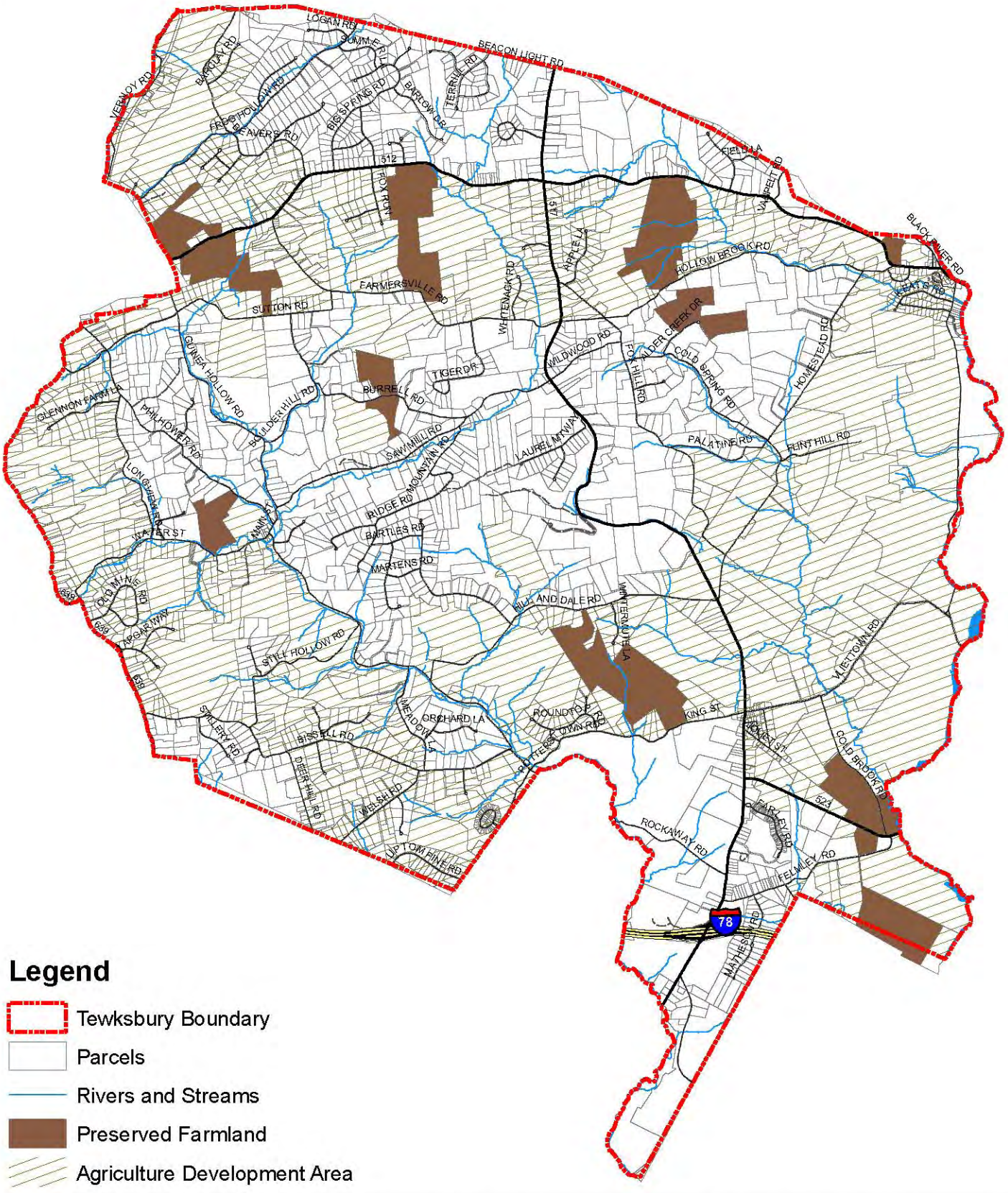
Agricultural Development Areas (ADAs) in Tewksbury Township are shown on **Figure 8b**. ADAs are areas where agricultural operations currently exist and are likely to continue, based on the presence of existing farms and productive agricultural soils (farmland soils are shown in **Figure 4h**). The ADAs were delineated by Hunterdon County and approved by the State. The SADC and the County Agricultural Development Board (CADB) will only fund the preservation of farmland parcels that lie within an ADA.

Preserved farms in Tewksbury are shown in **Figure 8b. Table 8.2** lists these preserved farms, a total of 1,063.78 acres (approximately 5% of the township), which have been preserved pursuant to the SADC.

Table 8.2: Preserved Farmland

BLOCK	LOT	FACILITY	OWNERSHIP	YEAR	ACRES
5	12	Young	SADC	1998	60.18
10	1.01	Wade	SADC		37.41
10	5.02	Wade	SADC		66.19
14	9.01	Smith	Tewksbury Land Trust Easement		71.62
14	23.02	Schenker	SADC	2008	72.77
15	7	Vernon/Callanan	SADC		37.97
16	11	Storms	SADC	1998	157.90
19	11.05	Simpson	SADC		28.35
19	11.06	Simpson	SADC		25.96
19	11.07	Simpson	SADC		19.16
20	2	Lauber	SADC		13.35
26	10	Vernon/Callanan	SADC		19.48
31	12.01	Emmet	SADC		50.00
38	3	Turnquist	SADC	1998	66.02
38	14	Walls/Hitchcock	SADC	1998	106.48
38	14.02	Walls/Hitchcock	SADC		9.35
38	14.03	Walls/Hitchcock	SADC	2003	12.09
42	6	Chandor	SADC	1996	46.17
42	6.01	Emmet	SADC		18.46
42	6.02	Emmet	SADC		11.38
43	3.01	Emmet	SADC		17.17
45	6.02	Emmet	SADC		5.67
45	6.03	Emmet	SADC		8.82
48	5	Emmet (Additional 22 acres in Readington)	SADC	2007	101.83
				Total Farmland Acres Preserved	**1063.78**

Sources: Hunterdon County Agriculture Development Board, 2005; Hunterdon County GIS data and NJDEP GIS data; Tewksbury Township Land Use Office; Highlands Water Protection and Planning Council, January 2008.



Legend

- Tewksbury Boundary
- Parcels
- Rivers and Streams
- Preserved Farmland
- Agriculture Development Area

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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0 0.25 0.5 1 1.5 Miles

Figure 8c: Preserved Farmland & Ag. Development Area

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

References: Open Space & Farmland

Association of New Jersey Environmental Commissions. December 2001. A Handbook for Public Financing of Open Space in New Jersey.

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Hunterdon County, Information Technology, Division of Geographic Information Systems. 2005. Open Space within Hunterdon County, New Jersey. http://gis.co.hunterdon.nj.us/

Hunterdon County
- Agriculture Development Board, 2005: http://www.co.hunterdon.nj.us/cadb.htm
- Columbia Trail: http://www.co.hunterdon.nj.us/depts/parks/guides/ColumbiaTrail.htm
- Cold Brook Preserve: http://www.co.hunterdon.nj.us/depts/parks/guides/ColdBrook.htm
- Open Space Trust Fund Program http://www.co.hunterdon.nj.us/openspac.htm
- Preserved Farms (October 2007): http://www.co.hunterdon.nj.us/cadb/farms.htm
- Why preserve farmland? (October 2005): http://www.co.hunterdon.nj.us/cadb/preserve.htm

McKenzie, Elizabeth C. "Farmland Preservation Plan Element" in Master Plan for Holland Township, Hunterdon County, New Jersey. Adopted 5/14/2001. 20 pages + appendix.

National Park Service. 1995. Economic Impacts of Protecting Rivers, Trails, and Greenway Corridors: A Resource Book. Fourth Edition. 154 pages. http://www.nps.gov/pwro/rtca/econ_all.pdf

Natural Resources Conservation Service (NRCS) Conservation Programs. http://www.nrcs.usda.gov/Programs/index_alph.html

NJ Conservation Foundation
- Garden State Greenways. http://www.gardenstategreenways.org
- 2005 Annual Report. http://njconservation.org/documents/NJCF2005AnnualReport.pdf

NJDEP Green Acres Program: http://www.nj.gov/dep/greenacres/

Tewksbury Township Land Use Office, Shana Goodchild. 2009. Personal Communication.

Tewksbury Township website. 2008. http://www.tewksburytwp.net.

Upper Raritan Watershed Association (URWA). 2008. http://www.urwa.org/land/tewksbury.html

Internet Resources: Open Space & Farmland

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

Hunterdon County Agriculture Development Board: http://www.co.hunterdon.nj.us/cadb.htm
- Mailing Address: Hunterdon Co. Ag. Development Board, PO Box 2900, Flemington, NJ 08822-2900
- Phone: 908.788.1490

Hunterdon County Open Space, Farmland and Historic Preservation Trust Fund:
http://www.co.hunterdon.nj.us/openspac.htm

Hunterdon Land Trust Alliance: http://www.hlta.org

Natural Resources Conservation Service (NRCS) Conservation Programs.
http://www.nrcs.usda.gov/Programs/index_alph.html

NJ Conservation Foundation: http://www.njconservation.org/

NJ Natural Lands Trust: http://www.state.nj.us/dep/parksandforests/natural/trust.html

NJDEP Division of Fish and Wildlife (grants and assistance with wildlife habitat):
http://www.njfishandwildlife.com/artwhip06.htm

NJDEP Division of Fish and Wildlife Landowner Incentive Program (LIP) Grants:
http://www.njfishandwildlife.com/ensp/lip_prog.htm

Rutgers New Jersey Agricultural Experiment Station (NJAES) – Agriculture Publications Online – useful information & links for farmers, gardeners, & consumers: http://njaes.rutgers.edu/ag/

Tewksbury Land Trust: Phone 908-879-4400 Address: PO Box 490 Oldwick, NJ 08858

9: HISTORIC RESOURCES

A. The History of Tewksbury Township

Humans arrived in New Jersey at least 9,000 - 10,000 years ago (Ashley, 2004). In nearby Kingwood Township, an archeological study found more than 3,000 Native American artifacts from the Paleo-Indian Period, many dating back to 841 BC or earlier, including ceramics, stone tools and food remains (Burrow et al, 1999 in Frenchtowner.com, 2006).

At the time the first Europeans arrived in the area, there may have been as few as 2,000 or as many as 12,000 humans living in what is now New Jersey (compared to 5,541 now living in Tewksbury Township and 8.7 million in New Jersey, according to the 2000 Census). These Indians belonged to the Lenape tribe.

Artifacts can be found scattered throughout the area, a result of the Indians' nomadic lifestyle, with traces of the Indians more frequently found in the valleys and along streams and rivers. The vicinity of Oldwick was probably a favored location, because a concentration of 59 sites was found in the area in a study of Indian habitations in Warren and Hunterdon Counties. Three of these sites were workshops, as indicated by the number of stone chips covering the ground, while the others were ordinary camps. Argillite implements predominate, while flint and jasper implements were also found. Many smaller sites were found scattered throughout the township (Schrabisch, 1917).

As the Indians became less nomadic, they cleared the forests for village sites and agriculture, and cut wood for fuel, shelters, canoes, tools and other implements. It was also common practice to deliberately set fires for the purpose of driving game and thinning and opening up forests.

The earliest non-Indian settlers came to Hunterdon County around 1700 from the Netherlands, Germany, Scotland, England and Ireland. These settlers acquired most of the land from the Native Americans, who relocated to other areas. The Early Agrarian Period is characterized by the clearing of woodlands for agriculture. A variety of crops and vegetables were grown, and sawmills and gristmills were built along streams (McCall, 2005).

Although the Indians had affected the landscape of New Jersey, according to Robichaud and Anderson (1994) it was the European settlers and their descendents who truly disturbed the vegetation. "By the time New Jersey became a state in 1778, no extensive areas of land well suited to farming remained wooded in the central part of the state" (Robichaud and Anderson, 1994). The remaining forests were frequently and repeatedly cut for cordwood.

The villages and small towns that flourished in the 18th and 19th centuries have changed little, including Oldwick,

Mountainville and Pottersville. Many of the older farmsteads still exist. Tewksbury became a township in 1755, separated from Lebanon Township.

The Late Agrarian and Industrial Period began in the late 1800's. Railroad lines allowed farmers to transport products throughout the East. Industry in Tewksbury Township included graphite and iron (magnetite) mining (see Section 3b), but the deposits were not extensive, and apparently none were very profitable (Bayley, 1910 and Volkert, 2002). The human population of New Jersey continued to grow, but the introduction of coal in 1850 began to allow the woodlands to recover to some extent. For example, Hunterdon County was only 14% forested in 1899, but had increased to 36% forest cover in 1987 (Robichaud and Anderson, 1994). According to the NJDEP land use data, Tewksbury is now nearly 50% forested (see Section 7a).

In the Modern Period, agriculture still dominated the local economy for the first half of the 20th century, but then waned, due to competition from large-scale farms in other states and the value of land for other uses (McCall, 2005).

Despite the burgeoning human population of New Jersey, the fact that most of the population is concentrated in urban areas has allowed some areas to remain rural or natural. Tewksbury Township is one of these areas. However, recently there has been a shift of population from urban and developed areas to rural areas, extending the suburbs and eliminating farms, forests and wetlands along the way.

Table 9.1: Criteria for Evaluation for Inclusion in the National Register of Historic Places

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. That are associated with events that have made a significant contribution to the broad patterns of our history; or

B. That are associated with the lives of persons significant in our past; or

C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That have yielded or may be likely to yield, information important in prehistory or history.

Note: Properties are usually at least 50 years old to be considered eligible.

Source: National Register of Historic Places Home Page: http://www.nationalregisterofhistoricplaces.com

B. Historic Preservation

A *Historic site* means any real property, man-made structure, natural object or configuration or any portion or group of the foregoing of historical, archaeological, cultural, scenic or architectural significance. A *Historic District* is one or more historic sites and intervening or surrounding property significantly affecting or affected by the quality and character of the historic site or sites (MLUL, 2002).

Historic preservation is the planned effort to help protect structures, objects and properties of historic importance. In 1966, the National Historic Preservation Act created the National Register of Historic Places, which offered the protection of privately owned historic buildings and properties from federal government actions. It established criteria (see **Table 9.1**) for inclusion on the National Register and created a review process for public projects that threatened encroachment or razing of registered properties. It also enabled states to setup similar processes to protect registered properties from municipal, county and state encroachments. New Jersey created its State Register of Historic Places in 1970.

In addition, the New Jersey Municipal Land Use Law (MLUL) gives municipalities the express authority to zone for the protection of historic resources and to regulate private encroachments on designated historic properties. The MLUL outlines a specific planning process regarding the creation of local historic districts and the review of development activity within the districts (Hunterdon County, 2006).

Hunterdon County's Open Space Preservation Trust is a dedicated county tax of $.03 per $100 assessed valuation to fund open space, farmland preservation and historic preservation projects. The county's Cultural and Heritage Commission, with input from the County Planning Board and other Departments, makes recommendations for eligible projects. The County Board of Chosen Freeholders has approval authority for which projects will be funded (McCall, 2005).

Table 9.2: National Register of Historic Places in Tewksbury Township

District Name: Cokesbury Historic District	**added 1997 - Hunterdon County - #97000802**
Location: Along Cokesbury-Califon Rd., Rt. 639, Water St., and McCatharn Rd., Clinton (500 acres, 44 buildings, 3 structures, 2 objects) Historic Significance: Architecture/Engineering, Event Architectural Style: Italianate, Queen Anne, Greek Revival Area of Significance: Community Planning And Development, Architecture, Commerce, Religion Period of Significance: 1800-1924 Owner: Private Historic Function: Commerce/Trade, Domestic, Education, Industry/Processing/Extraction, Religion	
District Name: Fairmount Historic District	**added 1996 - Hunterdon County - #96001470**
Location: Roughly, NJ 517 from the Morris--Hunterdon Co. line to NJ 512 and NJ 517 from Fox Hill to Wildwood Rds., Califon (4090 acres, 72 buildings, 5 structures, 1 object) Historic Significance: Architecture/Engineering, Event Architectural Style: Queen Anne, Italianate, Greek Revival Area of Significance: Exploration/Settlement, Industry, Architecture Period of Significance: 1800-1924 Owner: Private Historic Function: Agriculture/Subsistence, Domestic, Funerary, Industry/Processing/Extraction, Religion	
District Name: Mountainville Historic District	**added 1993 - Hunterdon County - #93001360**
Location: Guinea Hollow Rd., Saw Mill Rd., Main St., Rockaway Creek Rd. and Philhower Rd., Tewksbury Township, Mountainville (1970 acres, 64 buildings, 3 structures, 2 objects) Historic Significance: Event, Architecture/Engineering Architectural Style: Queen Anne, Italianate, Greek Revival Area of Significance: Exploration/Settlement, Industry, Architecture Period of Significance: 1800-1924 Owner: Private Historic Function: Agriculture/Subsistence, Domestic, Funerary, Industry/Processing/Extraction, Religion	

District Name: Oldwick Historic District	added 1988 - Hunterdon County - #88002153
Location: Roughly along CR 517, Church, King, James, Joliet and William Sts., Oldwick (1700 acres, 127 buildings, 12 structures) Historic Significance: Event, Architecture/Engineering Architectural Style: Early Republic, Late Victorian, Mid 19th Century Revival Area of Significance: Architecture, Industry, Commerce Period of Significance: 1700-1924 Owner: Private , Local Gov't Historic Function: Commerce/Trade, Domestic, Religion	
District Name: Pottersville Village Historic District	**added 1990 - Hunterdon County - #90001475**
Location: Properties fronting on Black River, Pottersville, McCann Mill and Hacklebarney Rds. and Fairmount Rd. E and Hill St., Pottersville (850 acres, 44 buildings, 2 structures) Historic Significance: Information Potential, Event, Architecture/Engineering Architectural Style: Italianate, Queen Anne, Other Area of Significance: Architecture, Historic - Non-Aboriginal, Exploration/Settlement, Industry, Commerce Period of Significance: 1750-1924 Owner: Private , State Historic Function: Agriculture/Subsistence, Domestic, Industry/Processing/Extraction, Religion	
District Name: Taylor's Mill Historic District	**added 1992 - Hunterdon County - #92000636**
Location: Jct. of Taylor's Mill and Rockaway Rds., Readington Township, Oldwick (180 acres, 2 buildings) Historic Significance: Architecture/Engineering, Person, Event Architectural Style: Other Historic Person: Col. John Taylor Area of Significance: Architecture, Military, Exploration/Settlement, Industry Period of Significance: 1750-1949; significant year 1760 Owner: Private , Local Gov't Historic Function: Domestic, Industry/Processing/Extraction	
Source: National Register of Historic Places, 2008	

C. Historic Inventory

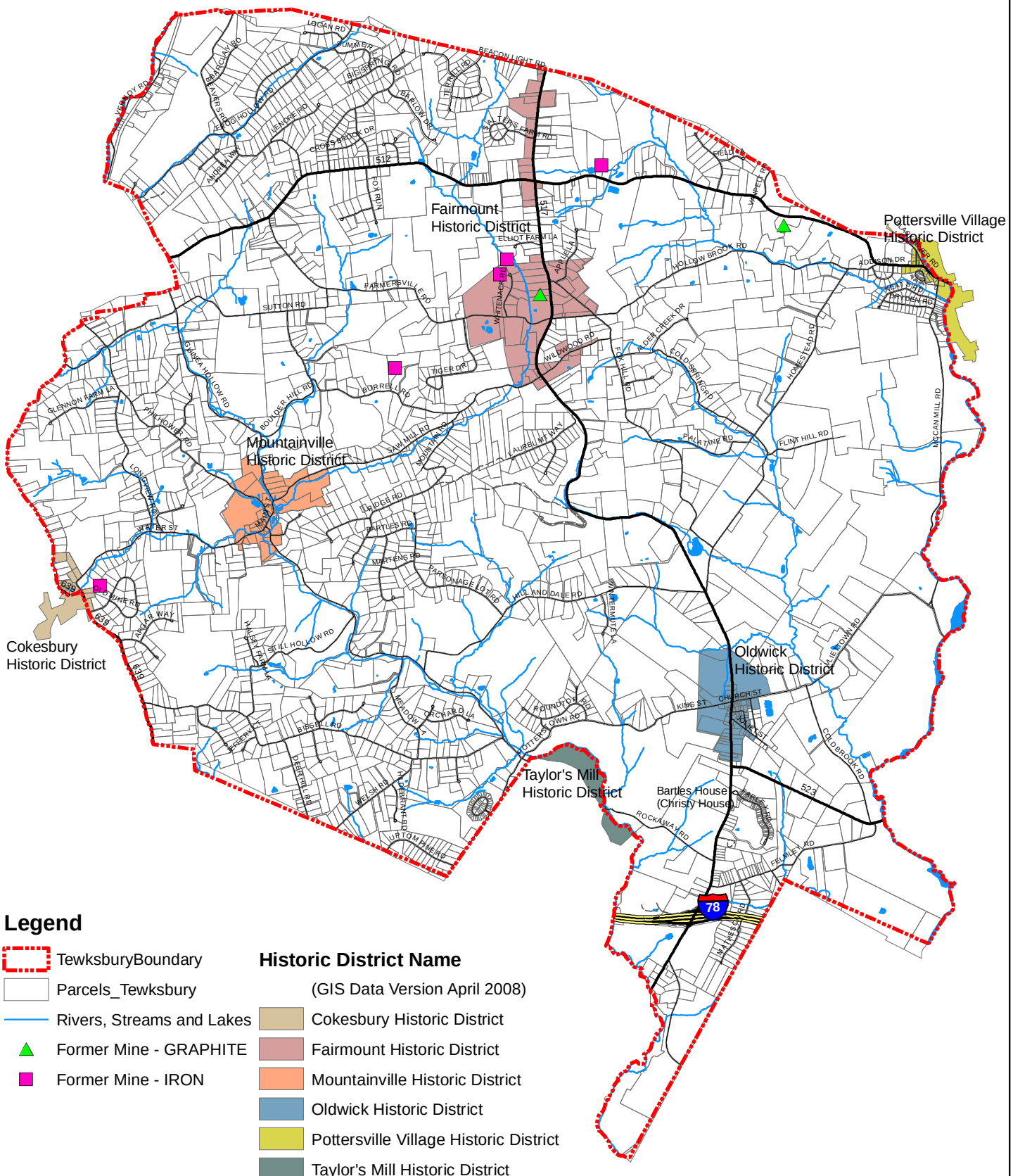
The Tewksbury Historical Society was formed in 1989 to preserve the history of the township (Tewksbury Times Online, February 2006).

Tewksbury Township encompasses part or all of six Historic Districts that are included on both the National and State Registers of Historic Places, including Cokesbury, Fairmount, Mountainville, Oldwick, Pottersville and Taylor's Mill (see **Table 9.2** and **Figure 9a**).

The oldest historic district in Tewksbury, *Oldwick* (formerly New Germantown) was originally founded by English settlers in the early 1700's. By the mid-18th century, a large number of German and Dutch immigrants had relocated to the area. In 1749 the Zion Evangelical Lutheran Church, the oldest German Lutheran parish in New Jersey, was constructed in the Gothic/Greek Revival style. The village experienced its greatest period of growth in the early to mid 19th century. The Oldwick United Methodist Church was built in 1865 in the Romanesque Revival style (Tewksbury Times Online, February 2006).

The *Pottersville Historic District* is located along both sides of the Lamington River (also known as the Black River). Portions of the village lie within Tewksbury (Hunterdon County), Washington and Chester Townships (Morris County) and Bedminster Township (Somerset County). The original mill was erected in the 1750's, and supplied grain to George Washington's Army. Many historic buildings still exist, such as the Dutch Reformed Church and the old Wortman Mill (Tewksbury Times Online, February 2006).

Beginning in the early 1800's, the *Mountainville Historic District* grew up at the intersection of what are now Rockaway Road, Main Street and Sawmill Road. Three mills were built at the confluence of four streams within the village (Tewksbury Times Online, February 2006).



Legend

- TewksburyBoundary
- Parcels_Tewksbury
- Rivers, Streams and Lakes
- Former Mine - GRAPHITE
- Former Mine - IRON

Historic District Name

(GIS Data Version April 2008)

- Cokesbury Historic District
- Fairmount Historic District
- Mountainville Historic District
- Oldwick Historic District
- Pottersville Village Historic District
- Taylor's Mill Historic District

Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

N

0 0.25 0.5 1 1.5 Miles

Figure 9a: Historic Districts & Historic Mines

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

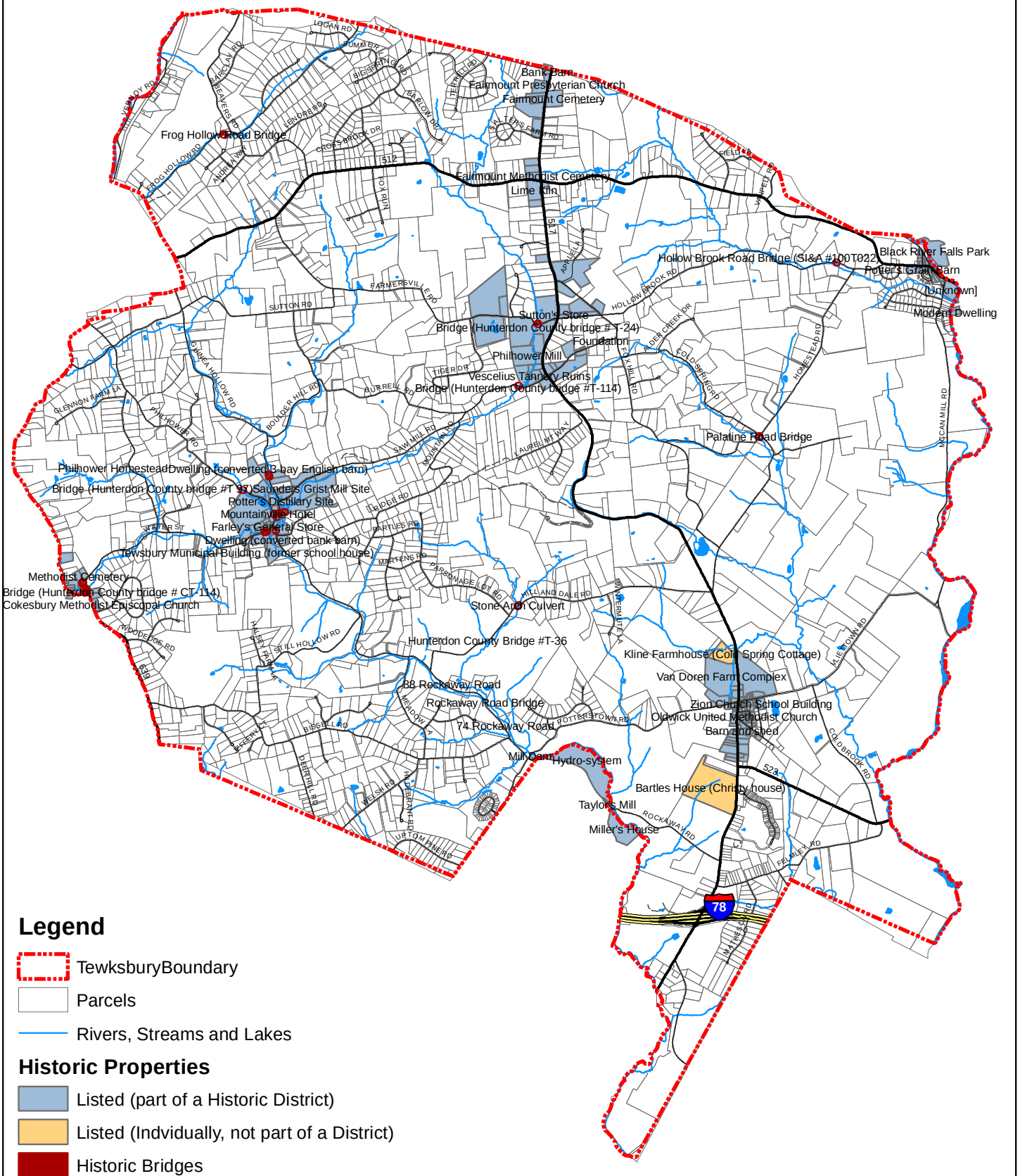
Taylor's Mill Historic District is located on the southern edge of Tewksbury. A stone grist mill built in 1760 by Col. John Taylor is said to have supplied General Washington's army during the Revolution (Hunterdon County Cultural and Heritage Commission, 2006).

In 1997, the Historic Preservation Commission distributed a two volume catalogue of historic buildings, houses, and other sites throughout Tewksbury. Copies of this Historic Resources Survey are available for public use at the Tewksbury Library and at the Township offices. The survey includes a brief discussion of individual properties located within the township's National Register-listed historic districts (Tewksbury Times Online, February 2006).

Individual historic properties, buildings and bridges identified in the NJDEP Historic Preservation Office's GIS data are listed in **Table 9.3** and **Figure 9b**.

Table 9.3: Historic Districts and Sites in Tewksbury Township

District	Name	Address
Cokesbury Historic District	13 dwellings	
	Bridge (Hunterdon County bridge # T-100)	
	Bridge (Hunterdon County bridge # T-99)	
	Bridge (Hunterdon County bridge # CT-114)	
	Former general store	
	Former Cokesbury Presbyterian Church	
	Methodist Cemetery	
Fairmount Historic District	3 dwellings	
	Fairmount Presbyterian Community House	
	Fairmount Presbyterian Parsonage	
Mountainville Historic District	1 dwelling (converted bank barn)	
	13 dwellings	
	Bridge (Hunterdon Co. bridge #T 106)	
	Bridge (Hunterdon County bridge #T 84)	
	Commercial Building (originally a "carriage factory")	
	Farley's General Store	
Oldwick Historic District	33 dwellings	
	Barn and shed	
	Kline Farmhouse (Cold Spring Cottage)	Route 517
	Oldwick Community Center (old Barnet Hall Academy)	
	Oldwick Firehouse	
	Oldwick United Methodist Church	
	Oldwick Village Garage	
	UTS (phone company) Building	
	Wagon House	
Pottersville Village Historic District	Unknown	
Taylor's Mill Historic District	Unknown	
Other	Bartles House (Christy House)	159 Oldwick Road
	Frog Hollow Road Bridge over minor tributary of South Branch Raritan River	
	Hollow Brook Road Bridge over tributary of Lamington River (NJDOT#100T022)	
	Palatine Road Bridge over Minor Tributary of the Lamington River	
Source: NJDEP Historic Preservation Office, 2004		



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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0 0.25 0.5 1 1.5 Miles

Figure 9b: Historic Properties

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

References: Historic Resources

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Internet Resources: Historic Resources

History of New Jersey (includes section on Hunterdon County) (ROOTS-L): http://www.rootsweb.com/roots-l/USA/nj/history.html

Hunterdon County History and Historic Preservation: http://www.co.hunterdon.nj.us/planning/historic.htm

National Register of Historic Places Home Page: http://www.nationalregisterofhistoricplaces.com

New Jersey Register of Historic Places Rules, N.J.A.C. 7:4 (Notice of Rule Proposal): http://www.nj.gov/dep/rules/notices/031708a.html

New Jersey Historic Preservation Office: http://www.state.nj.us/dep/hpo/

Tewksbury Historical Society: http://tewksburyhistory.net/index.html

10: REGIONAL RELATIONSHIPS

A. The Highlands Water Protection and Planning Act

The Highlands Water Protection and Planning Act (Highlands Act) (N.J.S.A. 13:20-1 et seq.), which became effective in August 2004, is a law that aims to preserve open space and protect the state's greatest diversity of natural resources including the precious water resources that supply drinking water to more than half of New Jersey's population. The Highlands Act defines the geographical boundary of the Highlands Region and the Highlands Preservation and Planning Areas (see **Figure 10a**); requires the NJDEP to establish regulations in the Highlands Preservation Area; and creates a Highlands Water Protection and Planning Council, which is responsible for developing a regional master plan for the Highlands Region.

Of the 800,000 acre Highlands Region, the *Highlands Preservation Area* includes 398,000 acres that are designated as exceptional natural resource value. More than $^1/_3$ of this area is undeveloped. Proposals for "major development" on properties within the preservation area will require a NJDEP Highlands Preservation Area Approval, which will be guided by the environmental regulations within the act. An example of major development is one that disturbs 1 or more acres of land or increases impervious surface by ¼ acre or more. Improvements to existing single family dwellings, such as an addition, garage, patio, driveway, swimming pool, garden or septic system are exempt. The *Highlands Planning Area* encompasses all areas of the Highlands that are not designated as the Highlands Preservation Area. The Highlands Act does not establish any new regulations for development within the Planning Area, however, the *Regional Master Plan*, which was adopted by the Highlands Water Protection and Planning Council, provides for enhanced standards, transfer of development rights and smart growth in this area.

The northwestern $^2/_3$ of Tewksbury Township (13,475 acres) is within the Highlands Preservation Area, while the remainder (6,860 acres) lies within the Planning Area.

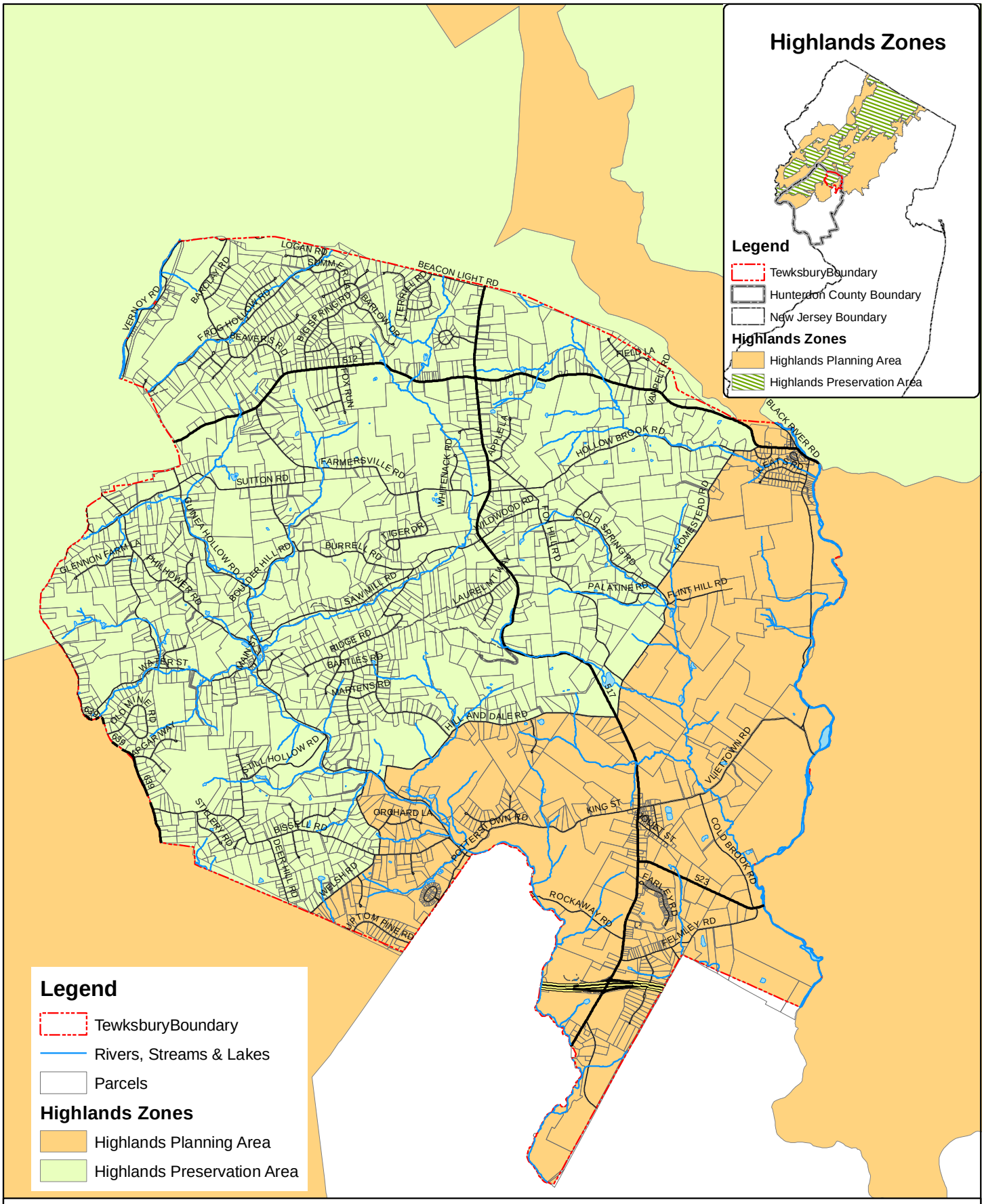
The Highlands Water Protection and Planning Council (Highlands Council) is composed of 15 members appointed by the Governor, 5 of whom must be municipal officials from the Highlands Region and 3 of whom must be county officials from the Highlands Region. The Council is responsible for carrying out the provisions of the Highlands Act.

The Highlands Council officially released the Highlands Regional Master Plan in November 2008, as well as the supporting technical information contained in the Technical Reports (NJDEP Highlands Council, 2008). This process generated an extensive amount of information at a regional scale.

Since the inception of this ERI writing project, it was intended to include Highlands information and data layers at the Township scale as part of the ERI document. In March 2009, the Highlands Council announced its Plan Conformance Grant Program specifications for *Module 4: Highlands Environmental Resource Inventory.*

The *Module 4: Highlands Environmental Resource Inventory for Tewksbury Township (draft)* was submitted in June 2009 as required for Basic Conformance. When reviewed and approved by the Highlands Council, it will be **Appendix E** of this document.

The purpose of the Highlands ERI addendum document echoes the purpose of this ERI as a whole, to "provide the base source for resource conservation." But with the additional goal of providing "a framework that supports the efforts of Tewksbury Township to bring its master plan, including the ERI, into conformance with the Highlands Regional Master Plan (RMP) (see **Appendix E**).



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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Figure 10a: NJDEP Highlands Zones

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

B. Hunterdon County Planning Board

The Hunterdon County Planning Board was established by the Board of Chosen Freeholders in 1957. The office is located at the Route 12 County Complex, Building #1. The Hunterdon County Planning Board's responsibilities are as follows:

- prepare and adopt a master plan for the physical development of the County,
- review subdivision and site plan applications,
- encourage municipal cooperation in matters of mutual and regional concern,
- advise the Board of Chosen Freeholders on capital budgets and expenditures, and maintain a file on municipal master plans and development regulations. (Hunterdon County Planning Board, 2007).

Hunterdon County Planning Board reviews all land subdivisions and site plans that are located on a County road or affect County facilities. The Planning Board prepared the Hunterdon County Open Space, Farmland and Historic Preservation Trust Fund Plan, which provides the Board of Chosen Freeholders with policy guidance on the County's open space, farmland and historic preservation goals. The Planning Board is also responsible for developing other planning documents, such as the Hunterdon County Farmland Preservation Plan, Hunterdon County Park and Recreation Master Plan, and the Hunterdon County Master Plan.

The Planning Board has written a number of publications, many of which are free or downloadable from the internet, including a Woodland Conservation Handbook (2003), Community Design Handbook (1999), Strategies for Managing Growth in Hunterdon County (1998), County Databook (demographics) (2003), and Sites of Historic Interest (1979). The Planning Board developed the *Hunterdon County Environmental Toolbox*, which consists of a series of model ordinances that municipalities may use to help manage growth and ensure environmentally sound development. Eleven model ordinances have been approved, with input and consensus by diverse interests in order to ensure they were legally sound, scientifically valid and responsive to the concerns of the diverse interest groups that would ultimately be affected by them (Hunterdon County Planning Board, 2007).

C. Water Quality Management Planning

Watershed management is the process of managing all of the water resources within the area of a watershed, rather than on a site-specific basis. 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 Office of Environmental Planning, 1997).

- Revisions to the Water Quality Management Planning Rules (N.J.A.C. 7:15) were adopted July 7, 2008. This rule establishes the following:
- procedures for preparation, adoption, amendment, revision, and certification of *Water Quality Management (WQM) Plans*;
- procedures for NJDEP's review of projects and activities for consistency with WQM plans;
- adoption of other NJDEP rules, priority systems and project priority lists, sludge management plans, regional stormwater management plans, effluent limitations, wastewater management plans, 201 Facilities Plans, and other documents in WQM Plans;
- coordination of WQM planning with the Highlands RMP, other programs and municipal zoning;
- mechanisms to resolve conflicts;

- procedures for submission, adoption, and updating *wastewater management plans (WMPs)*, procedures for WQM plan amendments and revisions, and the withdrawal of wastewater service areas where wastewater management plans are not current; the assignment of the duty to prepare and update wastewater management plans to county boards of chosen freeholders; and
- the process for identifying water bodies on the List of Water Quality Limited Segments and establishing total maximum daily loads (TMDLs) (see **Section 6E** for more about TMDLs) (NJDEP, 2008).

D. State Development & Redevelopment Plan

The NJ Department of Community Affairs Office of Smart Growth (OSG) implements the goals of the State Development and Redevelopment Plan to achieve comprehensive, long-term planning. The OSG coordinates planning throughout the state to protect the environment and guide future growth into compact, mixed-use development and redevelopment and integrates that planning with programmatic and regulatory land-use decisions at all levels of government and the private sector (NJ Department of Community Affairs, 2008).

The purpose of the 2001 State Plan is to "Coordinate planning activities and establish Statewide planning objectives in the following areas: land use, housing, economic development, transportation, natural resource conservation, agriculture and farmland retention, recreation, urban and suburban redevelopment, historic preservation, public facilities and services, and intergovernmental coordination" (N.J.S.A. 52:18A-200(f)). The State Plan is not a regulation but a statement of policy that has been adopted by the State Planning Commission to guide state, regional and local agencies in the exercise of their statutory authority (NJ State Planning Commission, 2001).

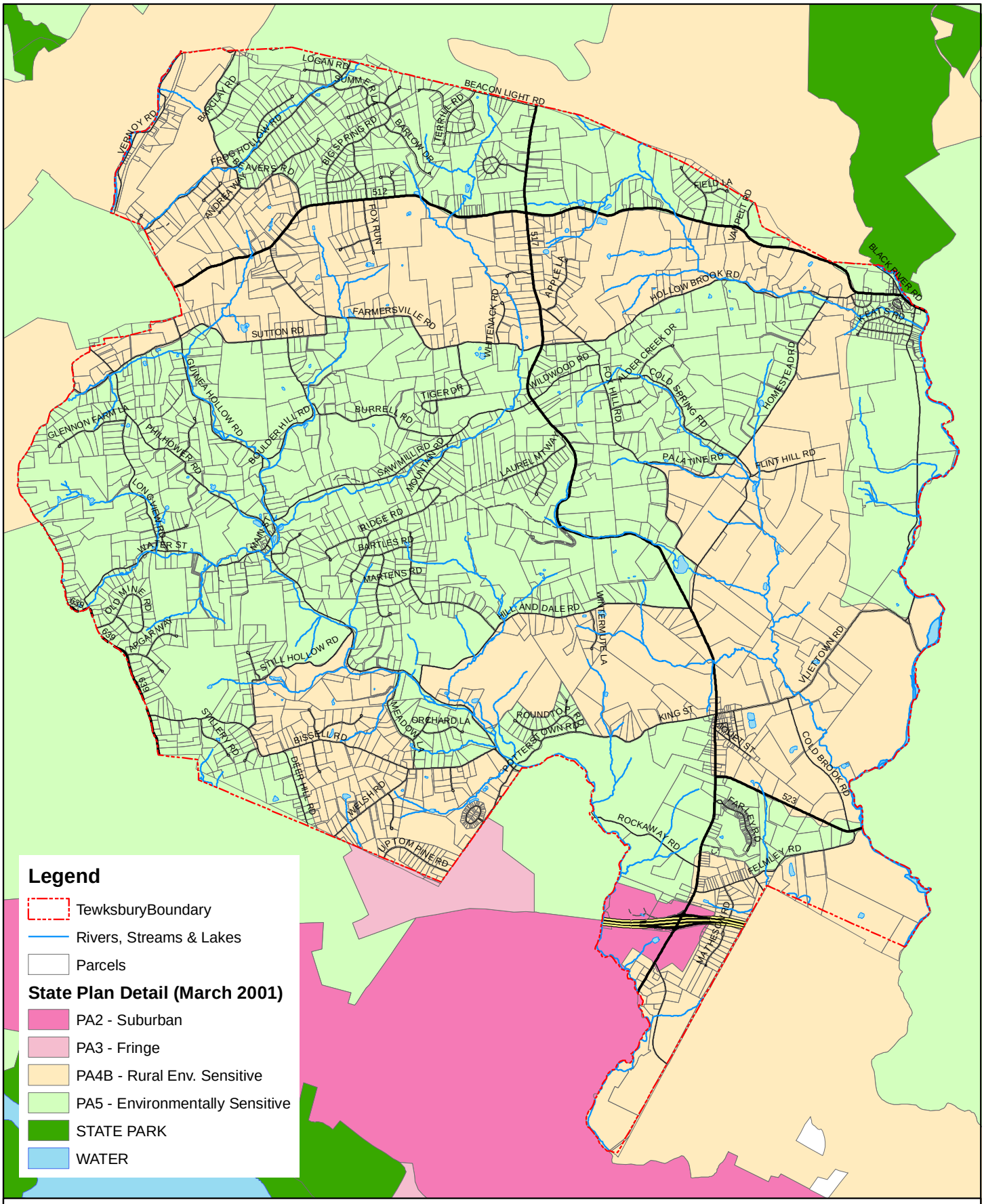
The 3 different planning zones found within Tewksbury include PA2-Suburban, PA4B-Rural Environmentally Sensitive, and PA5-Environmentally Sensitive, which are shown in **Figure 10b** and described below.

The State Plan goals for *PA2-Suburban Planning Area* are to provide for much of the state's future development; promote growth in Centers and other compact forms; protect the character of existing stable communities; protect natural resources; redesign areas of sprawl; reverse the current trend toward further sprawl; and revitalize cities and towns.

The State Plan goals for the *PA4B-Rural Environmentally Sensitive Planning Area* are to support continued agricultural development on lands with environmentally sensitive features; to maintain the Environs as large contiguous areas of farmland and other lands; revitalize cities and towns; accommodate growth in Centers; promote a viable agricultural industry; protect the character of existing stable communities; and confine programmed sewers and public water services to Centers.

The State Plan goals for the *PA5-Environmentally Sensitive Planning Area* are to protect environmental resources through the protection of large contiguous areas of land; accommodate growth in Centers; protect the character of existing stable communities; confine programmed sewers and public water services to Centers; and revitalize cities and towns (NJ State Planning Commission, 2001).

The State Plan has recognized the New Jersey Highlands (see **Section 10A**) as a *Special Resource Area* as a demonstration of the Highlands' critical importance to the state. The State Plan and Highlands process for municipalities and counties will be streamlined by providing for simultaneous agency reviews as well as joint meetings, whenever possible (Highlands Water Protection and Planning Council, 2008).



Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not NJDEP or county authorized.

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Figure 10b: State Development and Redevelopment Plan

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

References: Regional Relationships

Highlands
Highlands Water Protection and Planning Council. 2008. Highlands Regional Master Plan. 464 pages. http://www.highlands.state.nj.us/njhighlands/master/index.html

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Water Quality Management Planning
NJDEP. July 7, 2008 (latest amendment). N.J.A.C. 7:15: Water Quality Management Planning. 97 pages. http://www.nj.gov/dep/watershedmgt/DOCS/WQMP/wqmp_rule_0708.pdf

NJDEP Division of Watershed Management. 2008. http://www.state.nj.us/dep/watershedmgt/index.htm

NJDEP Office of Environmental Planning. January 1997. Draft Statewide Watershed Management Framework Document for the State of New Jersey.

State Plan
NJ Department of Community Affairs, Office of Smart Growth. 2008. New Jersey State Development and Redevelopment Plan Home Page. http://www.nj.gov/dca/osg/index.shtml

NJ State Planning Commission. March 1, 2001. New Jersey State Development and Redevelopment Plan Executive Summary. 58 pages. http://www.nj.gov/dca/divisions/osg/plan/

Internet Resources: Regional Relationships

Highlands Act & Highlands Council
NJDEP Highlands Council: http://www.highlands.state.nj.us/

Hunterdon County Planning Board
Home Page: http://www.co.hunterdon.nj.us/planning.htm

Watershed Management
Division of Watershed Management Home Page: http://www.state.nj.us/dep/watershedmgt/index.htm

State Development and Redevelopment Plan

Office of Smart Growth: http://www.nj.gov/dca/osg/index.shtml

11: ENVIRONMENTALLY SENSITIVE AREAS

Figure 11 provides a composite view of several of the features that make an area environmentally sensitive. This map shows wetlands, 150 foot wetlands buffers, floodplains, steep slopes, 300 foot C1 stream buffers, Landscape Project animal habitats that are ranked 3 (state threatened species), 4 (state endangered species) and 5 (federally endangered species), natural heritage priority sites (for rare species and ecological communities), and natural heritage grid map (for generalized locations of rare plants and natural communities).

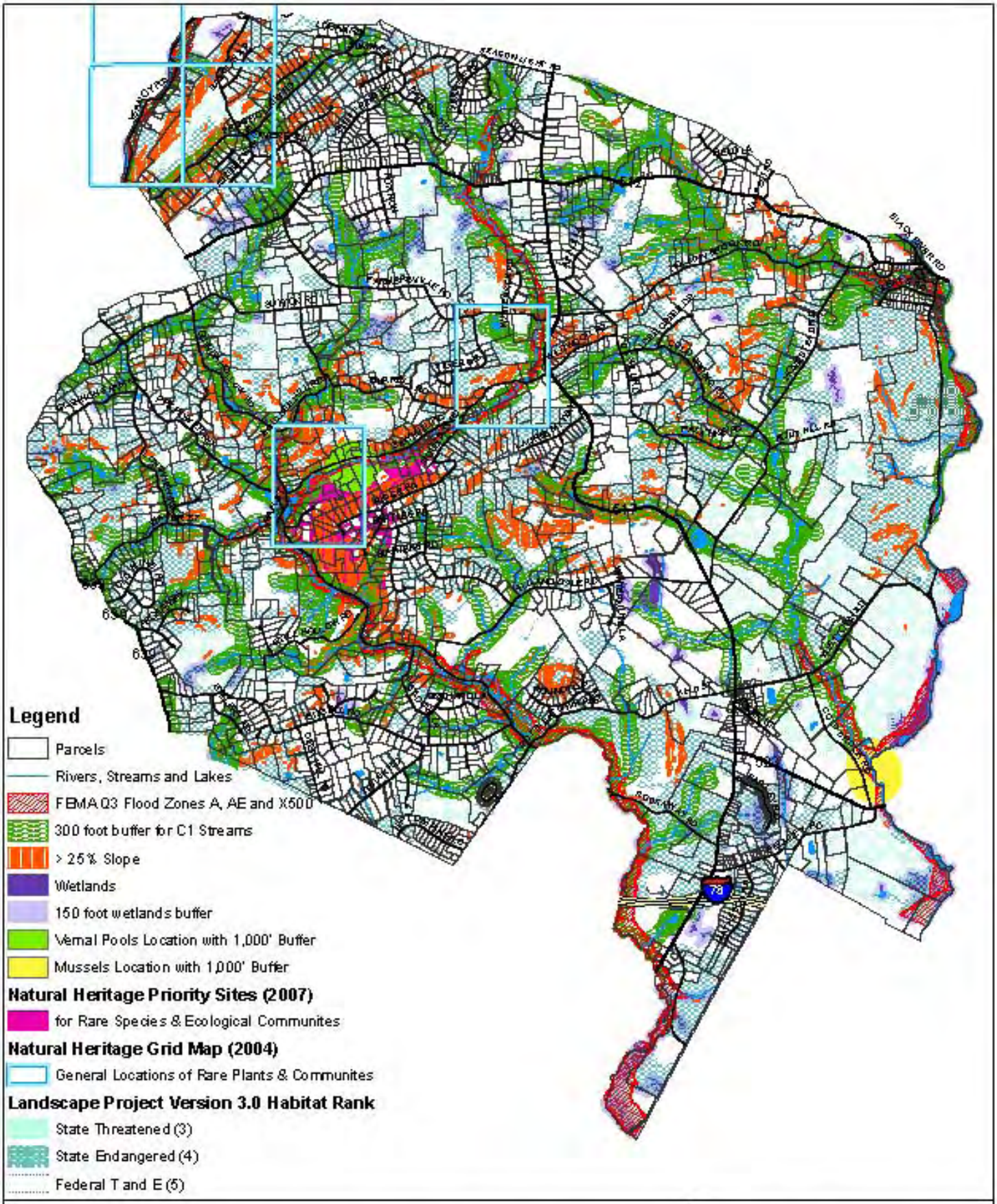

Figure 11: Environmentally Sensitive Areas

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

APPENDIX A: DATA USE AGREEMENTS

Contents

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.

A-2. Spatial Data Distribution Agreement for use of Hunterdon County GIS Data

(Required by County of Hunterdon Division of Geographic Information Systems.)

- Digital data received from the County of Hunterdon is to be used solely for internal purposes in the conduct of daily affairs.

- The data is 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 remain intact.

- Digital data received from the County of Hunterdon may not be reproduced or redistributed for use by anyone, without first obtaining written permission from the County of Hunterdon. This clause is not intended to restrict the distribution of printed mapped information produced from the digital data.

- Any sale distribution is prohibited without prior approval from the County of Hunterdon.

- Users agree to hold the County of Hunterdon, New Jersey and all their employees, and agents harmless from any claim, suit, or proceeding arising out of the use of the data in accordance with this agreement, including indemnification of the County of Hunterdon and the State of New Jersey for reasonable expenses incurred in defending such claims.

- The reproduction of any hard copy products, as provided by the County of Hunterdon, with the intent to sell for a profit is prohibited without the written consent from the County of Hunterdon.

- Any maps, publications, reports, or other documents produced as a result of this project which utilize Hunterdon County digital data will credit the County's Geographic Information System as the source of the data with the following credit/disclaimer:

  > "This (map/publication/report) was developed using Hunterdon County, New Jersey, Geographic Information System digital data, but this secondary product has not been verified by Hunterdon County and is not county-authorized."

- Users shall require any independent contractor, hired to undertake work which will utilize digital data obtained from the County of Hunterdon, to agree not to use, reproduce, or redistribute Hunterdon County GIS digital data for any purpose other than the specified contractual work. All copies of Hunterdon County GIS digital 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 the terms and conditions have been read and that the user is bound by these criteria.

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 Land Use Regulation Program, P.O. Box 401, Trenton, NJ 08625-0401.

The Landscape Project was developed by the Division of Fish & Wildlife, Endangered and Nongame Species Program to map critical habitat for rare animal species. Some of the rare species data in the Landscape Project is in the Natural Heritage Database, while other records were obtained from other sources. Natural Heritage Database response letters will list all species (if any) found during a search of the Landscape Project. However, any reports that are included with the response letter will only reference specific records if they are in the Natural Heritage Database. 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 THE TEWKSBURY TOWNSHIP ENVIRONMENTAL RESOURCE INVENTORY

Descriptions of Data Layers:

Data Disclaimers in **Appendix A** apply to the use of these data layers and the maps created from them. The user is responsible for understanding the accuracy limitations of the digital data layers, as documented in the accompanying report and metadata summaries, and the metadata files which accompany the data.

B-1: GIS Metadata – Summary of GIS Layers Used

Used for Figure	Source of Data	Data Title	Date
1a, 2a	Hunterdon County	Boundary - Municipalities of Hunterdon County	1/22/2001
	NJDEP, OIRM, BGIS	Boundary - NJDEP County Boundaries for the State of NJ	1/23/2003
1a, 2a, 2f, 10a	NJDEP, OIRM, BGIS	Boundary - NJDEP County Boundary for Hunterdon County, New Jersey	1/1/2003
	NJDEP, OIRM, BGIS	Boundary - NJDEP State Boundary of New Jersey	11/1/1998
1a, 6a	NJDEP, GS	NJDEP State Rivers for New Jersey (Third Order or Higher)	1/1/1993
1a, 6e	NJDEP, OIRM, BGIS	Boundary - NJDEP Municipality Boundaries for the State of New Jersey	11/14/2007
1b	NJDEP, OIRM, BGIS	New Jersey 2002 High Resolution Orthophotography (57 files)	7/31/2003
1c	Hunterdon County	Railroads	5/7/2007
	NJDEP, OIRM, BGIS	NJDEP Place Name Locations in the State of New Jersey	8/6/2004
	USGS, WRD	DGS99-1: USGS Topo Quads	5/27/1999
1e, 7a, 7b	NJDEP, OIRM, BGIS	NJDEP 2002 Land use/Land cover Update, N and S Branch Raritan Watershed Mgmt. Area, WMA-8 (03-2008)	3/4/2008
2a	NJDEP, DER, BAM	NJDEP Ambient Air Quality Monitors	3/1/2006
	NJDEP, GS	DGS00-1 NJDEP Drought Regions of New Jersey	5/1/2004
2c	NJDEP, DSRT	NJDEP Public Community Water Purveyor Service Areas	7/12/2004
	NJDEP, DWM, BWR	New Jersey Statewide Sewer Service Area	2/1/2008
	NJDEP, GS	DGS02-2 GIS Coverages of Public Community Water Supply Well Head Protection Areas for New Jersey	7/27/2007
	NJDEP, GS	New Jersey Public Community Water Supply Wells Database	6/28/2007
2d	Tewksbury Land Use	Tewksbury Township Mapped Wells	12/31/2000
2e	Tewksbury Land Use	Tewksbury Township Mapped Septic System Drainage Fields	12/31/2000
	Tewksbury Land Use	Tewksbury Township Mapped Septic Systems	12/31/2000
2f	NJDEP, GS	DGS02-7 Physiographic Provinces of New Jersey	6/30/2002
2g	Hunterdon County	Contours - 20 feet - Township	7/19/2005
2h, 11	Hunterdon County	Hunterdon County Steep Slopes	4/15/2003
3a	NJDEP, GS	DGS04-1 Earthquakes Epicentered In New Jersey	4/25/2005
	NJDEP, GS	DGS04-6 Bedrock Geology of New Jersey. (Scale 1:100,000) - bedrock	6/30/1999
	NJDEP, GS	DGS04-6 Bedrock Geology of New Jersey. (Scale 1:100,000) - faults	6/30/1999
	NJDEP, GS	DGS04-6 Bedrock Geology of New Jersey. (Scale 1:100,000) - folds	6/30/1999
	NJDEP, GS	DGS05-1 Selected Sand, Gravel and Rock Surficial Mining Operations in New Jersey	2/1/2005
3a, 9	NJDEP, GS	DGS03-2 Abandoned Mines of New Jersey	7/29/2005
3b	NJDEP, GS	DGS99-3 Surficial Geology of Hunterdon County, New Jersey (1:24,000)	1/1/1993
4a-h, 6b, 6c	USDA, NRCS	Soil Survey Geographic 2005 (SSURGO) Database for Hunterdon	12/7/2006
5b	NJDEP, GS	DGS98-5 Aquifers of New Jersey	1/1/1998
	NJDEP, GS	DGS98-6 Sole-Source Aquifers of New Jersey (1:100,000)	5/19/1998
5d	NJDEP, GS	DGS02-3 Ground Water Recharge for Hunterdon County, NJ	10/8/2004
5e	NJDEP, GS	Aquifer Recharge Potential for Hunterdon County, NJ	1/4/2005
5f	NJDEP, DWQ, BNPC	NJPDES Regulated Discharge to Ground Water Facility Locations	7/18/2007
	NJDEP, GS	DGS05-2 NJ's Ambient Ground Water Quality Network data	5/24/2007
	NJDEP, SRP	NJDEP Currently Known Extent of Groundwater Contamination (CKE) for New Jersey	3/1/2007
	NJDEP, SRP	NJDEP Deed Notice Extent Polygons in New Jersey, 2007	3/1/2007
	NJDEP, SRWM	NJDEP Known Contaminated Site List for New Jersey, 2005	2/1/2006
6a	~~NJDEP, OIRM, BGIS~~	~~NJDEP Municipality Boundaries for the State of New Jersey~~	~~11/14/2007~~

Used for Figure	Source of Data	Data Title	Date
		(Clipped to Coast)	
	NJDEP, OIRM, BGIS	NJDEP Watershed Management Areas in New Jersey	4/5/2000
6a, 6d	NJDEP, GS	NJDEP 14 Digit Hydrologic Unit Code delineations for New Jersey (DEPHUC14)	1/20/2006
6b, 11	FEMA	FEMA Flood Hazard Zones - Q3 Flood Data, HUNTERDON COUNTY, NEW JERSEY	5/23/1996
6c	NJDEP, OIRM, BGIS	NJDEP Linear Non-Tidal Wetlands of Hunterdon County, New Jersey, 1986	11/1/1998
6c, 11	NJDEP, OIRM, BGIS	NJDEP 2002 Land use/Land cover, N and S Branch Raritan Watershed Mgmt. Area, wetlands only	3/4/2008
6d, 11	NJDEP, DLM, BFBM	NJDEP Surface Water Quality Standards of New Jersey (June 2009 version)	6/1/2009
6e	NJDEP, DLM, BFBM	Ambient Stream Quality Monitoring Sites (1998 - 2008)	5/24/2007
	NJDEP, DLM, BFBM	NJDEP Ambient Biomonitoring Network (AMNET) 2004	12/1/2005
	NJDEP, DLM, BFBM	NJDEP Existing Water Quality Stations in New Jersey	10/19/2007
	NJDEP, DLM, BFBM	NJDEP Fish Index of Biotic Integrity Monitoring Network (2000-2006)	9/24/2007
	NJDEP, DLM, BFBM	NJDEP Supplemental Ambient Surfacewater Monitoring Network (SASMN)	10/19/2007
	NJDEP, DLM, BFBM	STORET Water Quality Monitoring Stations	8/1/2005
	NJDEP, ER, DWQ,PSPR1	NJPDES Surface Water Discharges in New Jersey, (1:12,000)	11/20/2007
	USGS, WRD	USGS continuous-streamflow gaging locations in New Jersey	4/17/2002
	USGS, WRD	USGS stream crest gaging locations in New Jersey	4/17/2002
	USGS, WRD	USGS stream lowflow gaging locations in New Jersey	4/17/2002
	USGS, WRD	USGS surface-water quality gaging stations in New Jersey	4/17/2002
7c	Rutgers CRSSA	Vernal Pools	
7d, 11	NJDEP, ENSP	NJDEP Landscape Project 3.0: Species Based Patches within the Highlands Extended Boundary	5/16/2008
7d	NJDEP, ENSP	NJDEP Landscape Project 3.0: Streams within the ENSP Highlands Extended Boundary with Mussels Rating	5/16/2008
7e, 11	NJDEP, OIRM, BGIS	Natural Heritage Grid Map	2/1/2004
7e, 11	NJDEP, OIRM, BGIS	NJDEP Natural Heritage Priority Sites	3/1/2007
8a	Hunterdon County	County Park Trail	
	Hunterdon County	Open Space - Hunterdon County	4/21/2003
	Tewksbury Land Use	Tewksbury Township/Banisch Associates	9/29/2009
	Highlands Council	Supporting LUCM Series Shape Files - Open Space	1/10/2008
8b	Tewksbury Land Use	Tewksbury Township 2008 Easement Inventory	1/28/2008
	Tewksbury Land Use	Tewksbury Township Inventory of Easements	
8c	Hunterdon County	County Preserved Farmland	4/21/2003
	Hunterdon County	Hunterdon CADB Agricultural Development Areas	4/21/2003
	Tewksbury Land Use	Tewksbury Township Preserved Farmland	9/29/2009
9	NJDEP, NHR, HPO	NJDEP Historic Districts of New Jersey, Edition 20080422	4/22/2008
	NJDEP, NHR, HPO	NJDEP Historic Properties of New Jersey	4/22/2008
10a	NJDEP, OPPS	NJ Highlands Preservation and Planning Area	12/1/2005
10b	NJDCA, OSG	Planning Areas of the NJ State Development and Redevelopment Plan, adopted March 1, 2001	6/20/2007
most	Hunterdon County	Boundary - Tewksbury Boundary Clipped from Municipalities of Hunterdon County	1/22/2001
	Hunterdon County	Lakes - Hunterdon County	10/13/2000
	Hunterdon County	Parcels - Tewksbury Township	2/20/2004
	Hunterdon County	Rivers - Hunterdon County	10/16/2000
	Hunterdon County	Road Centerlines - Hunterdon County	9/12/2007

Used for Figure	Source of Data	Data Title	Date
	Hunterdon County	Streams - Hunterdon County	10/4/2000
	NJDEP, OIRM, BGIS	NJDEP Open Water Areas of Hunterdon County, New Jersey 1986 (1:24000)	11/1/1998
	NJDEP, OIRM, BGIS	NJDEP Streams of Hunterdon County, New Jersey (1:24,000)	11/1/1998

B-2: GIS Metadata – Details of Data Layers Used

Federal Emergency Management Agency

FEMA Flood Hazard Zones - Q3 Flood Data, HUNTERDON COUNTY, NEW JERSEY
Publication Date: 5/23/1996 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6b, 11 Online Linkage: FEMA_Flood_ES_redmap5353314.zip
Short Description: The Q3 Flood Data are derived from the Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA).

Highlands Water Protection and Planning Council

Agriculture - Preserved Farms within Agricultural Resource Area (Draft)
Publication Date: 3/22/2007 Scale: Geospatial Data Presentation Format: raster digital data
Used for Figure: 8c Online Linkage: http://www.highlands.state.nj.us/
Short Description: NJ Highlands Region Preserved Farms within Agricultural Resource Area (Draft) as referenced by the Draft Land Use Capability Map Abstract (NJ Highlands, March 2007).

Critical Habitat - Mussels Location with 1,000 Foot Buffer (Draft)
Publication Date: 3/22/2007 Scale: Geospatial Data Presentation Format: raster digital data
Used for Figure: 11 Online Linkage: http://www.highlands.state.nj.us/
Short Description: Mussels Location with 1,000 Foot Buffer (Draft) within the Highlands Region as referenced by the Draft Land Use Capability Map Abstract (NJ Highlands, March 2007).

Critical Habitat - Vernal Pools Location with 1,000 Foot Buffer (Draft)
Publication Date: 3/22/2007 Scale: Geospatial Data Presentation Format: raster digital data
Used for Figure: 11 Online Linkage: http://www.highlands.state.nj.us/
Short Description: Vernal Pools Location with 1,000 Foot Buffer (Draft) within the Highlands Region as referenced by the Draft Land Use Capability Map Abstract (NJ Highlands, March 2007).

Critical Habitat - Water/Wetland Dependent Species Habitat (Draft)
Publication Date: 3/22/2007 Scale: Geospatial Data Presentation Format: raster digital data
Used for Figure: 11 Online Linkage: http://www.highlands.state.nj.us/
Short Description: Water/Wetland Dependent Species Habitat (Draft) within the Highlands Region as referenced by the Draft Land Use Capability Map Abstract (NJ Highlands, March 2007).

Supporting LUCM Series Shape Files - Open Space (Final Draft)
Publication Date: 1/10/2008 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 8a Online Linkage: http://www.highlands.state.nj.us/
Short Description: This file represents open space within the NJ Highlands Region. This file is a compilation of many different data sources that include federal, county, local, and non-profit groups.

Hunterdon County GIS

Boundary - Municipalities of Hunterdon County
Publication Date: 1/22/2001 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 1a, 2a Online Linkage: http://gis.co.hunterdon.nj.us
Short Description: Boundaries of municipalities in Hunterdon.

Boundary - Tewksbury Boundary Clipped from Municipalities of Hunterdon County
Publication Date: 1/22/2001 Scale: 1:12,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://gis.co.hunterdon.nj.us/website/HC_GIS_MAP_Download.htm
Short Description: Boundary of Tewkbury Township was clipped from the layer of the boundaries of municipalities in Hunterdon.

Contours - 20 feet - Township
Publication Date: 7/19/2005 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2g Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: This data set represents topographic elevation contour lines at 20 foot contours intervals for Tewkbury

Township. These data are georegistered to the NAD83 N.J. State Plane Coordinate System.

County Park Trail
Publication Date: Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 8a Online Linkage: http://gis.co.hunterdon.nj.us/website/HC_GIS_MAP_Download.htm
Short Description: This data set represents county park trails within Hunterdon County, and was obtained from the Hunterdon County GIS website.

County Preserved Farmland
Publication Date: 4/21/2003 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 8b Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: This data set represents farms preserved within Hunterdon County, and was obtained from the Hunterdon County GIS website. It does not include recently preserved properties.

Hunterdon CADB Agricultural Development Areas
Publication Date: 4/21/2003 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 8b Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: This data set represents preserved Agricultural Development Areas within Hunterdon County, and was obtained from the Hunterdon County GIS website.

Hunterdon County Steep Slopes
Publication Date: 4/15/2003 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2h Online Linkage: NA
Short Description: The NJDEP 10 Meter DEM was converted to a Percent Slope Raster for the County of Hunterdon using the Arcview 8.1.2 Spatial Analyst command Surface Analysis; Slope. These values were then reclassified into 3 categories (between 0 and 14.99%; between 15 and 24.99%; 25% and greater).

Lakes - Hunterdon County
Publication Date: 10/13/2000 Scale: 1:1,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: Lakes located within or adjacent to Hunterdon County were digitized to provide a hydrologic dataset for use in base mapping and analysis.

Open Space - Hunterdon County
Publication Date: 4/21/2003 Scale: 1:12,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 8a Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: This data set shows the location and relationship of all open space and recreational lands in the County of Hunterdon.

Parcels - Tewksbury Township
Publication Date: 2/20/2004 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http:\\gis.co.hunterdon.nj.us
Short Description: This data set represents tax map parcels in Tewksbury Township, and was obtained from the Hunterdon County GIS website.

Railroads
Publication Date: 5/7/2007 Scale: 1:2,400 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1c Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: This data set represents the railroad network for Hunterdon County.

Rivers - Hunterdon County
Publication Date: 10/16/2000 Scale: 1:1,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: Rivers located within or adjacent to Hunterdon County were digitized to provide a hydrologic dataset for use in base mapping and analysis.

Road Centerlines - Hunterdon County
Publication Date: 9/12/2007 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://gis.co.hunterdon.nj.us
Short Description: All road and ramp centerlines for Hunterdon County, as delineated by centerline striping using GPS in January 1998.

Streams - Hunterdon County
Publication Date: 10/4/2000 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://gis.co.hunterdon.nj.us/Hunterdon/HC_GIS_MAP_Download.htm
Short Description: This data set represents streams within Hunterdon County, and was obtained from the Hunterdon County GIS website.

NJ Department of Community Affairs, Office of Smart Growth (formerly the Office of State Planning)

Planning Areas of the NJ State Development and Redevelopment Plan, adopted March 1, 2001

Publication Date: 6/20/2007 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 10b Online Linkage: http://www.state.nj.us/dca/divisions/osg/resources/maps/gis.html
Short Description: This dataset contains the boundaries of the Planning Areas of the NJ State Development and Redevelopment Plan (NJSDRP).

NJDEP Department of Environmental Regulation (DER), Bureau of Air Monitoring (BAM)

NJDEP Ambient Air Quality Monitors
Publication Date: 3/1/2006 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/airqm.zip
Short Description: The ambient pollutant data is collected and analyzed to verify that the pollutants are in compliance with the National Ambient Air Quality Standards.

NJDEP Division of Landuse Management (DLM), Bureau of Freshwater & Biological Monitoring (BFBM)

Ambient Stream Quality Monitoring Sites (1998 - 2008)
Publication Date: 5/24/2007 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/swpts.zip
Short Description: This dataset is a GIS layer of points representing ambient stream sites monitored cooperatively by the NJDEP and the USGS for water quality parameters.

NJDEP Ambient Biomonitoring Network (AMNET) 2004
Publication Date: 12/1/2005 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/biopts200
Short Description: This data represents point sites sampled by NJDEP as part of its Ambient Biomonitoring Network (AMNET), which samples for benthic macroinvertebrates and habitat, in addition to chemical and physical parameters.

NJDEP Existing Water Quality Stations in New Jersey
Publication Date: 10/19/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/ewqpoi.zip
Short Description: This data represents sampling points for the EWQ (Existing Water Quality) project at NJDEP. The EWQ Network was designed to provide supplemental data for water quality for the entire state.

NJDEP Fish Index of Biotic Integrity Monitoring Network (2000-2006)
Publication Date: 9/24/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.nj.gov/dep/gis/digidownload/zips/statewide/fibi.zip
Short Description: This data represents the NJDEP Fish Index of Biotic Integrity (FIBI) Monitoring Network sample point locations for the years 2000 to 2006.

NJDEP Supplemental Ambient Surfacewater Monitoring Network (SASMN)
Publication Date: 10/19/2007 Scale: 1:2,400 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/sasmn.zip
Short Description: This data represents sampling points for the Supplemental Ambient Surfacewater Monitoring Network (formerly EWQ) project at NJDEP. The SASMN Network was designed to provide supplemental data for water quality for the entire state.

NJDEP Surface Water Quality Standards of New Jersey (June 2009 version)
Publication Date: 6/1/2009 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6d Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/swqs.zip
Short Description: This data, based on hydrography stream network, is a digital representation of New Jersey's Surface Water Quality Standards in accordance with N.J.A.C. 7:9 B. The SWQS establish the designated uses to be achieved and specify the water quality (criteria) necessary to protect the State's waters. In addition, a layer was created to show a 300 foot buffer around all C1 stream segments using ArcMap.

STORET Water Quality Monitoring Stations
Publication Date: 8/1/2005 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/storet.zip
Short Description: This GIS layer represents locations of water quality monitoring stations from NJDEP's NJ STORET Database. NJ STORET maintains NJDEP's water quality monitoring data from January 1, 1999 to the present.

NJDEP Division of Science, Research and Technology

NJDEP Public Community Water Purveyor Service Areas
Publication Date: 7/12/2004 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data

Used for Figure: 2c Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/watpurv19
Short Description: This is a graphical representation of the 1998 Public Community Water Purveyor Service Areas. Water purveyors are regulated by the NJDEP Bureau of Safe Drinking Water, under the Safe Drinking Water Act. Public Community Water Purveyors are systems that pipe water for human consumption to at least 15 service connections used year-round, or one that regularly serves at least 25 year-round residents.

NJDEP Division of Watershed Management (DWM), Bureau of Watershed Regulation (BWR)

New Jersey Statewide Sewer Service Area
Publication Date: 2/1/2008 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2c Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/statessa.zi
Short Description: This is a graphical representation of the States Sewer Service Area (SSA) mapping. The SSA mapping shows the planned method of wastewater disposal for specific areas.

NJDEP Division of Fish and Wildlife, Endangered and Nongame Species Program

NJDEP Landscape Project 3.0: Species Based Patches within the Highlands Extended Boundary
Publication Date: 5/16/2008 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 7d, 11 Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/landscape/highlands
Short Description: This data set is a product of the Landscape Project, a pro-active, ecosystem-level approach to the long-term protection of imperiled and priority species and their important habitats in New Jersey. This version, Version 3.0, shows species based patches within the ENSP Highlands Extended Boundary. ENSP employed the NJDEP 2002 aerial photo-based LU/LC data layer to delineate potential rare species habitat within the Highlands Region.

NJDEP Landscape Project 3.0: Streams within the ENSP Highlands Extended Boundary with Mussels Rating
Publication Date: 5/16/2008 Scale: Geospatial Data Presentation Format: vector digital dataUsed for Figure: 7d Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/landscape/highlands_streams.zip
Short Description: This data set is a product of the Landscape Project. An update to the DEP stream layer was completed with the DEP 2002 LU/LC classification and was incorporated into this current version of the Landscape Project (Version 3.0) within the ENSP Highlands Extended Boundary. Streams are valued only by mussel species. All mussel point occurrences within the Highlands Region were buffered by 50 meters.

NJDEP Environmental Regulation (ER), Division of Water Quality (DWQ), Bureau of Point Source Permitting - Region 1 (PSP-R1)

NJPDES Surface Water Discharges in New Jersey, (1:12,000)
Publication Date: 11/20/2007 Scale: 1:12,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njpdesswd
Short Description: New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge pipe GIS point coverage compiled from GPSed locations, NJPDES databases, and permit applications.

NJDEP Geological Survey

Aquifer Recharge Potential for Hunterdon County, NJ
Publication Date: 1/4/2005 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 5e Online Linkage: http://www.njgeology.org/geodata/
Short Description: A qualitative representation of the potential for aquifer recharge for Hunterdon County, NJ built upon the combination of ground-water recharge value rankings and well-yield-based aquifer rankings.

DGS00-1 NJDEP Drought Regions of New Jersey
Publication Date: 5/1/2004 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 2a Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs00-1.zip
Short Description: This shape file delineates New Jersey drought regions, counties, and municipalities. Drought regions provide a regulatory basis for coordinating local responses to regional water-supply shortages.

DGS02-2 GIS Coverages of Public Community Water Supply Well Head Protection Areas for New
Publication Date: 7/27/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 2c Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs02-2.htm
Short Description: A Well Head Protection Area (WHPA) in New Jersey is a map area calculated around a Public Community Water Supply (PCWS) well in New Jersey that delineates the horizontal extent of ground water captured by a well pumping at a specific rate over a two-, five-, and twelve-year period of time for confined wells.

DGS02-3 Ground Water Recharge for Hunterdon County, NJ
Publication Date: 10/8/2004 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 5d, 5e Online Linkage: http://www.njgeology.org/geodata/dgs02-3/dgs02-3.htm
Short Description: An estimation of ground-water recharge for Hunterdon County. Ground-water recharge is estimated using the NJGS methodology from NJ Geological Survey Report GSR-32. Land-use/land-cover, soil and municipality-based climatic data were combined and used to produce an estimate of ground-water recharge in inches/year.

DGS02-7 Physiographic Provinces of New Jersey
Publication Date: 6/30/2002 Scale: 1:100,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 2f Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs02-7.htm
Short Description: This data set delineates the boundaries of NJ's 4 Physiographic Provinces. The boundary between each province is determined by a major change in topography and geology.

DGS03-2 Abandoned Mines of New Jersey
Publication Date: 7/29/2005 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 3a, 9 Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgsdown/dgs03-2.zip
Short Description: This data consists of point shapefile of locations and attributes for abandoned mines.

DGS04-1 Earthquakes Epicentered In New Jersey
Publication Date: 4/25/2005 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 3a Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgsdown/dgs04-1.zip
Short Description: The New Jersey Geological Survey Digital Geodata Series DGS04-1 download contains a (GIS) point dataset in an ESRI shapefile which has data of earthquakes that had epicenters in New Jersey.

DGS04-6 Bedrock Geology of New Jersey. (Scale 1:100,000) - bedrock
Publication Date: 6/30/1999 Scale: 1:100,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 3a Online Linkage: http://www.state.nj.us/dep/njgs/geodata/
Short Description: The Bedrock Geology of New Jersey consists of statewide data layers (geology, faults, folds, dikes). The GIS data were scanned and digitized from United States Geological Survey Miscellaneous Investigations and Open-File Series 1:100,000 scale geologic maps compiled from 1984 to 1993.

DGS04-6 Bedrock Geology of New Jersey. (Scale 1:100,000) - faults
Publication Date: 6/30/1999 Scale: 1:100,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 3a Online Linkage: http://www.state.nj.us/dep/njgs/geodata/
Short Description: NJGS scanned and digitized data from USGS 1:100,000 scale geologic maps compiled from 1984 to 1993.

DGS04-6 Bedrock Geology of New Jersey. (Scale 1:100,000) - folds
Publication Date: 6/30/1999 Scale: 1:100,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 3a Online Linkage: http://www.state.nj.us/dep/njgs/geodata/
Short Description: NJGS scanned and digitized data from USGS 1:100,000 scale geologic maps compiled from 1984 to 1993.

DGS05-1 Selected Sand, Gravel and Rock Surficial Mining Operations in New Jersey
Publication Date: 2/1/2005 Scale: unknown Geospatial Data Presentation Format: vector digital data
Used for Figure: 3a Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs05-1.htm
Short Description: To provide an inventory of selected sand, gravel and rock mining operations in New Jersey.

DGS05-2 NJ's Ambient Ground Water Quality Network data
Publication Date: 5/24/2007 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 5f Online Linkage: http://www.njgeology.org/geodata/dgs05-2.htm
Short Description: This data layer shows the point locations of wells sampled for the Ambient Ground-Water Quality Monitoring Network (AGWQMN), which is an NJDEP/USGS cooperative project.

DGS06-3: Landslides in New Jersey
Publication Date: 3/1/2007 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: no Online Linkage: http://www.njgeology.org/geodata/dgs06-3.htm
Short Description: This GIS point shapefile of Landslides in New Jersey contains point locations and other attributes for 133 historic and recent landslide locations in NJ mapped by the NJGS. The landslides have occurred in the northern and central part of the state and include slumps, debris flows, rockfalls and rockslides.

DGS98-5 Aquifers of New Jersey
Publication Date: 1/1/1998 Scale: 1:250,000 Geospatial Data Presentation Format:
Used for Figure: 5b Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgsdown/dgs98-5.zip
Short Description: This data layer consists of the NJ Geological supply depiction of the aquifers of NJ.

DGS98-6 Sole-Source Aquifers of New Jersey (1:100,000)
Publication Date: 5/19/1998 Scale: 1:100,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 5b Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs98-6.zip
Short Description: This coverage allows users to identify EPA-defined sole-source aqufiers in New Jersey. This is in support

of some federally-mandated programs.

DGS99-3 Surficial Geology of Hunterdon County, New Jersey (1:24,000)

Publication Date: 1/1/1993 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 3b Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs99-3.zip
Short Description: DGS99-3 is an ARC/INFO Geographic Information Systems (GIS) coverage of surficial geologic materials of Hunterdon County, New Jersey. Surficial materials are the unconsolidated sediments that overlie bedrock formations, and that are the parent material for agronomic soils.

New Jersey Public Community Water Supply Wells Database

Publication Date: 6/28/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 2c Online Linkage: http://www.state.nj.us/dep/njgs/geodata/dgs97-1.zip
Short Description: The Public Community Water Supply (PCWS) Wells is a GIS point coverage with associated Microsoft Access relational database. It contains information for the wells in New Jersey that supply potable water to public communities.

NJDEP 14 Digit Hydrologic Unit Code delineations for New Jersey (DEPHUC14)

Publication Date: 1/20/2006 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6a, 6d Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dephuc14.
Short Description: Drainage basins were delineated from 1:24,000-scale. This data is not field checked and has no guarantees as to its accuracy. The minimum polygon size has not been defined, but the 14-digit hydrologic units have a defined minimum size of 3,000 acres. Some basins are smaller, which gives a reasonable geographic arrangement to the 14 digit sub-watersheds.

NJDEP State Rivers for New Jersey (Third Order or Higher)

Publication Date: 1/1/1993 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1a, 6a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stateriv.zip
Short Description: This data is a graphical representation of New Jersey's State Rivers that are third order or higher.

NJDEP Natural and Historic Resources (NHR), Historic Preservation Office

NJDEP Historic Districts of New Jersey, Edition 20080422

Publication Date: 4/22/2008 Scale: 1:12,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 9 Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/historic_di
Short Description: This data is produced and maintained by the New Jersey Historic Preservation Office (HPO) to provide provide accurate cultural resource information to government, regulated customers, and the public.

NJDEP Historic Properties of New Jersey

Publication Date: 4/22/2008 Scale: 1:12,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 9 Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/historic_properties.zip
Short Description: This data is produced and maintained by the New Jersey Historic Preservation Office (HPO) to provide accurate cultural resource information to government, regulated customers, and the public.

NJDEP Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS)

Boundary - NJDEP County Boundaries for the State of New Jersey

Publication Date: 1/23/2003 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1a, 2a, 2f Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stco.zip
Short Description: New Jersey county boundaries were digitized into NJDEP's GIS to provide basic jurisdictional information.

Boundary - NJDEP County Boundary for Hunterdon County, New Jersey

Publication Date: 1/1/2003 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1a, 2a, 2f, 10a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/cnb/huncnb.zip
Short Description: This data contains the Hunterdon County boundary.

Boundary - NJDEP Municipality Boundaries for the State of New Jersey

Publication Date: 11/14/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1a, 6e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stmun.zip
Short Description: Municipal boundaries in New Jersey were gathered from USGS topoquads and other sources in 1987.

Boundary - NJDEP State Boundary of New Jersey

Publication Date: 11/1/1998 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1a, 2a, 2f, 10a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/state.zip
Short Description: This data represents the New Jersey State Boundary.

Natural Heritage Grid Map

Publication Date: 2/1/2004 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 7e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/nhpgrid.zi
Short Description: The Natural Heritage Grid Map was produced by the Office of Natural Lands Management (ONLM) to provide a general portrayal of the geographic locations of rare plant species and ecological communities for the entire state without providing sensitive detailed information.

New Jersey 2002 High Resolution Orthophotography (57 files)
Publication Date: 7/31/2003 Scale: 1:2,400 Geospatial Data Presentation Format: remote sensing image
Used for Figure: 1b Online Linkage: http://njgin.nj.gov/OIT_IW/
Short Description: Digital color infrared (CIR) orthophotography of New Jersey in State Plane NAD83 Coordinates, U.S. Survey Feet. The digital orthophotography was produced at a scale of 1:2400 (1"=200') with a 1 foot pixel resolution. Digital orthophotography combines the image characteristics of a photograph with the geometric qualities of a map. There are 57 files which cover Tewksbury Township.

NJDEP 2002 Land use/Land cover Update, N and S Branch Raritan Watershed Mgmt. Area, WMA-8 (03-2008)
Publication Date: 3/4/2008 Scale: 1:2,400 Geospatial Data Presentation Format: vector digital dataUsed for Figure: 1e and others Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/lulc02/w08lu02.zip
Short Description: The 2002 Land Use/Land Cover (LU/LC) data sets were mapped by Watershed Management Area (WMA). There are additional reference documents listed in this file under Supplemental Information which should also be examined by users of these data sets. The data was created by comparing the 1995/97 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database to 2002 color infrared (CIR) imagery and delineating areas of change. The March 2008 version changed the land use type assigned to some land uses.

NJDEP 2002 Land use/Land cover, N and S Branch Raritan Watershed Mgmt. Area, wetlands only
Publication Date: 3/4/2008 Scale: 1:2,400 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6c, 11 Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/lulc02/w08lu02.zip
Short Description: Areas with Land Use Type=wetlands were selected from the 2002 Land Use/Land Cover (LU/LC) data sets. An additional layer was created by creating a 150 buffer surrounding all the wetlands (although NJDEP does not assign 150' buffers to all wetlands).

NJDEP Linear Non-Tidal Wetlands of Hunterdon County, New Jersey, 1986
Publication Date: 11/1/1998 Scale: 1:12,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6c Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/line/hunline.zip
Short Description: This data was derived from the freshwater wetlands (FWW) data generated under the New Jersey Freshwater Wetlands Mapping Program. The FWW are network coverages with both linear and polygon wetlands delineated and coded. Linear wetlands features were reselected out of FWW to form this dataset. Any arc that was a linear wetland feature was given a valid wetlands (CLASS) code in the original data set. This dataset is intended to serve as a resource for analysis rather than regulatory delineations. The NJDEP may change the linework based on more in depth analysis and field inspection for regulatory purposes. In addition, a layer showing a 150 foot buffer (which will not apply to all wetlands) around all linear wetlands was created with ArcMap.

NJDEP Municipality Boundaries for the State of New Jersey (Clipped to Coast)
Publication Date: 11/14/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/muncoast.z
Short Description: New Jersey municipal boundaries were digitized into NJDEP's GIS to provide basic jurisdictional information, showing the coastline.

NJDEP Natural Heritage Priority Sites
Publication Date: 3/1/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 7e Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/prisites.zip
Short Description: The Natural Heritage Priority Sites Coverage was created to identify the best habitats for rare plant and animal species and natural communities through analysis of information in the NJ Natural Heritage Database.

NJDEP Open Water Areas of Hunterdon County, New Jersey 1986 (1:24000)
Publication Date: 11/1/1998 Scale: 1:24000 Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/lakes/hunlakes.zip
Short Description:

NJDEP Place Name Locations in the State of New Jersey
Publication Date: 8/6/2004 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 1c Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/placenam0
Short Description: The place name locations in this data were obtained via download from the United States Geological Survey, taken from the USGS 7.5' topoquad series revised in 2004.

NJDEP Streams of Hunterdon County, New Jersey (1:24,000)
Publication Date: 11/1/1998 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: most Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/strm/hunstrm.zip

Short Description:

NJDEP Watershed Management Areas in New Jersey
Publication Date: 4/5/2000 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/depwmas.z
Short Description: This layer is a simplified version of the ARC/INFO dephuc14 data, and shows the outlines of the watershed management regions and areas to be used for the statewide watershed initiative.

NJDEP Office of Policy, Planning and Science

NJ Highlands Preservation and Planning Area
Publication Date: 12/1/2005 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 10a Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/highlands.
Short Description: This data set was developed to be a graphical representation of the legal, verbal description of the boundary within the Highlands Water Protection and Planning Act.

NJDEP Site Remediation Program, Division of Remediation Support, Information Support Element (ISE), Bureau of Information Services and Program Support (BISPS)

NJDEP Currently Known Extent of Groundwater Contamination (CKE) for New Jersey
Publication Date: 3/1/2007 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 5f Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/ckepoly.zi
Short Description: This data layer contains information about areas in the state which are specified as the Currently Known Extent (CKE) of ground water pollution.

NJDEP Deed Notice Extent Polygons in New Jersey, 2007
Publication Date: 3/1/2007 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 5f Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dna.zip
Short Description: This data layer identifies those Known Contaminates Sites (KCS) or sites on Site Remediations Programs' (SRP) Comprehensive Site List (CSL) that have been assigned a Deed notice. The deed notice (polygon) was developed to provide information regarding the spatial extent of soil contamination, as well as other information.

NJDEP Site Remediation Program and Waste Management (SRWM)

NJDEP Known Contaminated Site List for New Jersey, 2005
Publication Date: 2/1/2006 Scale: 1:1,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 5f Online Linkage: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/kcsl.zip
Short Description: The Known Contaminated Sites List for New Jersey 2005 are those sites and properties within the state where contamination of soil or ground water has been identified or where there has been, or there is suspected to have been, a discharge of contamination. This list of Known Contaminated Sites may include sites where remediation is either currently under way, required but not yet initiated or has been completed.

Rutgers University Center for Remote Sensing & Spatial Analysis

Vernal Pools
Publication Date: Scale: Geospatial Data Presentation Format:
Used for Figure: 7b Online Linkage:
Short Description: Vernal Pools locations obtained from Rutgers website and plotted as point locations on map.

Tewksbury Township Land Use Office

Tewksbury Township 2008 Easement Inventory
Publication Date: 1/28/2008 Scale: Geospatial Data Presentation Format: database
Used for Figure: 8b Online Linkage: NA
Short Description: Database of parcels with conservation easements. This database was joined to parcels.shp by the PIN (unique identifier of block and lot). Does not delineate boundaries of easements. Easements may exist on parcels not listed here.

Tewksbury Township Mapped Septic System Drainage Fields
Publication Date: 12/31/2000 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2e Online Linkage: NA

Short Description: Partial database created in 2000 from Hunterdon County and Township records of septic drainage field locations in Tewksbury. The township requires "as built" plans, but these locations have not been field verified. It includes roughly 20-25% of the septics in the township.

Tewksbury Township Mapped Septic Systems

Publication Date: 12/31/2000 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2e Online Linkage: NA
Short Description: Partial database created in 2000 from Hunterdon County and Township records of septic system locations in Tewksbury. The township requires "as built" plans, but these locations have not been field verified. It includes roughly 20-25% of the septics in the township.

Tewksbury Township Mapped Wells

Publication Date: 12/31/2000 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 2d Online Linkage: NA
Short Description: Partial database created in 2000 from Hunterdon County and Township records of well locations in Tewksbury. The township requires "as built" plans, but these locations have not been field verified. It includes roughly 20-25% of the wells in the township.

Tewksbury Township Open Space

Publication Date: 6/01/2009 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 8c Online Linkage: NA
Short Description: Tewksbury Land Use office maintains a list of preserved open space and farmland within Tewksbury Township.

United States Department of Agriculture, Natural Resources Conservation Service

Soil Survey Geographic 2005 (SSURGO) Database for Hunterdon

Publication Date: 12/7/2006 Scale: 1:20,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 4a-h, 6b, 6c Online Linkage: http://SoilDataMart.nrcs.usda.gov/
Short Description: SSURGO depicts information about the kinds and distribution of soils on the landscape. The soil map and data used in the SSURGO product were prepared by soil scientists as part of the National Cooperative Soil Survey. Hunterdon County soils data sets were downloaded from the Natural Resource Conservation Service (NRCS) Soil Data Mart. The soil map units are linked to attributes and interpretations in the National Soil Information System relational database. Photographic or digital enlargement of these maps to scales greater than at which they were originally mapped can cause misinterpretation of the data. The depicted soil boundaries, interpretations, and analysis derived from them do not eliminate the need for onsite sampling, testing, and detailed study of specific sites for intensive uses. Thus, these data and their interpretations are intended for planning purposes only.

United States Geological Survey, Water Resource Division

DGS99-1: USGS Topo Quads

Publication Date: 5/27/1999 Scale: 1:24,000 Geospatial Data Presentation Format: bitmap images
Used for Figure: 1c Online Linkage: http://www.state.nj.us/dep/njgs/geodata/index.htm
Short Description: N.J. Geological Survey DGS99-1 is a set of monochromatic, bit-mapped, TIFF (tagged image file format) images covering New Jersey. The images are derived from the U.S. Geological Survey 7-1/2' topographic quadrangle map Digital Raster Graphics (DRG) imagery.

USGS continuous-streamflow gaging locations in New Jersey

Publication Date: 4/17/2002 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.njgeology.org/geodata/dgs02-5/streamgage.zip
Short Description: This dataset is a GIS point coverage of continuous-streamflow gaging stations within the United States Geological Survey (USGS), Water Resource Division (WRD) streamflow-data-collection networks in the New Jersey District. Some of these sites are currently reporting streamflow data on the Interent. Other points in this coverage represent discontinued gages.

USGS stream crest gaging locations in New Jersey

Publication Date: 4/17/2002 Scale: Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.njgeology.org/geodata/dgs02-5/creststage.zip
Short Description: This dataset is a GIS point coverage of stream crest gaging stations within the USGS, WRD streamflow-data-collection networks in the New Jersey District. Some of these sites are measured occasionally. Other points in this coverage represent discontinued gages.

USGS stream lowflow gaging locations in New Jersey

Publication Date: 4/17/2002 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.njgeology.org/geodata/dgs02-5/lowflow.zip
Short Description: This dataset is a GIS point coverage of stream lowflow gaging stations within the United States Geological Survey (USGS), Water Resource Division (WRD) streamflow-data-collection networks in the New Jersey District. Some of these sites are currently reporting streamflow data on the Interent.

USGS surface-water quality gaging stations in New Jersey

Publication Date: 4/17/2002 Scale: 1:24,000 Geospatial Data Presentation Format: vector digital data
Used for Figure: 6e Online Linkage: http://www.njgeology.org/geodata/dgs02-5/wqgages.zip
Short Description: This dataset is a GIS point coverage of water-quality gaging stations within the United States Geological Survey (USGS), Water Resource Division (WRD) streamflow-data-collection networks in the New Jersey District. Some of these sites are current.

APPENDIX C: ENDANGERED SPECIES

Contents:

The following fact sheets are authored by the NJDEP Endangered and Nongame Species Program. These rare species have been reported within Tewksbury Township. Fact sheets were not available for all species.

Bald Eagle	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/baldeagle.pdf
Barred Owl	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/barredowl.pdf
Bobcat	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/bobcat.pdf
Bobolink	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/bobolink.pdf
Bog Turtle	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/bogtrtl.pdf
Cooper's hawk	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/coopers.pdf
Copperhead	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/species/copperhead.pdf
Eastern Box Turtle	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/bogtrtl.pdf
Grasshopper Sparrow	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/grasshoppersparrow.pdf
Jefferson Salamander	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/species/jeffereson_salamander.pdf
Mussels	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/mussels.pdf
Northern Spring Salamander	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/species/no_spring_salamander.pdf
Redheaded Woodpecker	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/redhdwdpckr.pdf
Red Shoulder Hawk	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/redshldhwk.pdf
Savannah Sparrow	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/savsparrow.pdf
Wood Turtle	Source: http://www.state.nj.us/dep/fgw/ensp/pdf/end-thrtened/woodtrtl.pdf

C-1. List of Rare Species of Hunterdon County

PAGE 1

9-Oct-01

HUNTERDON COUNTY
RARE SPECIES AND NATURAL COMMUNITIES
PRESENTLY RECORDED IN THE NEW JERSEY NATURAL HERITAGE DATABASE

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	GRANK	SRANK
*** Vertebrates					
ACCIPITER COOPERII	COOPER'S HAWK		T/T	G5	S3B,S4N
AMMODRAMUS HENSLOWII	HENSLOW'S SPARROW		E	G4	S1B
AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW		T/S	G5	S2B
ASIO OTUS	LONG-EARED OWL		T/T	G5	S2B,S2N
BARTRAMIA LONGICAUDA	UPLAND SANDPIPER		E	G5	S1B
BUTEO LINEATUS	RED-SHOULDERED HAWK		E/T	G5	S1B,S2N
CIRCUS CYANEUS	NORTHERN HARRIER		E/U	G5	S1B,S3N
CISTOTHORUS PLATENSIS	SEDGE WREN		E	G5	S1B
CLEMMYS INSCULPTA	WOOD TURTLE		T	G4	S3
CLEMMYS MUHLENBERGII	BOG TURTLE	LT	E	G3	S2
CROTALUS HORRIDUS HORRIDUS	TIMBER RATTLESNAKE		E	G4T4	S2
DOLICHONYX ORYZIVORUS	BOBOLINK		T/T	G5	S2B
EURYCEA LONGICAUDA LONGICAUDA	LONGTAIL SALAMANDER		T	G5T5	S2
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	LT	E	G4	S1B,S2N
LYNX RUFUS	BOBCAT		E	G5	S3
MELANERPES ERYTHROCEPHALUS	RED-HEADED WOODPECKER		T/T	G5	S2B,S2N
PASSERCULUS SANDWICHENSIS	SAVANNAH SPARROW		T/T	G5	S2B,S4N
PETROCHELIDON PYRRHONOTA	CLIFF SWALLOW		S/S	G5	S2B
POOECETES GRAMINEUS	VESPER SPARROW		E	G5	S1B,S2N
STRIX VARIA	BARRED OWL		T/T	G5	S3B
*** Ecosystems					
CAVE AQUATIC COMMUNITY	CAVE AQUATIC COMMUNITY			G4?	S2
CAVE TERRESTRIAL COMMUNITY	CAVE TERRESTRIAL COMMUNITY			G4?	S3
SHALE CLIFF/ROCK OUTCROP COMMUNITY	SHALE CLIFF/ROCK OUTCROP COMMUNITY			G3	S2?
*** Invertebrates					
ALASMIDONTA UNDULATA	TRIANGLE FLOATER			G4	S3
CICINDELA MARGINIPENNIS	COBBLESTONE TIGER BEETLE			G2G3	S1

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	GRANK	SRANK
ENALLAGMA BASIDENS	DOUBLE-STRIPED BLUET			G5	S3
LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL			G3G4	S1
LEPTODEA OCHRACEA	TIDEWATER MUCKET			G4	S1
POLYGONIA PROGNE	GRAY COMMA			G5	SH
PTICHODIS BISTRIGATA	SOUTHERN PTICHODIS			G3	S1S3
*** Other types					
BAT HIBERNACULUM	BAT HIBERNACULUM			G?	S2
*** Vascular plants					
ADLUMIA FUNGOSA	CLIMBING FUMITORY			G4	S2
AGASTACHE NEPETOIDES	YELLOW GIANT-HYSSOP			G5	S2
AGASTACHE SCROPHULARIIFOLIA	PURPLE GIANT-HYSSOP			G4	S2
AGRIMONIA MICROCARPA	SMALL-FRUIT GROOVEBURR			G5	S2
ARISTOLOCHIA SERPENTARIA	VIRGINIA SNAKEROOT			G4	S3
ASIMINA TRILOBA	PAWPAW		E	G5	S1
ASPLENIUM PINNATIFIDUM	LOBED SPLEENWORT		E	G4	S1
ASTER PRAEALTUS	WILLOW-LEAF ASTER		E	G5T5?	S1
BOTRYCHIUM ONEIDENSE	BLUNT-LOBE GRAPE FERN			G4Q	S2
CACALIA ATRIPLICIFOLIA	PALE INDIAN PLANTAIN		E	G4G5	S1
CARDAMINE ANGUSTATA	SLENDER TOOTHWORT			G5	S3
CAREX AMPHIBOLA VAR AMPHIBOLA	NARROW-LEAF SEDGE		E	G5T4Q	S1
CAREX BUSHII	BUSH'S SEDGE		E	G4	S1
CAREX DEWEYANA	DEWEY'S SEDGE		E	G5T5	S1
CAREX FRANKII	FRANK'S SEDGE			G5	S3
CAREX HITCHCOCKIANA	HITCHCOCK'S SEDGE			G5	S2
CAREX JAMESII	JAMES' SEDGE		E	G5	S1
CAREX LEPTONERVIA	FINE-NERVE SEDGE		E	G4	S1
CAREX MEADII	MEAD'S SEDGE			G4G5	SX.1
CAREX OLIGOCARPA	FEW-FRUIT SEDGE		E	G4	S1
CAREX PALLESCENS	PALE SEDGE			G5	S2
CAREX WILLDENOWII VAR WILLDENOWII	WILLDENOW'S SEDGE			G5T5	S2
CASTILLEJA COCCINEA	SCARLET INDIAN-PAINTBRUSH			G5	S2
CERCIS CANADENSIS	REDBUD		E	G5T5	S1
CHEILANTHES LANOSA	HAIRY LIPFERN			G5	S2
CHENOPODIUM SIMPLEX	MAPLE-LEAF GOOSEFOOT			G5	S2
CRATAEGUS CALPODENDRON	PEAR HAWTHORN		E	G5	S1
CRATAEGUS DODGEI	DODGE'S HAWTHORN			G4	S2

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	GRANK	SRANK
CRATAEGUS HOLMESIANA	HOLMES' HAWTHORN			G5	S1
CRATAEGUS SUCCULENTA	FLESHY HAWTHORN		E	G5	S1
CUSCUTA CEPHALANTHI	BUTTONBUSH DODDER		E	G5	S1
CYNOGLOSSUM VIRGINIANUM VAR VIRGINIANUM	WILD COMFREY			G5T5	S2
CYSTOPTERIS PROTRUSA	LOWLAND FRAGILE FERN			G5	S2
DESMODIUM HUMIFUSUM	TRAILING TICK-TREFOIL		E	G1G2Q	SH
DICENTRA CANADENSIS	SQUIRREL-CORN		E	G5	S1
DOELLINGERIA INFIRMA	CORNEL-LEAF ASTER			G5	S2
DRABA REPTANS	CAROLINA WHITLOW-GRASS		E	G5	SH
ELLISIA NYCTELEA	AUNT LUCY		E	G5	S1
ERAGROSTIS FRANKII	FRANK'S LOVE GRASS			G5	S2
HYBANTHUS CONCOLOR	GREEN VIOLET		E	G5	S1
HYDROPHYLLUM CANADENSE	BROAD-LEAF WATERLEAF		E	G5	S1
HYPERICUM PYRAMIDATUM	GREAT ST. JOHN'S-WORT			G4	S3
ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA		E	G2	S1
JEFFERSONIA DIPHYLLA	TWINLEAF		E	G5	S1
KUHNIA EUPATORIOIDES	FALSE BONESET		E	G5T5	S1
LATHYRUS VENOSUS	VEINY VETCHLING		E	G5	SH
LECHEA INTERMEDIA VAR INTERMEDIA	LARGE-POD PINWEED			G5T4T5	S2
LEMNA VALDIVIANA	PALE DUCKWEED		E	G5	S1
LINUM SULCATUM	GROOVED YELLOW FLAX		E	G5T5	S1
MONARDA CLINOPODIA	BASIL BEEBALM		E	G5	SH
ONOSMODIUM VIRGINIANUM	VIRGINIA FALSE-GROMWELL		E	G4	S1
PANICUM OLIGOSANTHES VAR OLIGOSANTHES	FEW-FLOWER PANIC GRASS			G5T5?	S1S2
PENSTEMON LAEVIGATUS	SMOOTH BEARDTONGUE		E	G5	S1
PHLOX PILOSA	DOWNY PHLOX		E	G5T5	SH
PINUS PUNGENS	TABLE MOUNTAIN PINE		E	G4	S1.1
PRUNUS ALLEGHANIENSIS	ALLEGHENY PLUM		E	G4T4	S1
PRUNUS PUMILA VAR DEPRESSA	LOW SAND CHERRY			G5T5	S2
PTELEA TRIFOLIATA	WAFER-ASH		E	G5T5	S1
PYCNANTHEMUM CLINOPODIOIDES	BASIL MOUNTAIN-MINT		E	G2	S1
PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN-MINT		E	G2	S1
RANUNCULUS MICRANTHUS	ROCK BUTTERCUP			G5	S2
RANUNCULUS TRICHOPHYLLUS VAR	THREAD-LEAF WATER BUTTERCUP			G5T5	S2

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	GRANK	SRANK
TRICHOPHYLLUS					
RHYNCHOSPORA GLOBULARIS	COARSE GRASS-LIKE BEAKED-RUSH		E	G5?	S1
RIBES MISSOURIENSE	MISSOURI GOOSEBERRY		E	G5	S1
RUDBECKIA FULGIDA	ORANGE CONEFLOWER		E	G5T4?	S1
SALIX LUCIDA SSP LUCIDA	SHINING WILLOW			G5T5	S1
SCUTELLARIA NERVOSA	VEINED SKULLCAP			G5	S2
SEDUM TELEPHIOIDES	ALLEGHENY STONECROP			G4	SX.1
SELAGINELLA RUPESTRIS	ROCK SPIKE-MOSS			G5	S2
SOLIDAGO RIGIDA	PRAIRIE GOLDENROD		E	G5T5	S1
STACHYS TENUIFOLIA	SMOOTH HEDGE-NETTLE			G5	S3
STELLARIA PUBERA	STAR CHICKWEED		E	G5	SH
TRIOSTEUM ANGUSTIFOLIUM	NARROW-LEAF HORSE-GENTIAN		E	G5	S1
VALERIANELLA RADIATA	BEAKED CORNSALAD		E	G5	S1
VERBENA SIMPLEX	NARROW-LEAF VERVAIN		E	G5	S1
VICIA CAROLINIANA	CAROLINA WOOD VETCH		E	G5	S1
VIOLA CANADENSIS	CANADIAN VIOLET		E	G5T?	S1
108 Records Processed					

Code	Definition
Federal Status	Federal Status (U.S. Fish and Wildlife Service definitions)
LT	Taxa formally listed as threatened.
Species Status	State Status
E	Endangered: Applies to a species whose prospects for survival within the state are in immediate of extinction within NJ.
T	Threatened: Applies to species that may become Endangered if conditions surrounding it begin to or continue to deteriorate.
SRank	State Rank Definitions
S1	Critically imperiled in New Jersey.
S2	Imperiled in New Jersey.
S3	Rare in state. Species ranked S3 are not yet imperiled in state but may soon be if additional populations are destroyed.
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: http://www.nj.gov/dep/parksandforests/natural/heritage/spplant_ap1.html for complete code definitions.	

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/imapnj/imapnj.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

Bald Eagle, *Haliaeetus leucocephalus*

Status: ***State:*** Endangered ***Federal:*** Threatened (proposed for de-listing)

Identification

© T. Vezo/ VIREO

Adult bald eagles are distinguished by their large size (7- to 8-foot wingspan), full white heads and tails and dark brown, almost black body. They reach their adult size by the time they can fly. Their adult plumage, however, develops in their fifth year. Prior to that, their juvenile appearance varies from year to year. In their first year, their wings are slightly broader and entirely dark brown. The next year they begin to molt their flight feathers and the trailing edge of their wings appears symmetrically serrated as shorter adult feathers replace the longer juvenile ones. Their plumage is usually mottled, brown and white, and is widely variable with a considerable amount of white on the breast and belly. Bald eagles are even more mottled in their third year and begin to show signs of change from dark brown to light yellow in their eye and bill color, and may have some lighter plumage appearing on their heads and tails.

During their fourth year, bald eagles begin to appear unmistakable as our national symbol. This is when they are transitioning from juvenile to adult and appear for the first time with a white head and tail. At this age, they retain some brown in the white plumage, giving them a dirty appearance. They also retain some white flecking in the brown of their bodies. In their next molt, they attain the clean white head and tail and solid brown body plumage of a full adult bald eagle.

Habitat

Bald eagle habitat consists of areas of forest that are associated with bodies of water. With fish as their primary diet, bald eagles in New Jersey have historically been associated with the forests near the Delaware River and Bay as well as all the rivers that empty into the Atlantic Ocean and Delaware Bay (Niles 1995). In northern and central New Jersey, bald eagles are resident on inland reservoirs and on the Delaware River. Throughout the state, these large birds require a nesting location that is safe from the threat of human disturbance and usually choose their nest tree accordingly. Typically, the tree they choose for building their large nests is a “super-canopy” tree that is taller than the trees immediately surrounding it. By nesting in such a tree, eagles can place their nest within the shelter of the crown and still be above the surrounding trees, enabling them to arrive and depart from the nest with ease.

In the northern part of the state, where the topography is hilly or mountainous, eagles can nest in trees that are on a slope and therefore have one side that is higher than its neighboring trees on the slope below it. Occasionally,

bald eagles will choose a lone tree in an open field.

In addition to nesting habitat, eagles also have habitat requirements for foraging and wintering, which might overlap their nesting habitat, but not necessarily. Foraging habitat for bald eagles consists of large perch trees near a body of water. Both of these elements are critical due to the "sit and watch" foraging behavior of eagles. Wintering habitat consists of the same, with the added condition of open, ice-free water. Parts of the Delaware River, such as the Delaware Water Gap, where the current is swift and the river remains open, or deep reservoirs with enough current or a dam to keep part of the water ice-free, serve as good wintering habitat for eagles. The tidal areas of southern New Jersey marshes are also ideal locations for winter foraging.

Status and Conservation

Long before the introduction of the pesticide DDT after World War II, habitat destruction, shootings and poisonings had greatly reduced the population of bald eagles in the lower 48 contiguous states. But the widespread use of DDT, which caused eagles to lay thin-shelled eggs that were often crushed during incubation, pushed the bird to the brink of extinction. New Jersey, where DDT was heavily used, in part for mosquito control, was no exception. By 1970, only one eagle nest remained in the state. Consequently, the bald eagle was listed as endangered under New Jersey's new Endangered Species Act in 1974 and listed as federally endangered throughout the lower 48 states in 1978.

Management of the state's only nest began in 1982, when biologists began climbing the nest tree to retrieve the thin-shelled eggs. They were then incubated in the lab underneath chickens before being returned to the nest as 10-day-old chicks, which were quickly cared for by the nest's adults. Shortly thereafter, the state launched a "hacking" program through which 60 eaglets, primarily from Canada, were released into the heart of New Jersey's bald eagle habitat between 1983 and 1989. Those efforts, combined with the 1972 federal ban on DDT, paid off rather quickly, with the appearance of the state's second eagle nest in 1988. Since then, biologists also have been successful in encouraging eagles to nest in certain areas by building "starter nests," which eagles add to once they adopt them for nesting (Clark and Niles 1998). Building nests for eagles works best when a pair has already claimed a territory, and the birds may be drawn to a sturdy nest in a super-canopy tree.

Since the second nest appeared, the number of eagle nests has increased steadily ever since. In 2001, a record 27 bald eagle nests were active statewide, mostly in southern New Jersey. A record 34 young fledged that year (Smith et al. 2001).

Barred Owl, *Strix varia*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

© Blaine Rothauser

On still spring evenings, the hooting and eerie caterwauling of barred owls resonate throughout the remote, swampy woodlands of New Jersey. The resounding song of the barred owl, often represented as "who cooks for you, who cooks for you allll," is often accompanied by loud "hoo-ah" calls and yowling reminiscent of monkeys. Barred owls may vocalize throughout the year, but are most expressive during courtship, from late February to early April. These owls often call at night but may also vocalize during the day.

The barred owl is a large fluffy-looking owl with brown barring on the upper breast and brown streaking on the lower breast and belly. The upperparts are brown with buffy-white barring. The tail is patterned with alternating bands of brown and buff-gray. The throat is white and the round head lacks ear tufts. The facial disk is grayish-white with a brown outline. The large facial disk funnels sounds towards the owl's proportionally gigantic ears, providing it with extraordinary hearing for detecting minute noises, such as the rustling of mice in the dark. Unlike all other eastern owls excluding the barn owl, the eyes of the barred owl are dark brown. The hooked bill is buff yellow. The feet and toes are feathered and the talons are dark brownish-black. Sexes are similar in plumage and, although there is much overlap, females may be larger than males. Juveniles resemble adults.

Barred owls fly with slow, moth-like wing beats that are interspersed with glides. In flight, the head appears large and the wings are broad and rounded. Soft feathers and serrated edges on the outer wing feathers minimize noise, enabling these and all other owls to fly silently--an advantage that enables them to surprise their prey.

The barred owl can be distinguished from most other New Jersey owls by its plumage, large size, distinctive vocalizations, and habitat selection. The great horned owl (Bubo virginianus), a common breeding species in the state, is also a large owl but has rich brown plumage and yellow eyes. The ear tufts of great horned owls may not be noticeable in flight, making them appear round-headed like a barred owl. The call of the great horned owl is a melancholy "hoo-hoo-hoo." Great horned owls, which often reside in forested uplands or near human habitation, are less restrictive in their habitat choice than barred owls. The barn owl (Tyto alba), the only other New Jersey owl with dark eyes, is white below and golden brown above. In addition, the barn owl, which resides in

open fields and grasslands, has a narrow body, long unfeathered legs, and a heart-shaped facial disk.

Habitat

Traditionally known as the "swamp owl," the barred owl is a denizen of remote, contiguous, old-growth wetland forests. These owls require mature wet woods that contain large trees with cavities suitable for nesting. Barred owl habitats typically have an open understory through which the owls can fly and hunt. The lack of large nesting cavities is often the primary limiting factor for barred owls. Consequently, these owls may nest immediately outside of a wetland or in sub-climax wetland forests if adequate nest sites are unavailable within a mature wetland forest. Barred owls are typically found in remote wilderness areas that may also contain other rare species such as the red-shouldered hawk (Buteo lineatus) or the Cooper's hawk (Accipiter cooperii). Barred owls typically shun human activity by avoiding residential, agricultural, industrial, or commercial areas. In northern New Jersey, barred owls favored sites that were at least 500 meters (1640 ft.) from human habitation and had little or no forest clearings or trails (Bosakowski 1987).

In southern New Jersey, barred owls inhabit both deciduous wetland forests and Atlantic white cedar (Chamaecyparis thyoides) swamps associated with stream corridors. Often such lowland forests are buffered by surrounding pine or pine/oak uplands that may protect the owls from human disturbance and provide additional foraging habitat. Mixed hardwood swamps are often dominated by red maple (Acer rubrum) and black gum (Nyssa sylvatica) and may include highbush blueberry (Vaccinium corymbosum), swamp magnolia (Magnolia virginiana), or greenbrier (Smilax spp.) in the shrub layer. Although barred owls utilize white cedars for roosting, they infrequently provide cavities that are large enough for nesting owls.

In northern New Jersey, barred owls inhabit hemlock ravines and mixed deciduous wetland or riparian forests. Oak hardwood forests containing white oak (Quercus alba), red maple, black birch (Betula lenta), black willow (Salix nigra), hickory (Carya spp.), white ash (Fraxinus americana), basswood (Tilia americana), tulip poplar (Liriodendron tulipifera), black cherry (Prunus serotina), and black gum may be occupied. Barred owls may also inhabit northern hardwood forests that contain sugar maple (A. saccharum), birch (Betula spp.), and beech (Fagus grandifolia). Dense stands of hemlock (Tsuga canadensis), white pine (Pinus strobus), Norway spruce (Picea abies), or other conifers provide cover for roosting owls and protection from harsh weather. Barred owls prefer flat, lowland terrain and avoid rocky slopes and hillsides.

As a resident species, barred owls establish territories with fairly stable boundaries that are continuously maintained throughout the year. In eastern North America, home range sizes of 86 to 370 hectares (213 to 914 acres) have been documented for barred owls (Johnsgard 1988).

Status and Conservation

The barred owl was traditionally a common resident within the deep wooded swamps of New Jersey. Historically, these owls were shot as trophies or because of alleged poultry predation. Collectors also looted young owls and eggs. Despite human

persecution, the barred owl persisted virtually unscathed until the early 1940s when the cutting of old growth forests and the filling of wetlands greatly reduced habitat throughout the state. Rampant habitat loss and associated barred owl population declines continued for the next several decades. Consequently, these owls were lost from many historic breeding locales.

Due to population declines and habitat loss, the barred owl was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the barred owl to be "demonstrably secure globally," yet "rare in New Jersey" (Office of Natural Lands Management 1992). Currently, barred owl populations appear to be declining due to development and fragmentation of large tracts of private forested lands. The barred owl population has been estimated at 37 pairs in South Jersey and 75 pairs in North Jersey (Sutton and Sutton 1985, Bosakowski 1988). But recent surveys in South Jersey indicate as much as a 30 percent decline there.

Bobcat, *Felis refus*

Status: ***State:*** Endangered ***Federal:*** Not listed

Identification

© Blaine Rothauser

Taxonomically, bobcats belong to the order Carnivora, or carnivores, meaning that they are primarily flesh-eaters. They are members of the Felidae family and are commonly known as felines. All members of this family look somewhat similar in appearance. Bobcats have retractable claws and five digits on each foot. Their pelt color varies throughout different parts of their range within the continental United States. In this part of the country, bobcats generally have a tawny to grayish-brown fur with spots and streaks and a whitish-colored underside that is also spotted and streaked. The fur around their lips, chin and underside of the neck are also light-colored. Bobcats have ruffs of fur on both sides of their face and small tufts on the ears. The top of their short tails is tipped black.

Like all other felines, bobcats have vertically shaped pupils that widen to maximize light reception for nocturnal activity. In addition, they have relatively long legs in relation to their bodies, with the hind legs being longer than the front. This posture accentuates the bobbed tail, which ranges in length from 5-7 in. A mature bobcat is approximately 35 in. in length and 20 in. high at the shoulders. Their weight ranges from about 15-25 lbs. for adult females and 20-35 lbs. for adult males. However, large males can weigh up to 40 lbs.

Habitat

Bobcats are extremely adaptable animals that can survive in a variety of habitats. In our western states they are found in deserts and mountains. In the South they inhabit swamps, river bottoms and forests. In the Northeast they can be found in forests, areas of mixed forest and agriculture and even rural areas near cities and small towns. In general, bobcats use rough, broken habitat that has a mix of early and late successional stages. They do not prosper in highly suburbanized areas or in areas that have been severely altered by intense agriculture. This explains their absence from many Midwest states. However, bobcats can survive in agricultural areas that are interspersed with natural cover if they support adequate prey populations (Godin 1977 and McCord 1977).

Bobcats prefer habitats that provide dense cover in the form of understory vines, briars, shrubs, and saplings (Leopold et al 1995). These cover types provide areas for resting, and protection from both weather and predators (Leopold et al 1995 and Godin

1977). In northern New Jersey, typical bobcat habitat consists of large areas of contiguous forest and fragmented forests interspersed with agricultural areas or early succession vegetation. Bobcats often use areas with rock outcrops, caves, and ledges that provide shelter and cover for hunting, resting and rearing young. Where rocky areas are not available, swamps, bogs, conifer stands and rhododendron and mountain laurel thickets provide good cover and excellent hunting grounds (New Jersey Division of Fish, Game and Wildlife 1995). In southern New Jersey, dense thickets of briars and conifers serve as resting and escape cover (New Jersey Division of Fish, Game and Wildlife 1995). Clearly, bobcats are extremely versatile creatures that have the ability to adapt to a wide variety of habitat types and prey species.

Status and Conservation

The bobcat has been extirpated from much of the Midwest due to habitat changes resulting from modern agricultural practices. It is considered endangered in Iowa, Indiana and Ohio. However, Illinois removed the bobcat from its threatened list in 1999 and Pennsylvania, which had permitted no legal hunting between 1970 and 1999, reinstituted a limited hunting and trapping season beginning in 2000.

In New Jersey, the bobcat population experienced severe declines near the turn of the 19th century as most forests were cleared for lumber, fuel, charcoal and agricultural use. As the remaining habitat became highly fragmented, bobcat numbers plummeted. During the 1950s and 1960s, reports of bobcat sightings and killings persisted, but by the early 1970s it was thought that the feline had been extirpated from the Garden State. The bobcat gained full legal protection under New Jersey regulations in 1972 when it was classified as a game species with a closed season (Lund 1979).

In 1977, the New Jersey Division of Fish, Game and Wildlife initiated a project to restore the species to suitable habitat within the state. Between 1978 and 1982, 24 bobcats were captured in Maine and released in northern New Jersey (James Sciascia, pers. comm. 1997). In the years that followed, reports of bobcat sightings increased, suggesting that the project had been a success. In 1991 the status of the bobcat was changed again to endangered under New Jersey's Endangered and Nongame Species Conservation Act.

The New Jersey Division of Fish and Wildlife's Endangered and Nongame Species Program (ENSP) conducted a scent post survey in 1995 and confirmed bobcat presence in Sussex, Warren, Morris, and Passaic counties. In addition, reliable bobcat sightings have been reported from Mercer, Somerset, Bergen, Burlington, Ocean, Atlantic, Cape May, Cumberland, and Salem counties (Sciascia, pers. comm. 1997).

In 1996, the ENSP began a pilot project using radio telemetry to monitor the movements of bobcats in northern New Jersey. The objective was to determine the bobcats' home range and habitat preferences in that part of the state. The work is continuing, although technological advances now allow biologists to fit bobcats with satellite transmitters. Bobcat locations can now be monitored on a continual basis using satellites.

Bobolink, *Dolichonyx oryzivorus*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

Photo by S. Maslowski, courtesy US FWS

Amid a sea of agriculture, the bubbly "bobo-o-link!" song of the bobolink echoes from within an overgrown weedy field. On a fall day at Cape May, a chorus of "plink" notes is heard overhead as a flock of bobolinks passes above a fallow grassland. These are the song and call of the bobolink, a sparrow-sized member of the blackbird family.

Bobolinks exhibit sexual dimorphism (gender differences) in plumage during the breeding season. The nuptial male is black overall with a creamy nape and hindneck, a white rump, and white scapulars (feathers at the base of the wing). The plumage of the female, which camouflages her during nesting, is relatively drab. The female is buffy with dark brown streaking on the back, sides, and rump and has dark stripes on the head. In non-breeding plumage, adult males resemble females. Immature bobolinks also resemble adult females but are more yellow and lack streaking on the sides of the body. All ages and sexes have a short, finch-like bill and pointed tail feathers.

Habitat

Bobolinks inhabit low-intensity agricultural habitats, such as hayfields and pastures, during the breeding season. In addition, lush fallow fields and meadows of grasses, forbs, and wildflowers are occupied. Bobolink nests are often placed in areas of greatest vegetative height and density. Although small numbers of bobolinks may nest in grasslands of 2 to 4 hectares (5-10 acres), larger sized fields support higher densities of nesting pairs (Jones and Vickery 1997a).

Similar habitats are occupied by bobolinks throughout their annual cycle. During migration, bobolinks inhabit fallow and agricultural fields, as well as coastal and freshwater marshes. On their South American wintering grounds, they occur in grasslands, marshes, rice fields, and farm fields.

Status and Conservation

Historic clearing of forests in the eastern United States during the 1700s and 1800s enabled numerous grassland species to expand their ranges, inhabiting the growing agricultural landscape. As a result, the bobolink became a common breeding species in the hayfields and pastures of New Jersey. However, by the early 1900s, bobolink

population declines were noted in the Northeast. The slaughter of migrant bobolinks in rice fields of the southern United States, market hunting, and modernized farming techniques likely caused this decline. During the 1960s and 1970s, changing agricultural practices, the conversion of fallow fields to forests, and the development of agricultural lands further shrunk bobolink populations in New Jersey.

Modern farming techniques, including frequent rotation of hayfields, early mowing of hay, decreased vegetative diversity, and the change from warm-season to cool-season grasses, have rendered agricultural fields less favorable for nesting bobolinks. In addition, alfalfa (Medicago sativa) fields, which offer poor nesting habitat for bobolinks, have replaced many timothy (Phleum spp.) and clover (Fabaceae) fields. The area of land cultivated as hay fields in the northeastern United States declined from 12.6 to 7.1 million hectares (31.1 to 17.5 million acres) from 1940 to 1986 (Martin and Gavin 1995). During the same period, the percentage of sites where alfalfa replaced hay increased from 20% to 60% (Bollinger and Gavin 1992). Habitat loss is largely responsible for the decline of bobolink populations in the United States and New Jersey detected by the Breeding Bird Survey from 1966 to 1999 (Sauer et al. 2000).

Due to population declines and habitat loss, the bobolink was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the bobolink to be “demonstrably secure globally,” yet “imperiled in New Jersey because of rarity” (Office of Natural Lands Management 1992).

Bog Turtle

Bog Turtle - ***State Endangered Species*** - **Pl.3**
(*Clemmys muhlenbergii*)

Identification: 3" - 4 1/2". A large orange or yellow patch on each side of the head is a key identifying mark of the Bog Turtle. The carapace varies from light brown to black, with each scute on the carapace showing a pattern of concentric circles; large scutes may have a light center. The moderately domed carapace may be rough or smooth, and is weakly keeled along the midline. The hingeless plastron is dark brown to black; may have some yellow in the middle. The limbs are typically brown, but may be flecked with orange.
Where to find them: The Bog Turtle is among the most difficult to find because of its elusive behavior and rarity as a result of habitat destruction. It prefers marshes, wet meadows, and fens featuring plant species such as sedges, rushes, mosses, skunk cabbage, cattail, jewelweed, and smartweed.
When to find them: Mid-April through June as it basks in the sun on sedge tussocks and matted vegetation litter.
Range: Entire state. The greatest numbers occur in the agricultural landscapes of northwestern and southwestern New Jersey.
Conservation Status: Habitat loss, pollution, and illegal collecting have negatively impacted bog turtle numbers in New Jersey. In addition to protecting sites currently occupied by this species, management of suitable bog turtle habitat is important. Such management includes suppression of vegetative succession and controlling undesirable (often exotic) plant species.

Bog Turtle

(*Clemmys muhlenbergii*)
- text pg. 12

Key Features
- **Orange/yellow patch on head.**
- **Carapace: light brown to black.**
- **Plastron: hingeless; dark brown to black.**

NEW JERSEY DIVISION OF Fish and Wildlife

New Jersey Division of Fish and Wildlife ~ 2003

Conserve Wildlife

Excerpt from: Schwartz, V. & D. Golden, "Field Guide to Reptiles and Amphibians of New Jersey". New Jersey Division of Fish and Wildlife 2002.
Order the complete guide at - http://www.state.nj.us/dep/fgw/products.htm

Cooper's hawk, *Accipiter cooperii*

Status: ***State:*** Endangered ***Federal:*** Not listed

Identification

On a cool fall day at Cape May Point, observers scan the skies as streams of accipiters zip past at tree-level. Darting through the cedars in pursuit of a yellow-rumped warbler is a Cooper's hawk, one of the three species of North American accipiters-woodland hawks that prey chiefly on birds. The Cooper's hawk, as well as its accipiter cousins, the sharp-shinned hawk (Accipiter striatus) and the northern goshawk (A. gentilis), are forest-nesting raptors that are able to quickly maneuver through dense cover while chasing prey.

© B.K. Wheeler/ VIREO

About the size of a crow, the Cooper's hawk has short, rounded wings and a long, narrow tail. When soaring, the head extends beyond the wrist, making it appear large-headed. In flight, the silhouette of a Cooper's hawk appears cross-shaped, whereas the similarly plumaged sharp-shinned hawk looks small-headed and T-shaped. Sharp-shinned hawks usually exhibit a shorter, more squared-off tail. In addition, the wing beats of the Cooper's hawk are stiffer and more powerful than the fluttery wing beats of the sharp-shinned hawk.

The adult Cooper's hawk has a dark cap, blue-gray back, and rusty, barred underparts. The juvenile's back is brown with rufous (reddish brown) feather edges and sparse white spotting, and the underparts are light colored with brown vertical streaking on the breast. In all ages, the tail is usually rounded and has a white edge along the tip. Juveniles molt into adult plumage during their second year. Eye color changes from yellow-green in immature birds to dark orange or red in adults. Females are significantly larger than males. The call of the Cooper's hawk, which is often given during the breeding season, is a loud and nasal "cak-cak-cak."

Habitat

During the breeding season, Cooper's hawks inhabit deciduous, coniferous, and mixed riparian or wetland forests. In southern New Jersey, breeding habitats include large, remote red maple (Acer rubrum) or black gum (Nyssa sylvatica) swamps and, on occasion, Atlantic white cedar (Chamaecyparis thyoides) swamps. Within these sites, high-bush blueberry (Vaccinium corymbosum) and greenbrier (Smilax rotundifolia) typically dominate the shrub layer. Adjacent upland pine or mixed pine/oak forests

provide an additional habitat buffer for nesting Cooper's hawks. In northern New Jersey, Cooper's hawks inhabit mixed riparian woodlands, eastern hemlock (Tsuga canadensis) / white pine (Pinus strobus) forests, and conifer plantations. Dominant tree species within such habitats may include red maple, sugar maple (Acer saccharum), eastern hemlock, white pine, black birch (Betula lenta), white oak (Quercus alba), scotch pine (Pinus sylvestris), and Norway spruce (Picea abies).

Cooper's hawk nest sites are often located within sub-climax forests that provide a closed canopy, moderate to heavy shrub cover, and trees more than 30 years old. Territories often contain forest edges and small openings along streams or roads, which may be used for hunting. In northern New Jersey, Cooper's hawk territories contained over 70% forested habitat within 0.3 km (0.2 miles) of nest sites and were, on average, 0.5 km (0.3 miles) away from the nearest house (Bosakowski et al. 1993). Home ranges of breeding Cooper's hawks in the United States may comprise 105 to 1,800 hectares (260 to 4,450 acres) (Johnsgard 1990, Rosenfield and Bielefeldt 1993).

During the 1970s, when the Cooper's hawk was first listed as an endangered species in New Jersey (1974), breeding was documented only within large, contiguous forests. As the Cooper's hawk population increased, pairs have nested in smaller woodlots containing mature trees and fragmented woods within agricultural, suburban, or urban landscapes. This may be attributed to both a larger breeding population and increased fragmentation of forested habitats. Cooper's hawks may exhibit limited tolerance for human disturbance and habitat fragmentation.

Cooper's hawks, which occur year-round in New Jersey, use many of the same habitats in winter as during the breeding season. However, because of limited prey availability during the winter months, habitat use during this season is less restrictive than during the breeding season. Consequently, Cooper's hawks forage within a variety of forest types as well as woodland edges. Wintering hawks may also frequent residential areas where they hunt songbirds and doves at bird feeders. Cedar forests, conifer groves, and other dense woods that provide protection from harsh weather are favored for roosting.

Status and Conservation

Until the mid-1930s, many raptor species, including the Cooper's hawk, were shot in large numbers during migration and on their breeding grounds because of suspected poultry and game bird predation. Regardless, the Cooper's hawk remained a fairly common breeding species in New Jersey's forests until the 1950s when habitat loss caused population declines. In addition, the pesticide DDT impaired reproduction and contributed to population declines observed from the 1950s to 1970s. Due to the reduction in the state's breeding population and the loss of habitat, the Cooper's hawk was listed as an endangered species in New Jersey in 1974. The New Jersey Natural Heritage Program considers the Cooper's hawk to be "apparently secure globally," yet "rare in the State (breeding)" (Office of Natural Lands Management 1998). Concern for this species is evident in nearby states, such as New Hampshire, Rhode Island, and Connecticut, where it is listed as threatened, and Massachusetts and New York, where it is considered a species of Special Concern. The National Audubon Society also included the Cooper's hawk on its Blue List of Imperiled Species from 1971 to 1982 and in 1986, the final year of the list.

Following the nationwide ban of DDT in 1972 and the reforestation of fallow lands throughout the state, Cooper's hawk populations began to recover. Cooper's hawks experienced increases in New Jersey Christmas Bird Counts from 1959 to 1988 and Breeding Bird Surveys from 1980 to 1999 (Sauer et al. 1996, Sauer et al. 2001). Other recent surveys have also shown a substantial increase in the breeding population of Cooper's hawks in New Jersey. As a result, the status of the Cooper's hawk was reclassified from endangered to threatened in New Jersey in 1999. The loss of large, contiguous forests remains a threat to this species and warrants the continued protection of Cooper's hawk nesting habitats.

Northern Copperhead

Northern Copperhead - *VENOMOUS* - Pl.19

(*Agkistrodon contortix mokasen*)

Identification: 22" - 53". The Copperhead, with its red-brown ground color and darker crossbands, is easily camouflaged in the leaf litter of a forest floor. The dark brown, saddle-shaped crossbands are narrow on top and wide on the sides. The Copperhead has scattered dark spots in lighter areas. As the name indicates, the triangular, unmarked head is a copper color. The young have a yellow tail tip. Scales are weakly keeled; anal plate is single.
Where to find them: Favors rocky, wooded uplands and wooded wetlands; may be found hiding in rotting woodpiles, or perfectly camouflaged on leafy forest floor. The Copperhead will den with other species of snakes in the winter, particularly the Timber Rattlesnake.
When to find them: Active May through October.
Range: Rocky talus slopes and forest habitats in the Northern Region. These habitats are scattered throughout the Northern Region, but are primarily located in Sussex, Warren, Hunterdon, and Passaic Counties.

WARNING: Do NOT attempt to handle this snake!

Northern Copperhead - VENOMOUS!
(Agkistrodon contortix mokasen)* - *text pg. 28

Key Features
- **Coppery-red head.**
- **Dark "hourglass" shaped bands that are wider on sides than top (compare with water snake - Pl. 10).**
- **Shovel-shaped head.**
- **Vertical pupils and facial pit.**
- **Scales weakly keeled.**

NEW JERSEY DIVISION OF Fish and Wildlife

New Jersey Division of Fish and Wildlife ~ 2002

Conserve Wildlife

Excerpt from: "Field Guide to Reptiles and Amphibians of New Jersey"
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Eastern Box Turtle

Box Turtles are known for their ability to hide in their shells, closing the doors to all threats. New Jersey has one species of Box Turtle, the Eastern Box Turtle.

Eastern Box Turtle (*Terrapene carolina carolina*) - Pl.4

Identification: 4 " - 8 1/2". The combination of the high, domed, weakly keeled carapace, and the hinged plastron that can tightly close front and back, make the Eastern Box Turtle distinct from all other turtles in New Jersey. The carapace and plastron have yellow, orange, olive or tan markings on a brown or black background; different animals may show relatively more dark or light coloration. The Eastern Box Turtle has a hooked upper jaw, and four toes on each hind foot. The male has a central concave area in the rear lobe of the plastron, while the female has a flatter or more convex plastron. Most males have red eyes; females have yellow-brown eyes. Young have flatter, less ornate shells.
Where to find them: The Eastern Box Turtle is our most terrestrial species. It prefers woods and meadows. In hot, dry weather it may be found in muddy areas or shallow pools, or hiding under rotten logs or other decaying vegetation.
When to find them: Active April through September.
Range: Entire state.

Eastern Box Turtle

(*Terrapene carolina carolina*)
- text pg. 13

Key Features
- **Carapace: highly domed and weakly keeled.**
- **Plastron: hinged.**
- **The carapace & plastron both have yellow, orange, olive, or tan markings on a brown or black background.**

New Jersey Division of Fish and Wildlife ~ 2003

Excerpt from: Schwartz, V. & D. Golden, "Field Guide to Reptiles and Amphibians of New Jersey". New Jersey Division of Fish and Wildlife 2002.
Order the complete guide at - http://www.state.nj.us/dep/fgw/products.htm

Grasshopper Sparrow, *Ammodramus savannarum*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

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A small, secretive songbird, the grasshopper sparrow is more often heard than seen as its insect-like melody emits from dense grasses. Its song consists of one to two chips followed by a buzzy trill reminiscent of a grasshopper. This sparrow also sings a series of buzzy notes.

The grasshopper sparrow has a stocky body that is brown above with buff streaking. On adults, the breast and sides are solid buff and the belly is white. The buff breast and sides of juveniles are marked with dark brown vertical streaking. Grasshopper sparrows have flat heads with relatively large bills. The crown is dark brown with light central stripes atop the head and behind the eye. The lores (between the eyes and the bill) are orange or golden. The tail is short and brown.

Habitat

Grasshopper sparrows breed in grassland, upland meadow, pasture, hayfield, and old field habitats. Nesting grasshopper sparrows may occur on agricultural lands and airports where such habitats occur. Although grasshopper sparrows may use small grasslands, open areas of over 40 hectares (100 acres) are favored. Optimal habitat for these sparrows contains short- to medium-height bunch grasses interspersed with patches of bare ground, a shallow litter layer, scattered forbs, and few shrubs. Clumped grasses, such as poverty grass (Danthonia spicata) and broom-sedge (Andropogon virginicus), provide cover and foraging areas and are consequently favored over sod or matting grasses. In addition, orchardgrass (Dactylis glomerata), alfalfa (Medicago sativa), red clover (Trifolium pratense), lespedeza (Lespedeza spp.), and dewberry (Rubus spp.) provide sparrow habitat. Shrubs, fence posts, and tall forbs are used as song perches. However, habitats may become unsuitable for nesting grasshopper sparrows if shrub cover becomes too dense. Consequently, the presence and density of grasshopper sparrows at breeding sites varies annually due to habitat changes. Habitat use during the nonbreeding season is similar, although less restrictive, to that of the breeding season, as these sparrows may inhabit thickets, weedy lawns, vegetated landfills, fence rows, open fields, or grasslands.

Status and Conservation

In the eastern United States, the historic distribution of grasshopper sparrows was restricted to natural grasslands created by fires or flooding. However, the boom in agriculture during the late 1800s and early 1900s enabled this species to spread its range and increase in numbers, making it a fairly common breeder in New Jersey. By the 1950s and 1960s, expanding development of open areas, coupled with dwindling acreage of land devoted to farming or pasture, led to decreases in grasshopper sparrow populations. Continued declines in the northeast were noted in the 1970s and 1980s, when the species was considered locally distributed and uncommon. The number of grasshopper sparrows detected on Breeding Bird Survey routes in New Jersey, the eastern United States, and throughout the country declined from 1966 to 1999 (Sauer et al. 2000).

As the result of population declines and severe habitat loss, the grasshopper sparrow was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers this species to be "apparently secure globally," yet "imperiled in New Jersey because of rarity" (Office of Natural Lands Management 1992). Currently, grasshopper sparrows occur in small, localized, and unstable populations in the Northeast. Consequently, other nearby states have listed this species as endangered (Maine, Connecticut), threatened (Massachusetts, Rhode Island), or of special concern (New York). In New Jersey, the survival of grasshopper sparrows is critically linked with management practices for grassland birds on airports, agricultural lands, and pastures.

Jefferson Salamander

Jefferson Salamander (*Ambystoma jeffersonianum*) - Pl.21

Identification: 4 1/4" - 8 1/4". Ground color of this slender salamander is dark brown or gray; the underside is lighter than the sides. The limbs and lower sides of the body are usually marked by tiny bluish-gray speckles. These speckles are bright on young individuals, but fade with age. The Jefferson Salamander closely resembles the Blue-spotted Salamander, but the Jefferson Salamander has a gray area around the vent while the Blue-spotted has a black area around the vent. Also, the snout is wider and extends further forward in the Jefferson Salamander than in the Blue-spotted Salamander.
Where to find them: The Jefferson Salamander breeds in vernal pools located in upland deciduous forests.
When to find them: Breeds in late winter and early spring.
Range: Northern Region: Sussex, Warren, Hunterdon, Morris, Passaic, and Bergen Counties.
Note: The Jefferson and Blue-spotted Salamanders hybridize over most of the Northern Region. Within this area, colors and patterns may vary greatly among hybrids and their parents, and definite identification to either species is extremely difficult. The Audubon guide, although inaccurate in the description of the hybrids' breeding biology, has good examples of how some of these hybrids might look (see plates for Tremblay's Salamander and Silvery Salamander). Genetic analysis is the only method that can definitively distinguish hybrids.

Jefferson Salamander

(*Ambystoma jeffersonianum*) - *text pg. 30*

Key Features
- **Long toes and body with a gray to dark brown base color.**
- **Belly paler than sides.**
- **Juveniles may have blueish-white flecks on body.**

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MUSSELS

FRESHWATER MUSSELS:

Dwarf wedgemussel, *Alasmidonta heterodon*

Status: ***State:*** Endangered ***Federal:*** Endangered

Brook floater, *Alasmidonta varicosa*

Status: ***State:*** Endangered (pending) ***Federal:*** Species of Special Concern

Green floater, *Lasmigona subviridis*

Status: ***State:*** Endangered (pending) ***Federal:*** Species of Special Concern

Yellow lampmussel, *Lampsilis cariosa*

Status: ***State:*** Threatened (pending) ***Federal:*** Species of Special Concern

Eastern lampmussel, *Lampsilis radiata*

Status: ***State:*** Threatened (pending) ***Federal:*** Not listed

Eastern pondmussel, *Ligumia nasuta*

Status: ***State:*** Threatened (pending) ***Federal:*** Not listed

Tidewater mucket, *Leptodea ochracea*

Status: ***State:*** Threatened (pending) ***Federal:*** Not listed

Triangle floater, *Alasmidonta undulata*

Status: ***State:*** Threatened (pending) ***Federal:*** Not listed

Identification

All freshwater mussels have a calcium carbonate bivalve shell that is divided into a left and right half. The shell consists of three layers; the outer periostracum, the middle calcium carbonate, and the inner nacre. The periostracum (or epidermis) protects underlying calcium carbonate from the corrosive action of low pH water and damage from moving sand and gravel. A thin prismatic layer of crystalline calcium carbonate lies beneath the periostracum. The nacre or mother-of-pearl is the innermost and often thickest layer of the shell. It is comprised of thin, stacked calcium carbonate plates that lie parallel to the shell's surface. In many species, the color and texture of the nacre are important for identification.

Lateral and pseudocardinal teeth, separated by an interdentum, are located dorsally inside the shell. Lateral teeth are elongated and raised interlocking structures along the hinge line of a valve, whereas pseudocardinal teeth are triangular-shaped hinge teeth near the shell's anterior-dorsal margin. The interdentum is a flattened area of the hinge plate between the lateral and pseudocardinal teeth. The three points of apposition, which are taxonomically important in most species, serve to hold the two valves together. Some groups entirely lack lateral and pseudocardinal teeth. The umbo or beak is the dorsally raised, inflated area of the bivalve shell. Representing the oldest part of the shell, umbones appear as external swellings and are often points of taxonomic significance.

The valves are held closed by internal mussels. Empty shells show scars of former mussel attachment areas. Freshwater mussels have a large, muscular foot that extends between the valves and functions in locomotion and anchorage. The anterior and posterior retractor muscles draw the foot into the shell, while the anterior protractor helps in foot extension. Large anterior and posterior abductors draw the shell together.

Habitat

New Jersey's Endangered and Threatened Freshwater Mussel Species:

The **dwarf wedgemussel** is a rare freshwater mussel with a trapezoid-to-ovate or "humpbacked" shell rarely exceeding 1.5 in. in length. It is characterized by having two lateral teeth on the right valve of the shell, but only one on the left (thus the species name *heterodon*). The ventral margin is mostly straight. The beaks are low and rounded, projecting only slightly above the hinge line. The periostracum, or outer shell, is dark brown or yellowish brown and often exhibits greenish rays in young mussels. The nacre, or inner shell, is bluish or silvery white.

The dwarf wedgemussel once existed in 70 localities within 15 major Atlantic slope drainage basins from New Brunswick, Canada to North Carolina (U.S. Fish and Wildlife Service 1993). Today however, this species is thought to be extirpated from all but approximately 30 small sites in New Hampshire, Vermont, Maryland, North Carolina, New York, Connecticut, Virginia, and New Jersey.

In New Jersey, the dwarf wedgemussel historically inhabited areas of the Delaware, Hackensack, and Passaic rivers. These populations, however, are thought to

be extirpated because of water quality degradation and other factors. There are only three known active state occurrences of this elusive species; the Paulins Kill, Pequest River, and a portion of the upper Delaware River.

Preferred habitat of the dwarf wedgemussel ranges from muddy sand to sand and gravel/pebble bottoms in rivers and creeks with slow to moderate current. Favoring clean and relatively shallow water with little silt deposition, this species is known to co-occur with other freshwater mussels such as the eastern elliptio (*Elliptio complanata*), triangle floater (*Alasmidonta undulata*), creeper (*Strophitus undulatus*), eastern floater (*Pyganodon cataracta*) and eastern lampmussel (*Lampsilis radiata*).

Fish species identified as suitable hosts for the dwarf wedgemussel include the tessellated darter (*Etheostoma olmstedi*), mottled sculpin (*Cottus bairdi*) and Johnny darter (*Etheostoma nigrum*, not found in N.J.) (Michaelson and Neves 1995).

The **brook floater** has a small, kidney-shaped shell that is slightly thicker towards the anterior. There is a conspicuous posterior slope with wavy ridges perpendicular to the growth lines. The ventral margin is straight and slightly concave centrally. The outer shell color ranges from yellowish brown to dark brown and the nacre is a glossy bluish-white to orange in the umbo region. The pseudocardinal teeth exist as weak knobs and lateral teeth are absent. The species has a bright orange to pinkish foot.

The brook floater ranges from the Savannah River Basin in South Carolina north to the St. Lawrence River Basin in Canada and west to the Ohio River Basin of West Virginia. In New Jersey, there are reported occurrences in the Stony Brook, Musconetcong, Raritan, Lamington and upper Delaware rivers.

Habitat of the brook floater includes rapids or riffles on rock and gravel substrates. The species prefers small streams and is commonly associated with the eastern elliptio (*Elliptio complanata*) (Clarke 1981). Reported host fishes for the species that occur in New Jersey include the slimy sculpin (*Cottus cognatus*), longnose dace (*Rhinicthys cataractae*), golden shiner (*Notemigonus crysoleucas*) and pumpkinseed (*Lepomis gibbosus*).

The **green floater** is a small, rare mussel with an ovate trapezoid shell that is fragile and thin. The posterior ridge is rounded. The outer shell is light yellow or brown with many green rays, especially in juveniles. The pseudocardinal and lateral teeth are small and delicate. The beak cavity is shallow. The nacre can be white to blue and is iridescent towards the posterior end.

Photo courtesy North Carolina Wildlife Resources Commission

The green floater can be found from the Cape Fear River Basin in North Carolina north to the Hudson River Basin and westward to St. Lawrence River Basin in New York. In New Jersey, the species once occurred in the Passaic, Raritan, Delaware, and Pequest rivers, but is now represented by a single known individual in the Stony Brook in Mercer County.

This species can be found in smaller streams, most often in pools and eddies with gravelly and sandy bottoms (Ortmann 1919). It is averse to strong currents (Clarke

1985). The host fish is not known. There is some evidence that the green floater may not require a host fish in order to complete its life cycle (Barfield and Watters 1998, Lellis and King 1998).

The **yellow lampmussel** has a medium-sized shell, with males elliptical and somewhat elongate and females more ovate. Shells are moderately inflated and thick. The anterior margin is rounded and the ventral margin is slightly curved. The umbos are swollen and raised above the hinge line. The pseudocardinal teeth are compressed and the beak cavity is somewhat deep. The periostracum is smooth, shiny and usually yellow with brown patches. The nacre is white to bluish white. There may be green or black rays on the posterior slope.

Photo courtesy North Carolina Wildlife Resources Commission

The species ranges from Georgia to the Lower Ottawa River Canada and eastward to Nova Scotia. New Jersey occurrences of the yellow lampmussel are restricted to the Delaware River.

The yellow lampmussel prefers large rivers that drain more than 1,200 sq. Km (Strayer 1993), and is often found in sand/silt substrates. Although the host fish has not been identified, a migratory species such as the alewife is the suspected host.

Shells of the **eastern lampmussel** are elliptical and have a rounded posterior ridge. The posterior and anterior ends are rounded and swollen umbos extend above the hinge line. The periostracum is brown and extensively rayed. The nacre is white and may be tinged with pink or salmon. This species has long lateral teeth and two pseudocardinal teeth on the left and right valves.

Photo courtesy North Carolina Wildlife Resources Commission

The eastern lampmussel ranges from South Carolina north to the St. Lawrence River Basin. In New Jersey, the species is known from locations in the Ramapo, Pequannock, and Wallkill rivers.

The eastern lampmussel is found in a variety of habitats. It is reported to prefer medium to coarse sands. The host fish is unknown.

The **eastern pondmussel** can be distinguished by its bluntly pointed posterior and distinctive posterior ridge. The shells are elongate and twice as long as wide. The dorsal margin is straight and the ventral margin (the side that opens) is curved. The beaks are low and located in the anterior quarter of the shell. The lateral teeth are long and straight. The pseudocardinal teeth are compressed. The nacre is white, but can also vary

Photo courtesy North Carolina Wildlife Resources Commission

from an iridescent blue to salmon. The periostracum is greenish yellow to dark olive or brown.

The eastern pondmussel occurs from Cape Fear River Basin, North Carolina, to the St. Lawrence River Basin, Canada, and westward through northern parts of the continent's Interior Basin. In New Jersey, the species can be found in the Delaware River and several of its tributaries.

The eastern pondmussel is often associated with tidewaters. The host fish is unknown.

The **tidewater mucket** appears similar to the yellow lampmussel. The shell is small; males are elliptical and females are ovate, subinflated and thin. The anterior end is rounded; the posterior margin is evenly rounded, somewhat pointed in males and truncated in females. The beaks are moderately swollen, raised above the hinge line, and are located near the middle of the shell. The periostracum is yellow to brown or olive green and is often covered with fine green rays. The pseudocardinal teeth are compressed; the lateral teeth are short and curved. The beak cavity is shallow and the nacre is bluish-white and sometimes pink.

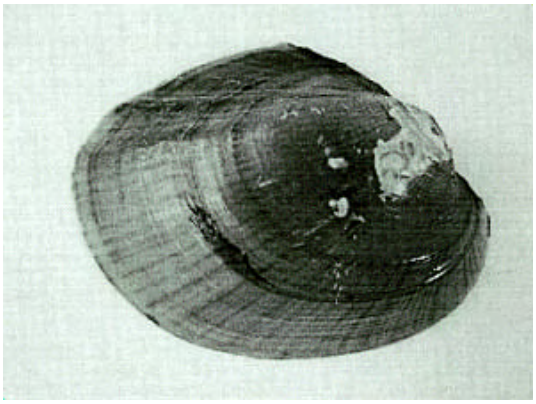

Photo courtesy North Carolina Wildlife Resources Commission

The tidewater mucket ranges from the Savannah River Drainage Basin in Georgia north into Nova Scotia. In New Jersey, the species occurs in the Delaware River.

This species is associated with tidewaters and can be found in sand/silt substrates. The host fish is undetermined.

The **triangle floater** is a small, ovate to triangular shaped mussel. The lateral teeth are absent, but there is an interdental projection in the left valve. The pseudocardinal teeth are large and well-developed. The periostracum is yellowish-green to black and is extensively rayed. The nacre is pinkish-salmon posteriorly and whitish on the anterior portion.

The triangle floater is a generalist and can be found in a variety of stream and river habitats. The host fish is not determined.

Status and Conservation

The dwarf wedgemussel is afforded protection through federal and state Endangered Species acts, federal and state Clean Water acts, Flood Hazard Area Control Act rules (stream encroachment), and environmental reviews of proposed development projects. The other species listed above are scheduled to be listed as state endangered or threatened in late 2001/early 2002. Federal and state Clean Water acts, stream encroachment rules, environmental reviews of proposed development projects and the state Endangered Species Act will serve to help protect existing populations.

Northern Spring Salamander

Northern Spring Salamander - Pl.26

(*Gyrinophilus porphyriticus porphyriticus*)

Identification: 4 1/4" - 8 5/8". The Northern Spring Salamander has a reddish coloration—typically either pink/orange or light brown with a reddish tinge. Darker markings form a faintly mottled or netlike pattern, but this mottling is not always obvious. Older individuals are darker. A faint light line bordered by a faint gray line runs from eye to tip of snout. The tail is keeled.
Where to find them: Found in cool mountain streams and shaded seepages.
When to find them: Active April through September.
Range: Northern Region: undeveloped mountainous habitat of Warren, Sussex, and Passaic Counties.

Northern Spring Salamander

(*Gyrinophilus porphyriticus porphyriticus*) - *text pg. 35*

Key Features
- **Brownish-pink to red ground color.**
- **Light line running from eye to nostril.**
- **Scattered black spots on belly & throat.**

New Jersey Division of Fish and Wildlife ~ 2002

Red-headed woodpecker, *Melanerpes erythrocephalus*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

Photo courtesy NJ ENSP

The red-headed woodpecker is a robin-sized bird, readily distinguished by its vibrant black, white, and red plumage. Brilliant red cloaks the head, neck, and throat and is separated from the white breast by a thin black border. The belly, undertail coverts, and rump are white, contrasting with the black tail, back, and upperwing coverts. White inner secondaries and tertials adjacent to black outer secondaries and primaries (flight feathers) form a white patch on the inner wing that is conspicuous in flight.

Though they lack the striking plumage of adults, juvenile red-headed woodpeckers are similarly patterned. The head and wings of juveniles are brown and the white belly has a variable amount of brown streaking. The back is brown with dark brown barring and the white wing patch is also marked with dark barring. During their first fall and winter, juveniles molt into adult plumage.

Although the male is slightly larger, the sexes are indistinguishable by plumage. On all ages and sexes, the iris is brown and the legs are gray. The chisel-shaped bill is heavy and colored blue-gray. Like other woodpeckers, the red-headed has zygodactyl feet, in which two toes point forward and two point backward, enabling it to cling vertically to trees. In addition, the tail feathers are stiff and pointed, serving to prop the woodpecker up against a tree. Red-headed woodpeckers fly low over the ground in an undulating manner. The call of the red-headed woodpecker is a repeated "qweer".

Habitat

Red-headed woodpeckers inhabit open woods, both upland and wetland, that contain dead or dying trees and sparse undergrowth. Such habitat is often created by disturbances such as fire, flooding, or insect outbreaks. A sparse understory is favored for foraging and dead or dying trees are required for nesting. Red-headed woodpeckers occupy similar habitats throughout the year, seeking wintering sites such as open riparian or pine forests and orchards that contain nut and mast producing trees.

In southern New Jersey, typical red-headed woodpecker nesting sites include upland oak or mixed oak/pine forests that contain both living and dead trees. Pitch pine (Pinus rigida), white oak (Quercus alba), and red oak (Q. rubra) are often found in the overstory and lowbush blueberry (Vaccinium vacillans) or huckleberry (Gaylussacia spp.) dominate the ground cover. In northern New Jersey, red-headed woodpeckers breed in open upland forests, beaver marshes, or wetland forests associated with floodplains or

swamps. Such wetland habitats, which often provide an abundance of dead trees, may contain oak (Quercus spp.), hickory (Carya spp.), elm (Ulmus spp.), and hackberry (Celtis occidentalis) in the overstory and sedge (Carex spp.) on the ground.

Status and Conservation

During the late 1700s and 1800s, the red-headed woodpecker was a common and widespread species in the Northeast. In the 1870s and 1880s, large concentrations of these birds, including flights of several hundred, were observed during fall migration at New York and Long Island, where it is now an uncommon migrant. Stone (1965) stated that the red-headed woodpecker was a rare fall migrant at Cape May, with only one to two records, on average, per year. Currently, an average of eight per season is observed each fall at Cape May (Sibley 1997). This apparent increase in the number of birds recorded at Cape May is likely due to increased coverage by birders rather than an actual increase in red-headed woodpecker populations. Stone (1908) also described the red-headed woodpecker as a rare breeder in south Jersey that was "never found in the Pine Barrens." However, this again may reflect a lack of coverage during historic times.

By the turn of the 20th century, red-headed woodpeckers had suffered population declines due to road mortality, competition with European starlings for nesting cavities, and harvesting for the millinery trade in which populations of many avian species were greatly reduced to provide feathers for women's hats. Farmers at this time also killed red-headed woodpeckers because they damaged fruit and berry crops. Further population declines resulting from habitat loss, limited availability of nesting sites, and road mortality were noted from the 1930s to the 1970s. Red-headed woodpeckers experienced declines survey-wide on Christmas Bird Counts from 1959 to 1988 (Sauer et al. 1996). The Breeding Bird Survey detected annual declines of red-headed woodpeckers in New Jersey and the northeast from 1966 to 1999 (Sauer et al. 2001). Currently, the species is considered to be rare in the Northeast.

Due to population declines, the red-headed woodpecker was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the red-headed woodpecker to be "demonstrably secure globally," yet "imperiled in New Jersey because of rarity" (Office of Natural Lands Management 1998). Loss of breeding habitat and regional population declines in areas such as New Jersey and New York led the National Audubon Society to include the red-headed woodpecker on its Blue List of Imperiled Species in 1972 and from 1976 to 1981 (Arbib 1975, Tate 1986). In addition, the National Audubon Society has recognized the red-headed woodpecker as a species of special concern since 1982 (Tate 1986).

Red-shouldered Hawk, *Buteo lineatus*

Status: ***State:*** Endangered (breeding population), Threatened (nonbreeding population)
Federal: Migratory Nongame Bird of Management Concern

Identification

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The red-shouldered hawk is a crow-sized buteo, or soaring hawk. The adults are strikingly plumed, with rufous (brownish red) shoulder patches and a rufous barred breast. Rufous lesser and median upperwing coverts form the "red shoulders" evident on this species. The flight feathers of adults are barred black and white and show a white crescent-shaped window across the primaries, which is visible in flight. The underparts, which are rufous with white barring, often exhibit thin, dark streaks on the chest. The head and back are dark brown. The black tail is bisected by several narrow white bands. Although females average slightly larger than males, plumage is similar for both sexes. The call of the red-shouldered hawk is a series of nasal drawn-out "aahhh" cries.

Juvenile red-shouldered hawks can be distinguished from adults by their overall browner, less brilliant plumage. The shoulder patches of juveniles are paler rufous and the crescents across the primaries are tawny. The underparts are whitish with variable amounts of brown streaking. The tail is brown with several thin pale bands. Adult plumage appears in the second year.

The red-shouldered hawk is a long-tailed buteo with squared-off wings and a protruding head. Characterized by quick choppy wingbeats interspersed with short glides, the flight style of this hawk is similar to that of an accipiter. When soaring, most buteos hold their wings straight out, whereas the red-shouldered hawk bows its wings forward.

Habitat

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. Consequently, breeding barred owls (Strix varia) and Cooper's hawks (Accipiter cooperii) are often found in habitats containing red-shouldered hawks.

Red-shouldered hawks select large deciduous and, to a lesser extent, coniferous trees for nesting. Nests have been documented in oak (Quercus spp.), pine (Pinus spp.), maple (Acer spp.), ash (Fraxinus spp.), beech (Fagus grandifolia), birch (Betula spp.),

basswood (Tilia americana), chestnut (Castanea dentata), hemlock (Tsuga canadensis), elm (Ulmus spp.), cherry (Prunus spp.), hickory (Carya spp.), and tulip poplar (Liriodendron tulipifera). Forest characteristics include a closed canopy of tall trees, an open subcanopy, and variable amounts of understory cover.

Red-shouldered hawks inhabit wetland forest types unique to the different physiographic regions throughout northern and southern New Jersey. In north Jersey, they occupy riparian forests, wooded wetlands, beaver meadows, and mesic (slightly moist) lowland forests. Within the Pequannock Watershed, red-shouldered hawks are found in stream bottomlands and coniferous or mixed forests containing eastern hemlock or white pine (Pinus strobus). Nests are predominately located in wilderness areas where there are abundant wetlands, small forest openings, and limited areas of large open water such as lakes. In the Pequannock Watershed, red-shouldered hawks avoid areas of human inhabitation, steep uplands, dry slopes, open water, areas with limited conifers, and areas with too many or too few forest openings. Although red-shouldered hawks require extensive tracts of forested habitat for nesting, territories may also contain edges where the birds forage.

The majority of red-shouldered hawk nests in southern New Jersey are contained within vast contiguous freshwater wetlands. Hardwood or mixed hardwood/cedar swamps containing red maple (Acer rubrum), black gum (Nyssa sylvatica), sassafrass (Sassafras albidum), sweetbay magnolia (Magnolia virginiana), and Atlantic white cedar (Chamaecyparis thyoides) are occupied by red-shouldered hawks. Often, such large forested tracts are surrounded by oak/pine forests or agricultural fields. Although red-shouldered hawks nest in large contiguous tracts of wet old growth forests in Cumberland County, they occupy younger wet woods, often on private property safeguarded from high levels of human activity, in Cape May County.

An-area sensitive species, the red-shouldered hawk typically nests away from residences, roads, and development. In the Pequannock Watershed, red-shouldered hawk nests were located an average of 1,013 m and a standard deviation of plus or minus 614 m (3,324 ± 2,014 ft.) from the nearest building; and an average of 812 m and a standard deviation of plus or minus 634 m (2,664 ± 2,080 ft) from the nearest road (Bosakowski et al. 1991). Red-shouldered hawks avoid small fragmented woodlots and forests that do not contain trees large enough for nesting.

Red-shouldered hawks require large contiguous wooded tracts of 100 to 250 hectares (250 to 620 acres) (Johnsgard 1990). Eastern populations occupy breeding home ranges of 109 to 339 hectares (270 to 838 acres) (Crocoll 1994). In the Pequannock Watershed, red-shouldered hawk breeding densities were estimated at one nest per 450 hectares (1,112 acres) with an average distance of 1.2 to 1.6 km (0.75 to 1.0 mi.) between nests in areas containing the highest breeding concentrations (Bosakowski et al. 1991). Home range sizes of males exceed those of females, during both the breeding and nonbreeding seasons. Individuals of either sex may expand their home ranges while rearing young or throughout the winter months.

During the nonbreeding 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.

Status and Conservation

The red-shouldered hawk was once considered a common resident of wet lowland forests in New Jersey. Only a century ago, bounties were placed on birds of prey, which were accused of poultry and game predation. This unfortunate practice, coupled with egg collecting and the placement of wild red-shouldered hawks in captivity, may have caused initial population declines. The clearing of forests and filling of wetlands exacerbated red-shouldered hawk declines, which were noted as early as the mid-1920s. Reduced numbers of red-shouldered hawks wintering in New Jersey were documented from the early 1950s to the 1970s, as development increased and forest contiguity and patch size decreased. As a result, the red-shouldered hawk, with an estimated 100 breeding pairs in the state, was listed as a threatened species in New Jersey in 1979. In 1982, the U.S. Fish and Wildlife Service listed the red-shouldered hawk as a Migratory Nongame Bird of Management Concern due to population declines and restricted habitat requirements. In addition, the red-shouldered hawk was included on the National Audubon Society's Blue List of Imperiled Species from 1972 to 1986, the final year of the list.

During the 1980s, habitat loss continued to pose an increasing threat, causing red-shouldered hawk populations to decline ever further. By the late 1980s and early 1990s, the state's breeding population was estimated at only 36 pairs, nearly one-third the population size at the time of original listing. As a result, the breeding population of the red-shouldered hawk was reclassified as endangered in 1991. The nonbreeding population remained listed as threatened. The New Jersey Natural Heritage Program considers the red-shouldered hawk to be "demonstrably secure globally," yet "imperiled in New Jersey because of rarity" (Office of Natural Lands Management 1992). Habitat loss and declines of red-shouldered hawks in the Northeast have resulted in the listing of this species as threatened in New York and of special concern in Connecticut.

Savannah Sparrow, *Passerculus sandwichensis*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

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The savannah sparrow is a small drab sparrow that is brown above and white below with brown streaking on the breast and sides. The back, nape, and crown are also patterned with variable amounts of dark brown streaking. There is a beige wing bar and the tail is short, brown, and notched. The head is brown with an obscure white crown stripe, a dark brown malar (mustache) stripe, yellow lores (between the eyes and the bill) and eyeline, and a white throat. The legs and feet are pink and the bill is a light pinkish-horn color. The sexes are similar in plumage. Juveniles resemble adults, but are buffer colored with more streaking.

The savannah sparrow closely resembles the song sparrow (Melospiza melodia). However, the song sparrow lacks yellow lores, has a longer, rounded tail, and its streaking forms a distinctive spot on the upper breast. The Ipswich sparrow (P. sandwichensis princeps), a race of savannah sparrow that breeds on Sable Island, Nova Scotia and winters along the Atlantic Coast, is larger and paler than the typical eastern race of savannah sparrow (P. sandwichensis savanna).

The song of the savannah sparrow consists of two to three chips followed by two buzzy trills. The insect-like melody is represented as, tsit tsit tsit, tseee tsaay. The call is a mild tsip.

Habitat

Indigenous to open habitats, the savannah sparrow nests in hay and alfalfa fields, fallow fields, grasslands, upland meadows, airports, pastures, and vegetated landfills. The species also formerly nested within salt marsh edges and coastal grasslands in New Jersey. Suitable tracks must provide a mix of short and tall grasses, a thick litter layer, dense ground vegetation, and scattered shrubs, saplings, or forbs. Because savannah sparrows are relatively tolerant of vegetative succession, they may occupy fields of varied ages, including those containing early woody growth. During the nonbreeding season, savannah sparrows inhabit coastal dunes, drier portions of salt marshes, roadside edges, agricultural and fallow fields, pastures, airports, vegetated landfills, and golf courses.

Status and Conservation

At the southern edge of its breeding range, the savannah sparrow has been a traditionally local and uncommon breeding species in the Garden State. Historically, the clearing of forests for farmland and the filling of coastal marshes provided habitat for breeding savannah sparrows. As agriculture began to decline in the Northeast, farms were developed or left idle, slowly growing into forests. In areas where farming continued, agricultural practices shifted, resulting in large monocultures and earlier and more frequent mowing of hayfields. Wetlands protection regulations prohibited the filling of coastal marshes, resulting in an inland shift in the distribution of savannah sparrows.

With the decline in traditional agriculture, breeding populations of savannah sparrows also began to fall. From 1966 to 1999, the number of savannah sparrows detected on Breeding Bird Survey routes declined in the Northeast and throughout the United States (Sauer et al. 2000). Likewise, Christmas Bird Counts revealed a significant decrease in wintering savannah sparrows from 1959 to 1988 (Sauer et al. 1996). Due to population declines and habitat loss, the savannah sparrow was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers this species to be "demonstrably secure globally," yet "imperiled in New Jersey because of rarity" (Office of Natural Lands Management 1992).

From 1981 to 1982, the breeding population of savannah sparrows in New Jersey was estimated at 45 to 50 pairs (Wander 1981, 1982). In the late 1990s, the New Jersey Breeding Bird Atlas confirmed nesting savannah sparrows in 21 blocks and located probable pairs in an additional 29 blocks (Walsh et al. 1999).

Wood Turtle, *Clemmys insculpta*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

© Robert Zappalorti

As the taxonomic name insculpta indicates, the wood turtle is distinguished by the sculpted or grooved appearance of its carapace, or upper shell. Each season a new annulus, or ridge, is formed, giving each scute (a scale-like horny layer) a distinctive pyramid-shaped appearance. As the turtle ages, natural wear smoothes the surface of the shell. While the scutes of the carapace are brown, the plastron, or underneath shell, consists of yellow scutes with brown or black blotches on each outer edge. The legs and throat are reddish-orange. The male wood turtle has a concave plastron while that of the female is flat or convex. The male also has a thicker tail than the female. Adult wood turtles measure 14 to 20 cm (5.5 to 8.0 in.) in length (Conant and Collins 1991).

Habitat

Unlike other turtle species that favor either land or water, the wood turtle resides in both aquatic and terrestrial environments. Aquatic habitats are required for mating, feeding, and hibernation, while terrestrial habitats are used for egg laying and foraging. Freshwater streams, brooks, creeks, or rivers that are relatively remote provide the habitat needed by these turtles. Consequently, wood turtles are often found within streams containing native brook trout (Salvelinus fontinalis). These tributaries are characteristically clean, free of litter and pollutants, and occur within undisturbed uplands such as fields, meadows, or forests. Open fields and thickets of alder (Alnus spp.), greenbrier (Smilax spp.), or multiflora rose (Rosa multiflora) are favored basking habitats. Lowland, mid-successional forests dominated by oaks (Quercus spp.), black birch (Betula lenta), and red maple (Acer rubrum) may also be used. Wood turtles may also be found on abandoned railroad beds or agricultural fields and pastures. Nevertheless, wood turtle habitats typically contain few roads and are often over one-half of a mile away from developed or populated areas (Zappalorti et al. 1984). Individuals from relict or declining populations are also sighted in areas of formally good habitat that have been fragmented by roads and development.

Status and Conservation

Historically, the wood turtle was a fairly common species within suitable habitat in New Jersey. By the 1970s, however, declines were noted as wood turtles were absent from many historic sites due to habitat loss and stream degradation. Consequently, the wood turtle was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the wood turtle to be "demonstrably secure globally," yet "rare in New Jersey" (Office of Natural Lands Management 1992).

Since the late 1970s, biologists have monitored and surveyed wood turtle sites in New Jersey, providing valuable data regarding the life history, reproduction, and habitat use of these turtles in the state. There is, however, a continuing need to examine the productivity and juvenile survival of wood turtles, which may be threatened by disturbance or predation.

In 1995, the wood turtle was proposed for inclusion on the federal endangered species list. Despite declines in several northeastern states, populations were considered stable enough throughout the species' entire range to deny listing. However, the wood turtle was considered by the U.S. Fish and Wildlife Service as a species that, "although not necessarily now threatened with extinction may become so unless trade in them is strictly controlled" (U.S. Fish and Wildlife Service 1995). As a result, international trade of these turtles is strictly monitored and regulated through the CITES Act (Convention on International Trade in Endangered Species of Wild Flora and Fauna Act). The New Jersey Endangered Species Act prohibits the collection or possession of wood turtles.

APPENDIX D: LOCAL & REGIONAL CONSERVATION GROUPS

The following non-profit groups may be of interest to readers of this report. Listing does not constitute an endorsement by Tewksbury Township or Kratzer Environmental Services.

Association of NJ Environmental Commissions	www.anjec.org
ANJEC is a private, nonprofit educational organization for environmental commissioners, concerned individuals and organizations to protect natural resources and improve the quality of life in NJ.	
Central Jersey Trout Unlimited	www.cjtu.org
Our mission is to conserve, protect and restore New Jersey's cold water fisheries and their environments.	
ConserveOnline	www.conserveonline.org
ConserveOnline is a "one-stop" online, public library, created and maintained by The Nature Conservancy in partnership with other conservation organizations.	
Conserve Wildlife Foundation of New Jersey	www.conservewildlifenj.org
The Conserve Wildlife Foundation of NJ is a private, not-for-profit organization dedicated to conserving and protecting New Jersey's endangered and threatened wildlife.	
Earth Share of New Jersey	www.earthsharenj.org
A coalition of leading environmental organizations working to promote human health and welfare through environmental management, conservation, advocacy, research, education, and grassroots organizing in New Jersey.	
Garden State EnviroNet	www.gsenet.org
New Jersey environmental news and information.	
Highlands Coalition	www.highlandscoalition.org
The Highlands Coalition seeks to protect and enhance the sustainability of natural and human communities in the Highlands region of PA, NJ, NY and CT	
Hunterdon Coalition	www.hunterdoncoalition.org
The Hunterdon Coalition is made up of a mix of local officials and activists to promote public involvement in land use decisions.	
Hunterdon County Soil Conservation District	www.state.nj.us/agriculture/rural/natrsrc.htm
The New Jersey Department of Agriculture helps to protect and conserve the state's soil, water and related natural resources technical, financial and regulatory assistance and provides educational outreach to landowners throughout the state.	
Hunterdon County - Rutgers Cooperative Research and Extension	www.co.hunterdon.nj.us/depts/rutgers/rutgers.htm
The Cooperative Extension serves as the educational outreach arm of the US Dept. of Agriculture to provide research based information concerning agriculture, nutrition and food safety.	
Hunterdon Land Trust Alliance	www.hlta.org
The HLTA's mission is to preserve the county's scenic beauty, and its environmental and historic resources; to provide for the permanent preservation of farmland and to support and foster agricultural viability; and to promote the conservation and appropriate management of woodlands and open space.	

International Rivers	www.irn.org
International Rivers Network protects rivers and defends the rights of communities that depend on them.	
National Wildlife Federation	www.nwf.org
The National Wildlife Federation promotes wildlife conservation.	
Native Plant Society of New Jersey	www.npsnj.org
The Native Plant Society of NJ is a statewide non-profit organization founded for the appreciation, protection, and study of the native flora of New Jersey.	
Natural Resources Defense Council	www.nrdc.org
The Natural Resources Defense Council's purpose is to safeguard the Earth: its people, its plants and animals and the natural systems on which all life depends.	
NatureServe	www.natureserve.org
NatureServe is a network providing the scientific basis for effective conservation of rare and endangered species and threatened ecosystems. NJ Natural Heritage Program is the local program for NJ:	www.state.nj.us/dep/parksandforests/natural/heritage/index.html
New Jersey Aquarium	www.njaquarium.org
The New Jersey Academy for Aquatic Sciences promotes the understanding, appreciation and protection of aquatic life and habitats through research, education and youth development programs.	
New Jersey Audubon	www.njaudubon.org
The NJAS is a statewide non-profit organization which fosters environmental awareness and a conservation ethic among NJ's citizens; protects NJ's birds, other animals, and plants, especially endangered and threatened species; and promotes preservation of NJ's valuable natural habitats.	
New Jersey Community Water Watch	www.waterwatchonline.org/nj
New Jersey Community Water Watch is a joint program between AmeriCorps and the NJPIRG Law and Policy Center that works to empower students and community members to address water quality problems in NJ's urban areas through education, cleanups and stream monitoring.	
New Jersey Conservation Foundation	www.njconservation.org
The NJCF mission is to preserve New Jersey land and natural resources for the benefit of all now and for future generations. As a leading innovator and catalyst for saving land, NJCF: creates and promotes strong land use policies; protects strategic lands.	
New Jersey Future	www.njfuture.org
New Jersey Future's mission is to achieve smart growth statewide: growth that protects New Jersey's open lands and natural resources, improves communities, transportation and housing choices through research, policy analysis, public education and advocacy.	
New Jersey Chapter Sierra Club	www.newjersey.sierraclub.org
Mission is to explore, enjoy, and protect the wild places of the earth; To practice and promote the responsible use of the earth's ecosystems and resources; To educate and enlist humanity to protect and restore the quality of the natural and human environments.	
New Jersey Section - American Water Works Association	www.njawwa.org
The NJAWWA is dedicated to the promotion of public health and welfare in the provision of drinking water of unquestionable quality and sufficient quantity by advancing the technology, science, management and government policies relative to the stewardship of water.	
New Jersey Water Supply Authority – Watershed Protection Unit	www.njwsa.org/wpu/
The NJWSA formed its Watershed Protection Programs Unit in Fiscal Year 1999 to improve the protection of water resources for the Raritan River Basin, the Manasquan River watershed and the	

Delaware & Raritan Canal and its tributary watersheds.
PlanSmart NJ www.plansmart.org PlanSmart NJ is a statewide civic action group committed to improving the quality of community life through the advancement of sound land use planning and regional cooperation.
Save Our Resources Today www.sort.org Environmental news, links and calendar of events.
South Branch Watershed Association www.sbwa.org The South Branch Watershed Association (SBWA) is a not-for-profit organization dedicated to protecting the environment in the watershed of the South Branch Raritan River.
Tewksbury Land Trust PO Box 490 Oldwick, NJ 08858 The Tewksbury Land Trust is a private not-for-profit land trust dedicated to preservation of land in Tewksbury Township. It currently has easements and fee-simple holdings in excess of 200 acres.
Tewksbury Trail Association www.tta-nj.org The Tewksbury Trail Association (TTA) is a nonprofit organization dedicated to preserving green space, open land, and the natural beauty of Tewksbury Township and the surrounding areas of Hunterdon County, New Jersey. The TTA is committed to cultivating and maintaining agriculturally-sensitive bridle paths for horseback riding and other equine-related activities.
The Nature Conservancy - NJ www.nature.org/wherewework/northamerica/states/newjersey/ The mission of the Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.
Upper Raritan Watershed Association www.urwa.org URWA's mission is to ensure the protection of the natural resources of the Upper Raritan Watershed through education, advocacy, land preservation and stewardship.
Watershed Partnership for New Jersey www.wpnj.org The Watershed Partnership for NJ is a statewide network of watershed education and outreach representatives from more than 70 non-profit, government, educational and private organizations.
Wild New Jersey www.wildnj.com/ Created to foster an understanding of, and respect for, wildlife and wild places in the Garden State.

APPENDIX E: MODULE 4: HIGHLANDS ENVIRONMENTAL RESOURCE INVENTORY FOR TEWKSBURY TOWNSHIP

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(86 pages)