5: GROUND WATER

A. Water Cycle

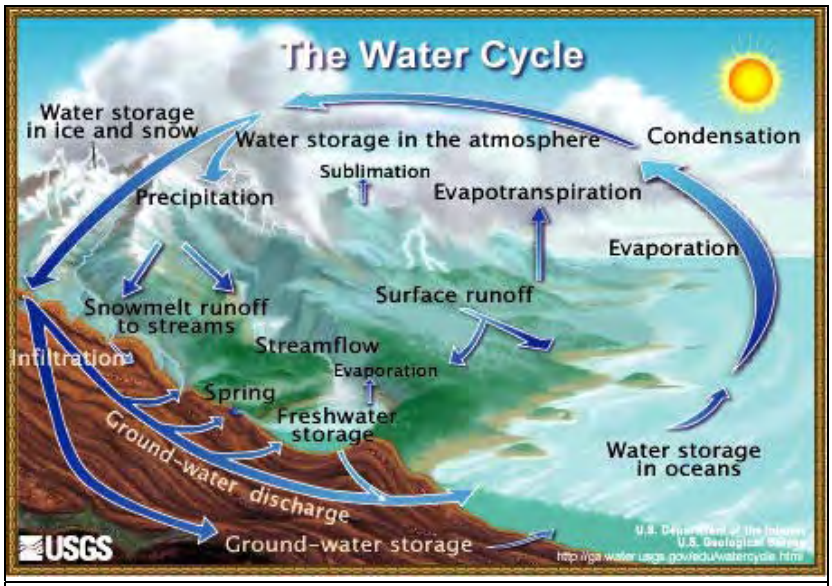


Figure 5a: The Water Cycle
Source: USGS, no date

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.

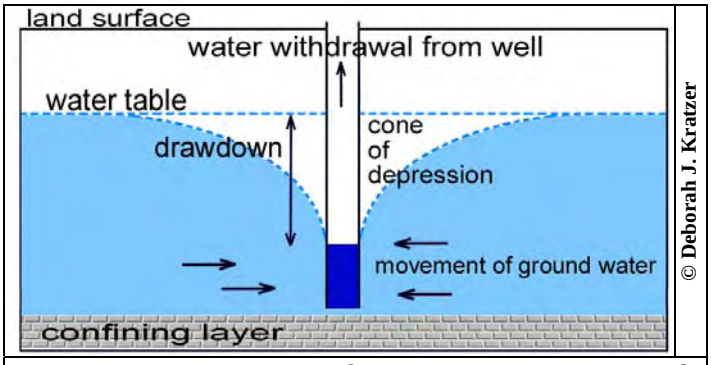


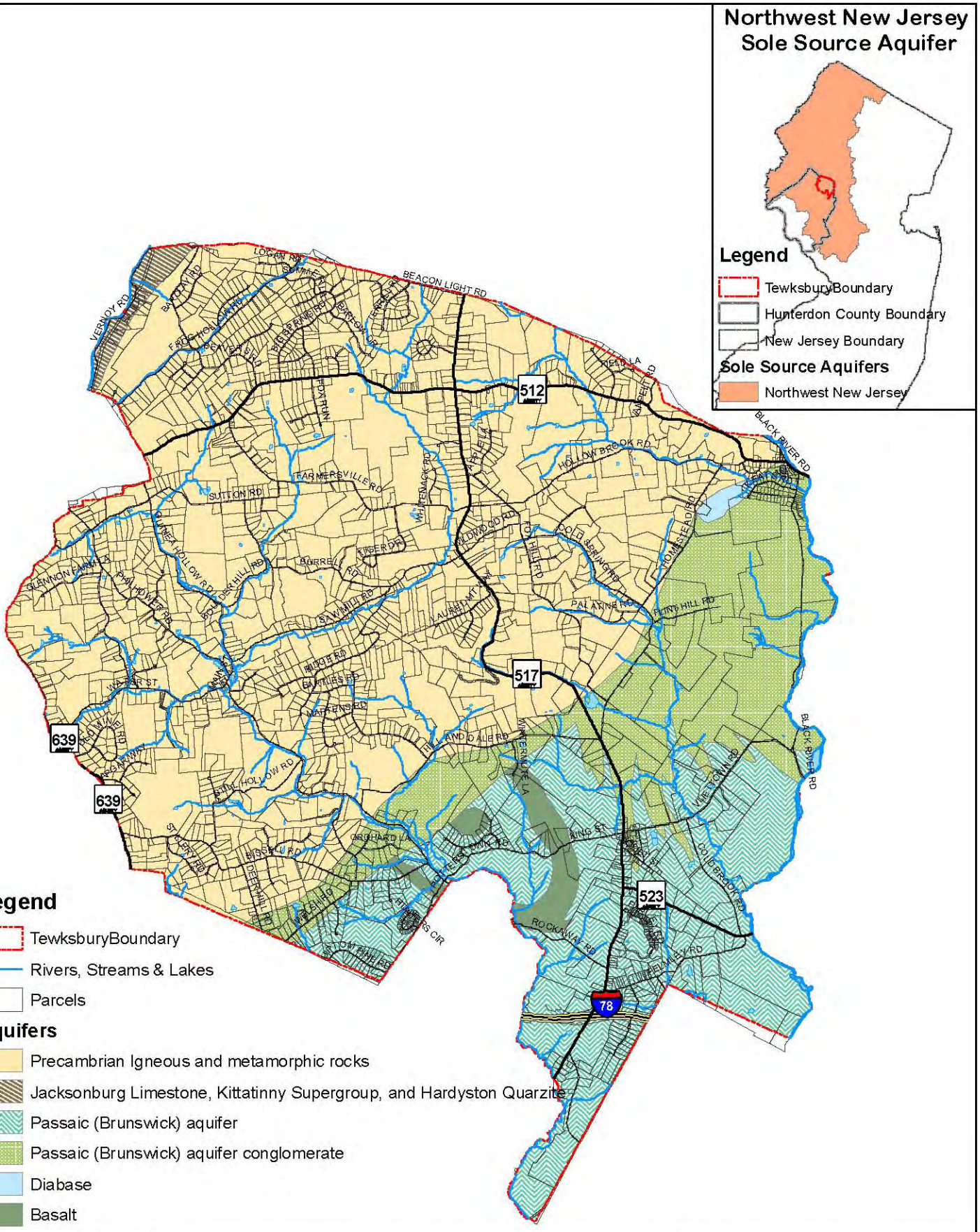
Figure 5b: Illustration of Drawdown and Cone of Depression

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.



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 5c: Aquifers & Sole Source Aquifers

Tewksbury Township ERI, 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).

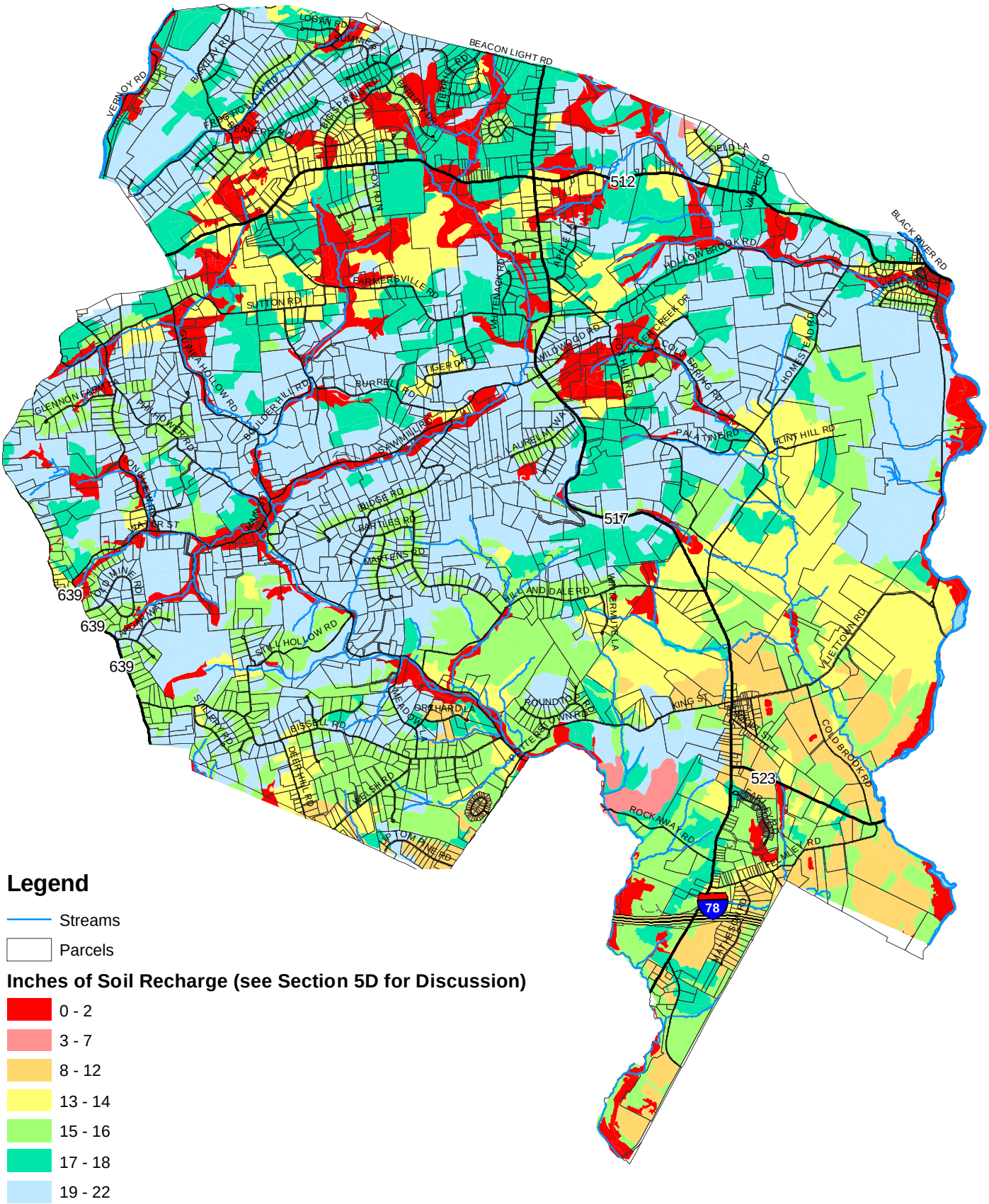
To ensure that water is available during all weather conditions for human consumption as well as ecosystems dependent on water, the NJDEP established the Planning Threshold, or *dependable yield*, to be used for planning purposes. *Dependable yield*, is defined as "the water yield maintainable by a ground-water 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*.



Legend

Streams

Parcels

Inches of Soil Recharge (see Section 5D for Discussion)

- 0 - 2
- 3 - 7
- 8 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 22

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 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.

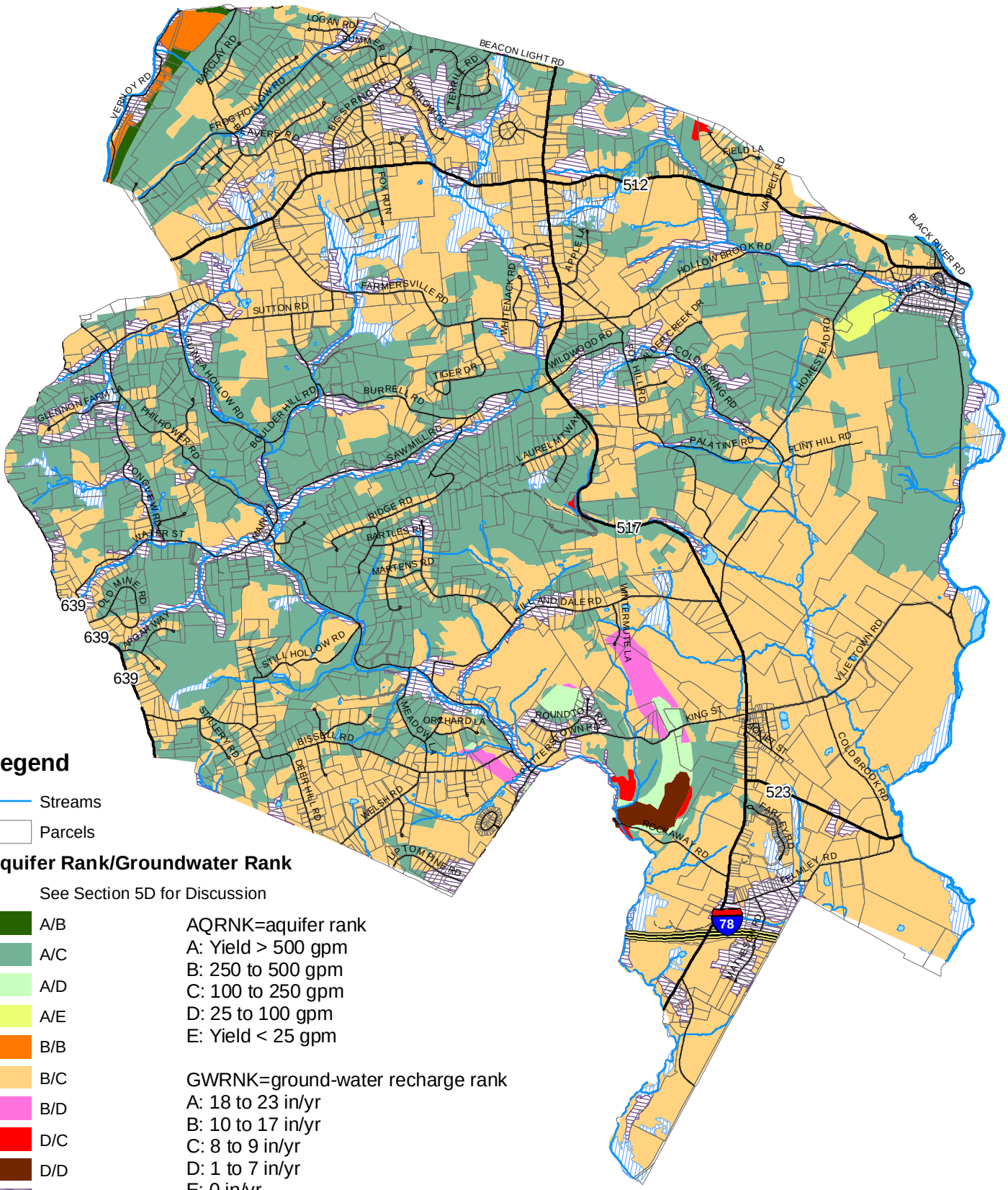
Tewksbury Ground Water Resources Study

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		

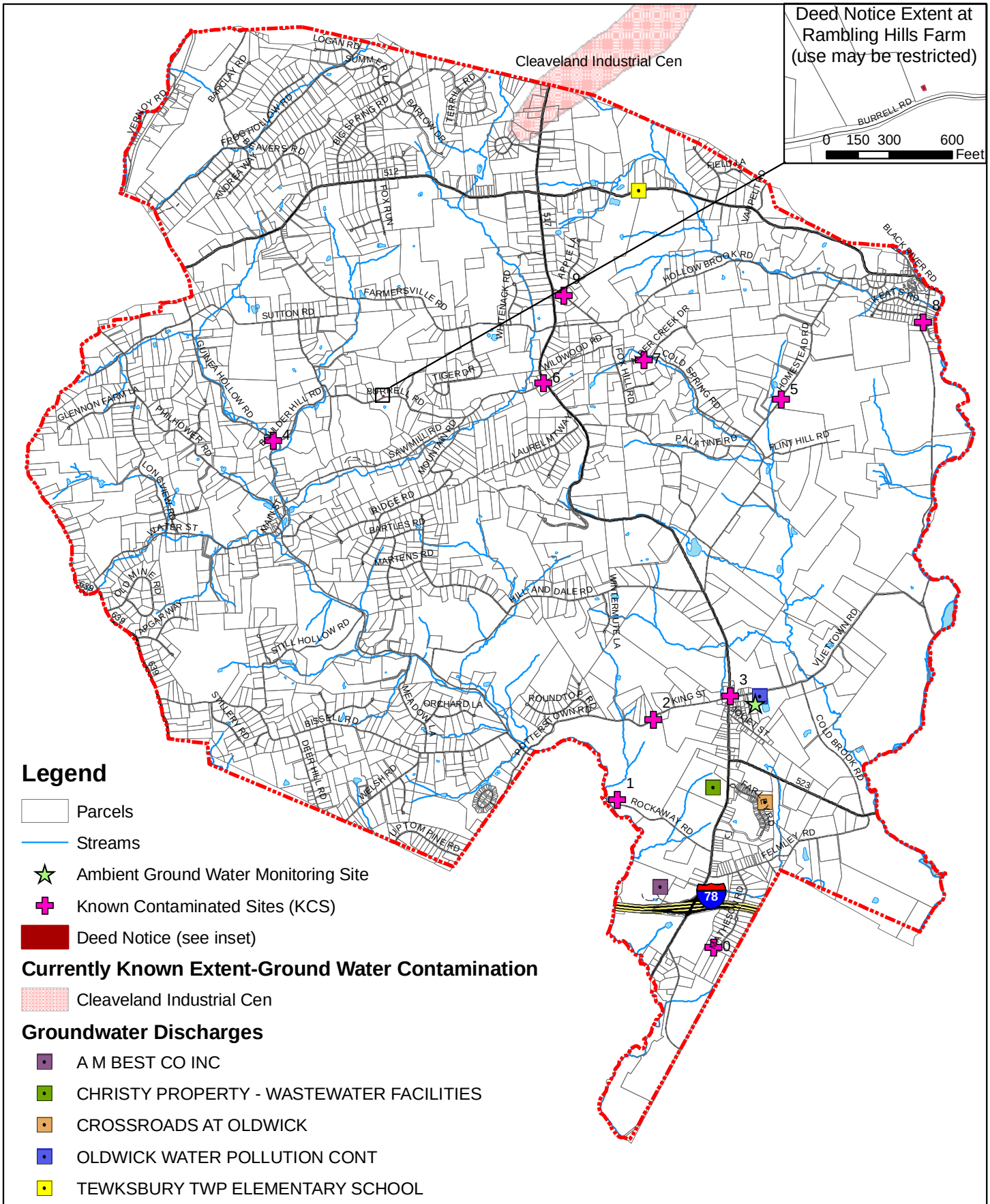
***STATUS – all sites in this list are Active:** This status is designated when a contaminated site is assigned to a remedial program and measures such as a preliminary assessment, remedial investigation or cleanup work is underway; **Status Date:** The date that the site was assigned to the contact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

N

0 0.25 0.5 1 1.5 Miles

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

Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

J. Ground Water Level Monitoring

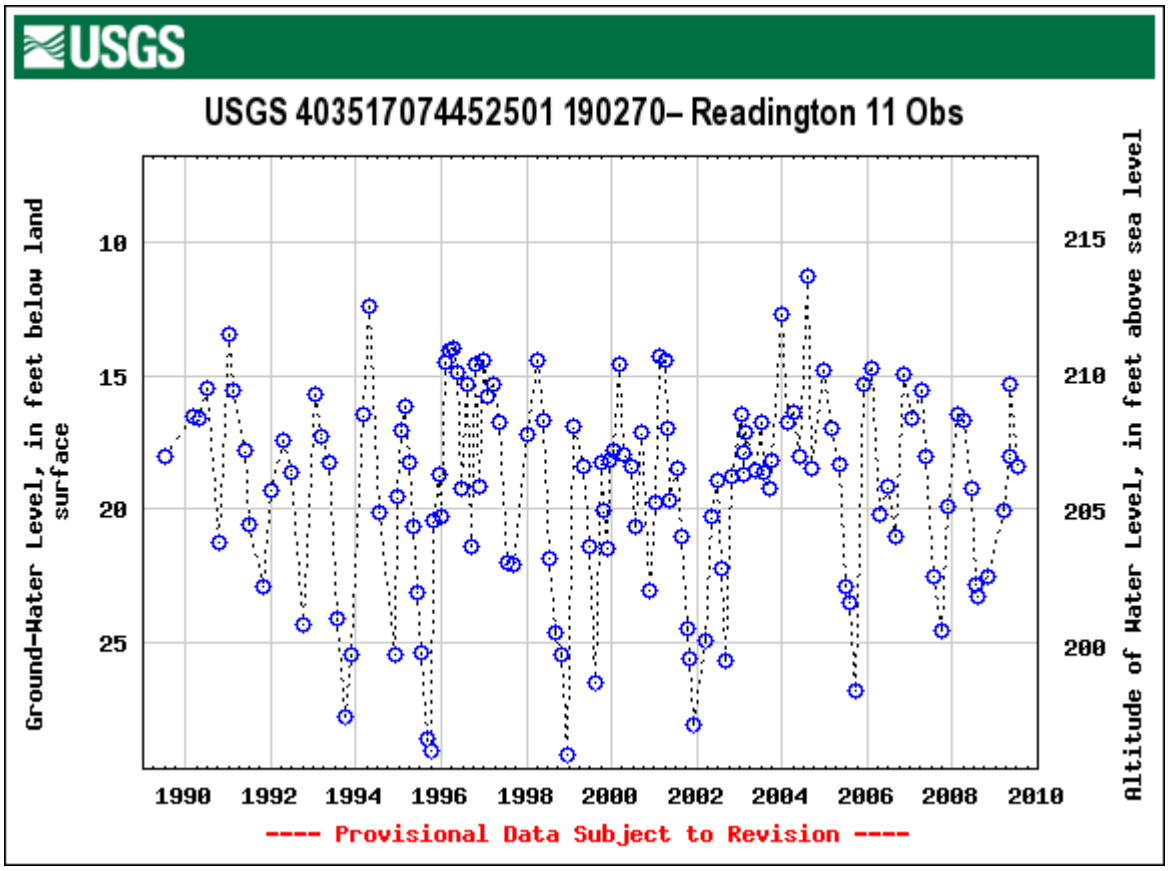
The *ground water level* is the distance from the land surface (i.e. top of well casing) to the water in a well. Ground water level monitoring is critical for determining the current state of the ground water, identifying trends and predicting ground water drought. In addition to drought, over-withdrawal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



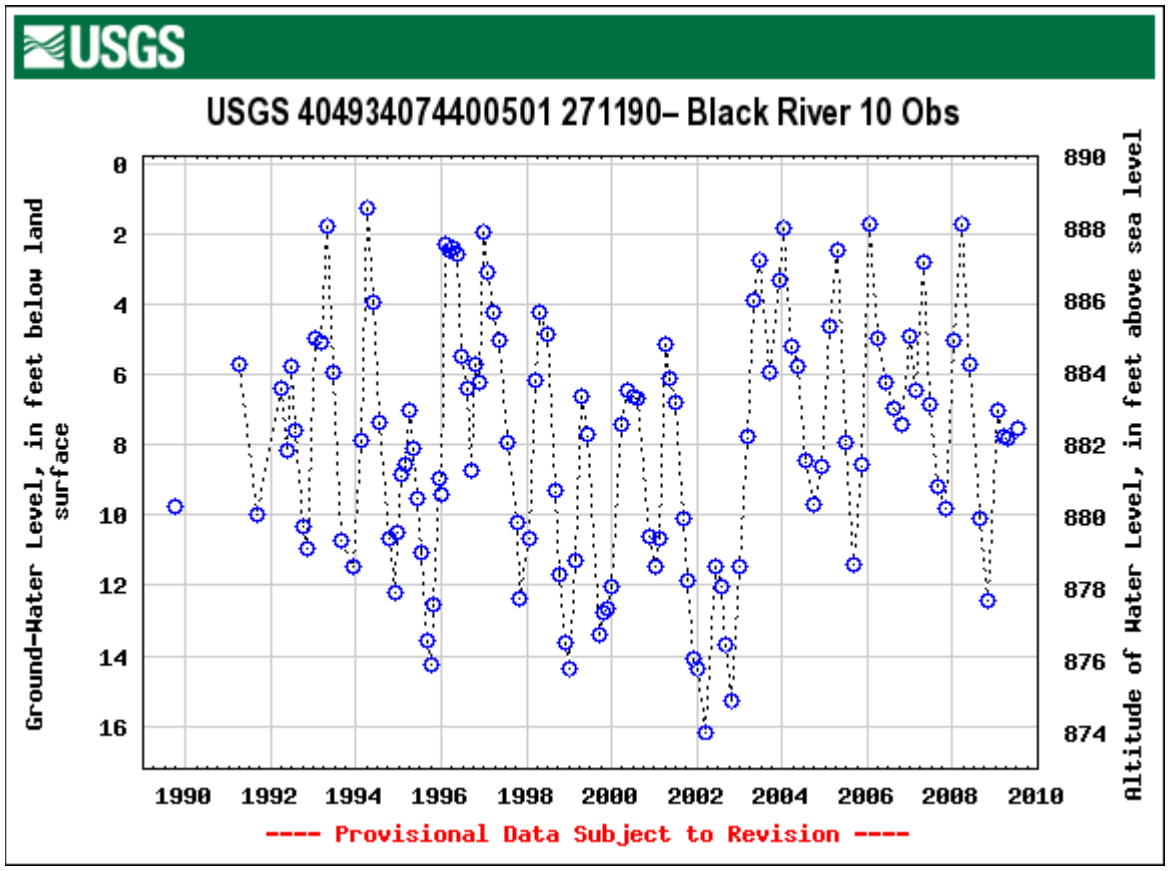


Figure 5g: Ground Water Level at Readington and Black River (Chester) Stations monitored by USGS Source: USGS, 2009

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

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- 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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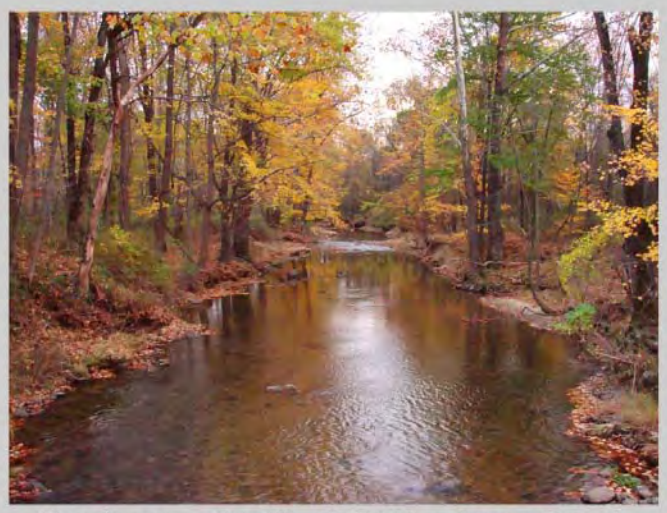
USGS - Water Resources of NJ: http://nj.usgs.gov/

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

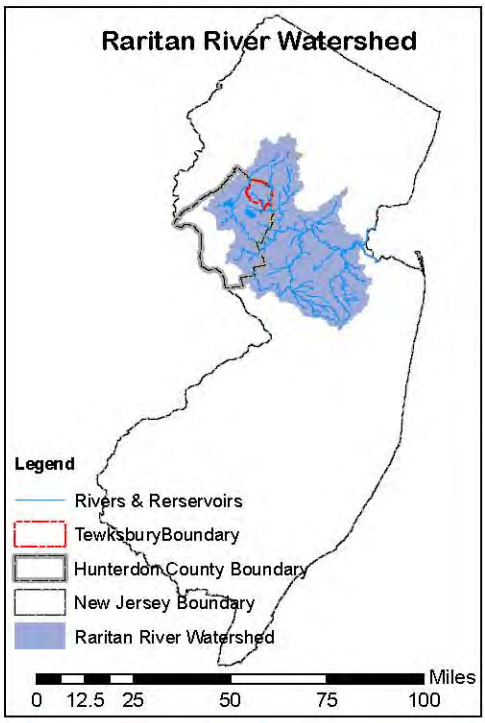
Figure 6a shows the watersheds, sub-watersheds and streams either within or partially within Tewksbury Township. The classification system used by the NJDEP assigns each watershed a *14-digit Hydrologic Unit Code (HUC14[15])*. The HUC14 is a hierarchical system where the first 4 digits (also known as 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.

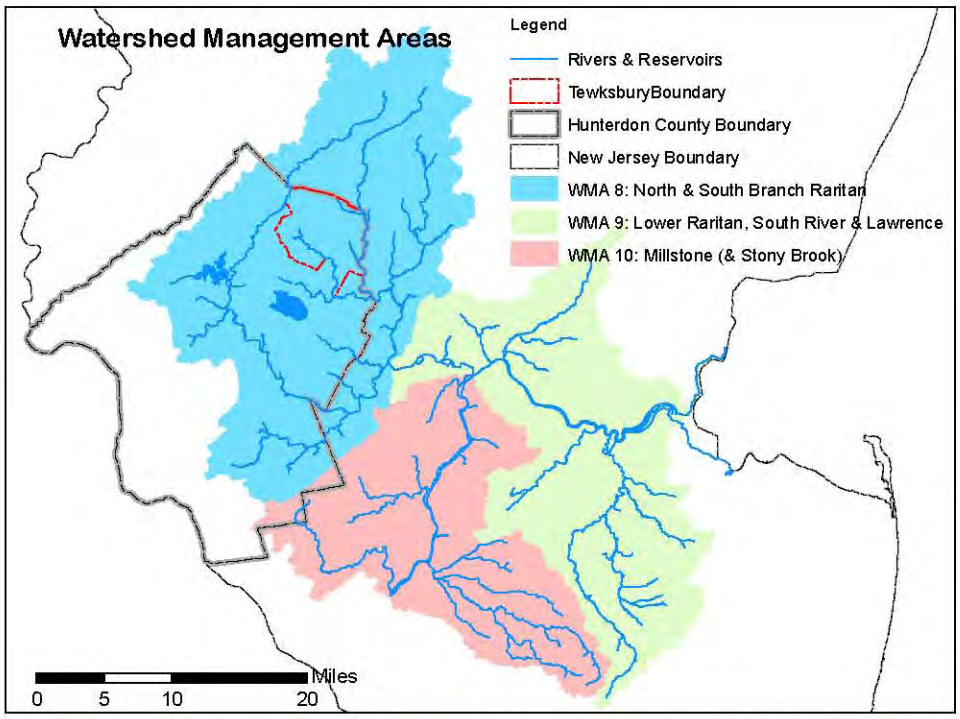
> "Water is vital to life and comprises an invaluable natural resource which is not to be abused by any segment of the State's population or economy."
> (NJAC 7:9B)

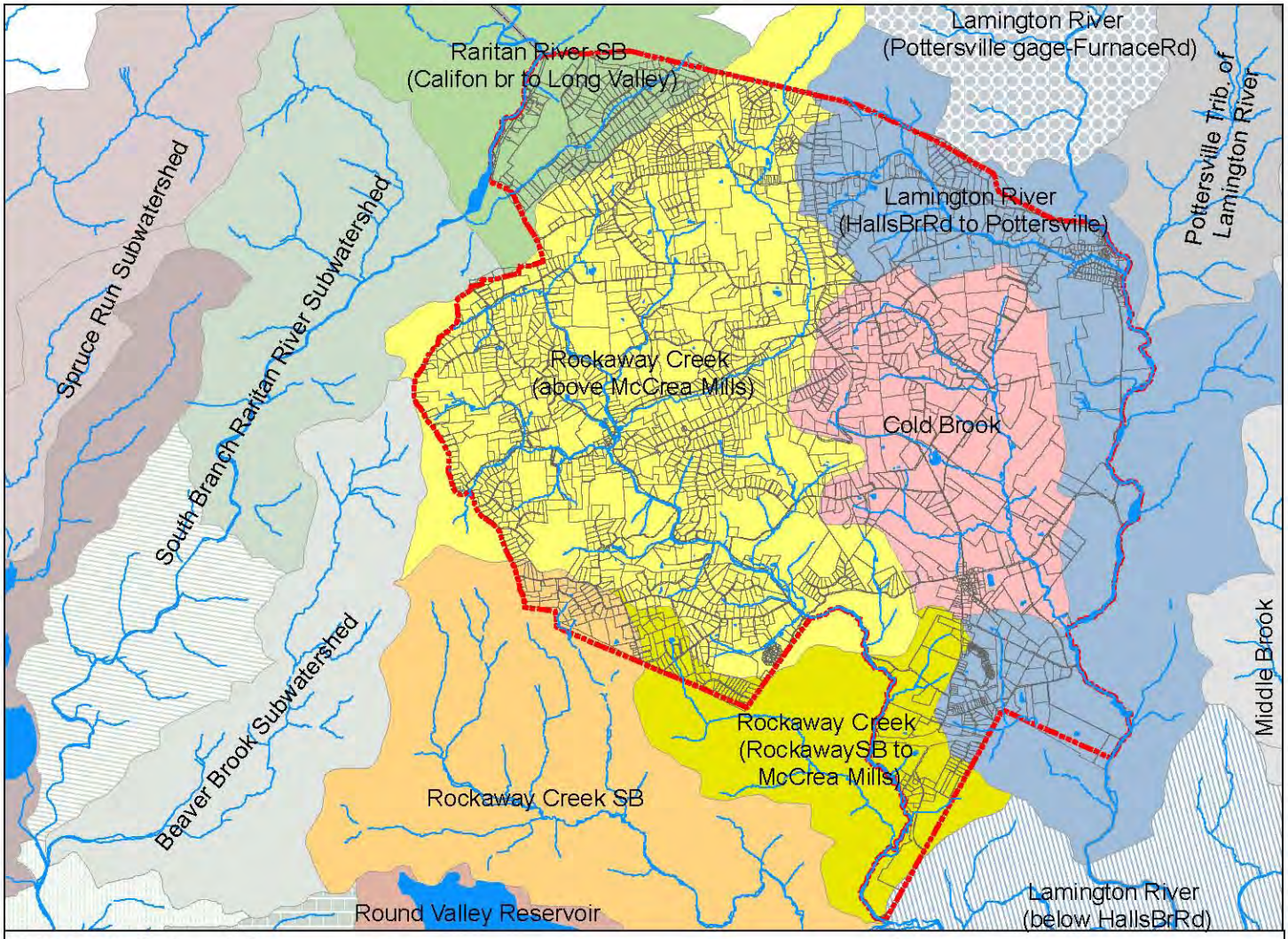
When using the NJDEP's *Watershed Management Areas (WMA's)*, all of Tewksbury falls within WMA 8, which includes both the North and South Branches of the Raritan River (see top right inset in **Figure 6a**).

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.

N

0 0.5 1 2 Miles

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.

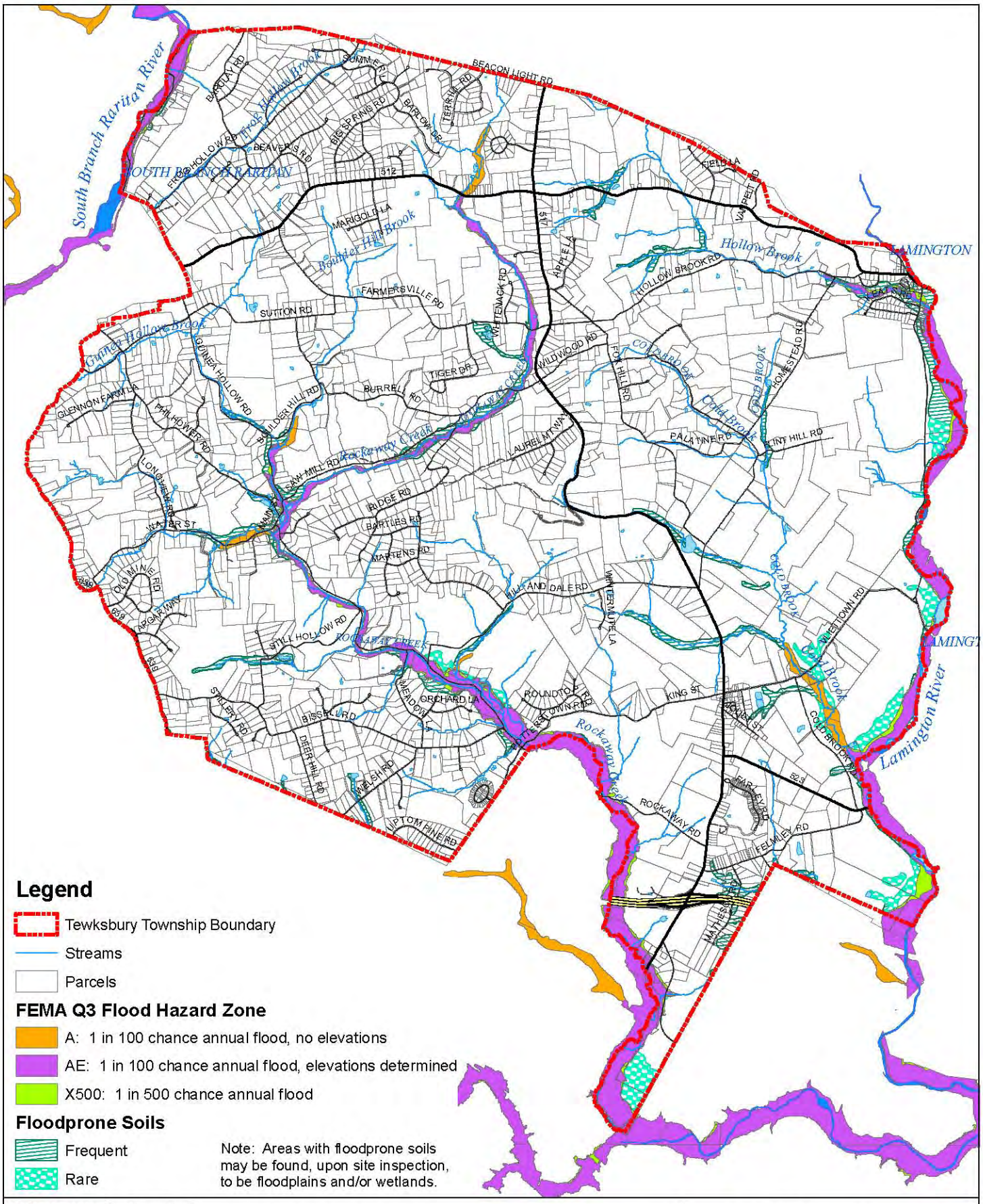
Cold Brook has minimal floodplains in its upper reaches, but its floodplain east of Oldwick to its confluence with the Lamington River ranges from about 200 to 500 feet wide. The Lamington River's floodplain marks the eastern edge of the Township, ranging for the most part from 500 to 700 feet wide, 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.
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 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**).

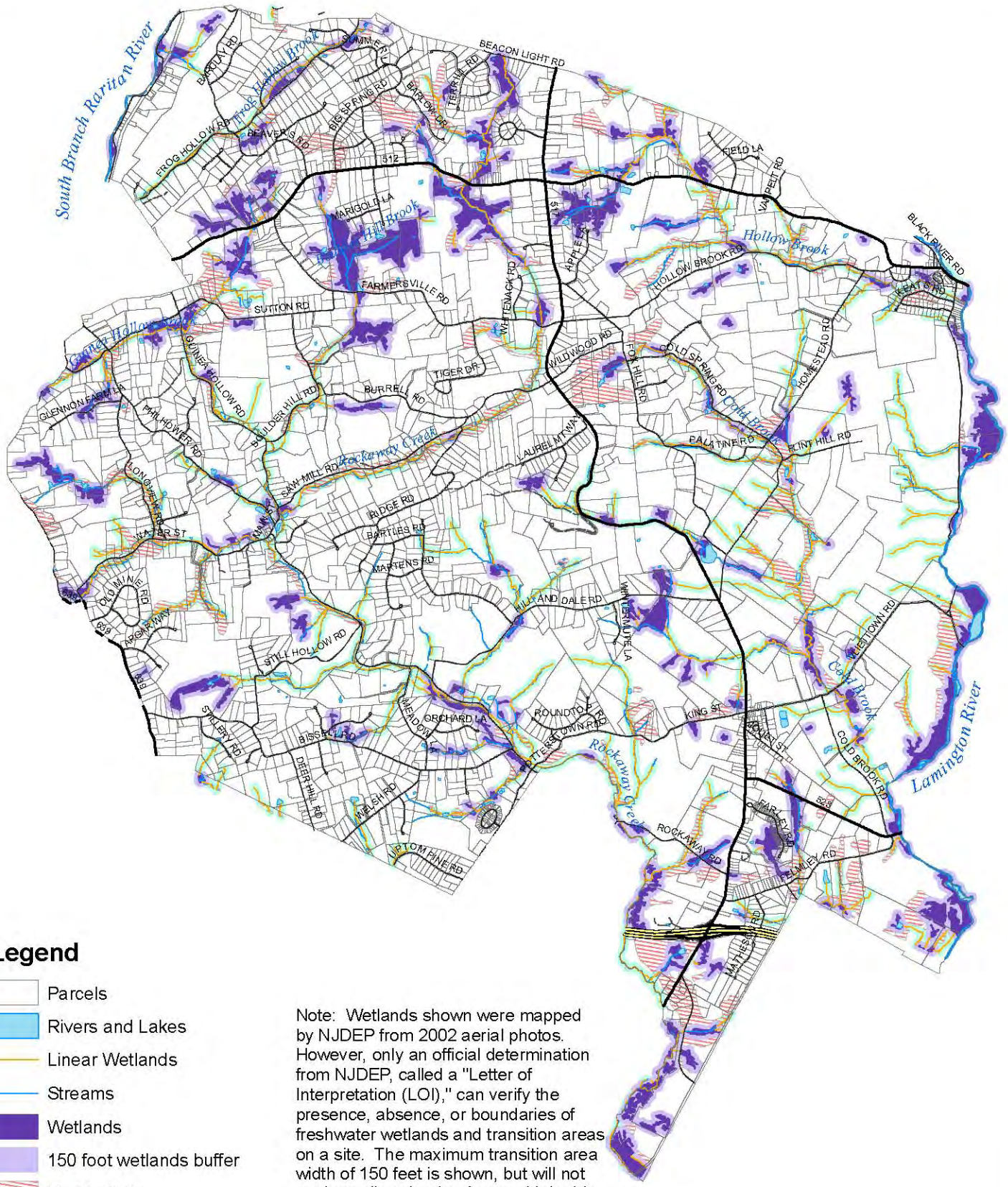
D. Surface Water Quality Standards

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**).

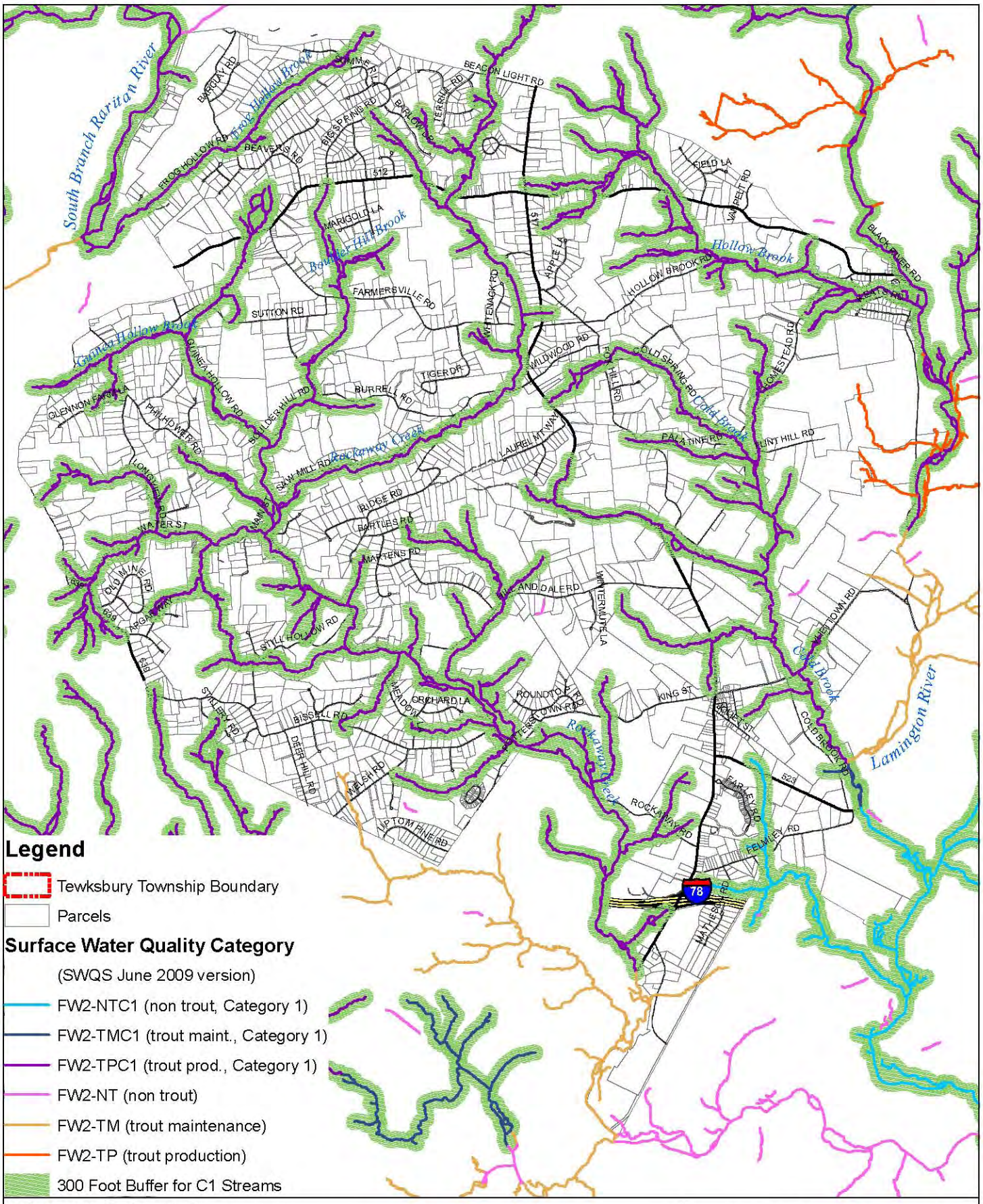
Table 6.2 describes the definitions of the categories, while **Figure 6d** illustrates the stream categories within Tewksbury. In **Figure 6d**, "category" is shown, which is a compendium of all surface water classification designations for a given water body. Category describes a stream's surface water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



Legend

- Tewksbury Township Boundary
- Parcels

Surface Water Quality Category

(SWQS June 2009 version)

- FW2-NTC1 (non trout, Category 1)
- FW2-TMC1 (trout maint., Category 1)
- FW2-TPC1 (trout prod., Category 1)
- FW2-NT (non trout)
- FW2-TM (trout maintenance)
- FW2-TP (trout production)
- 300 Foot Buffer for C1 Streams

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 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.

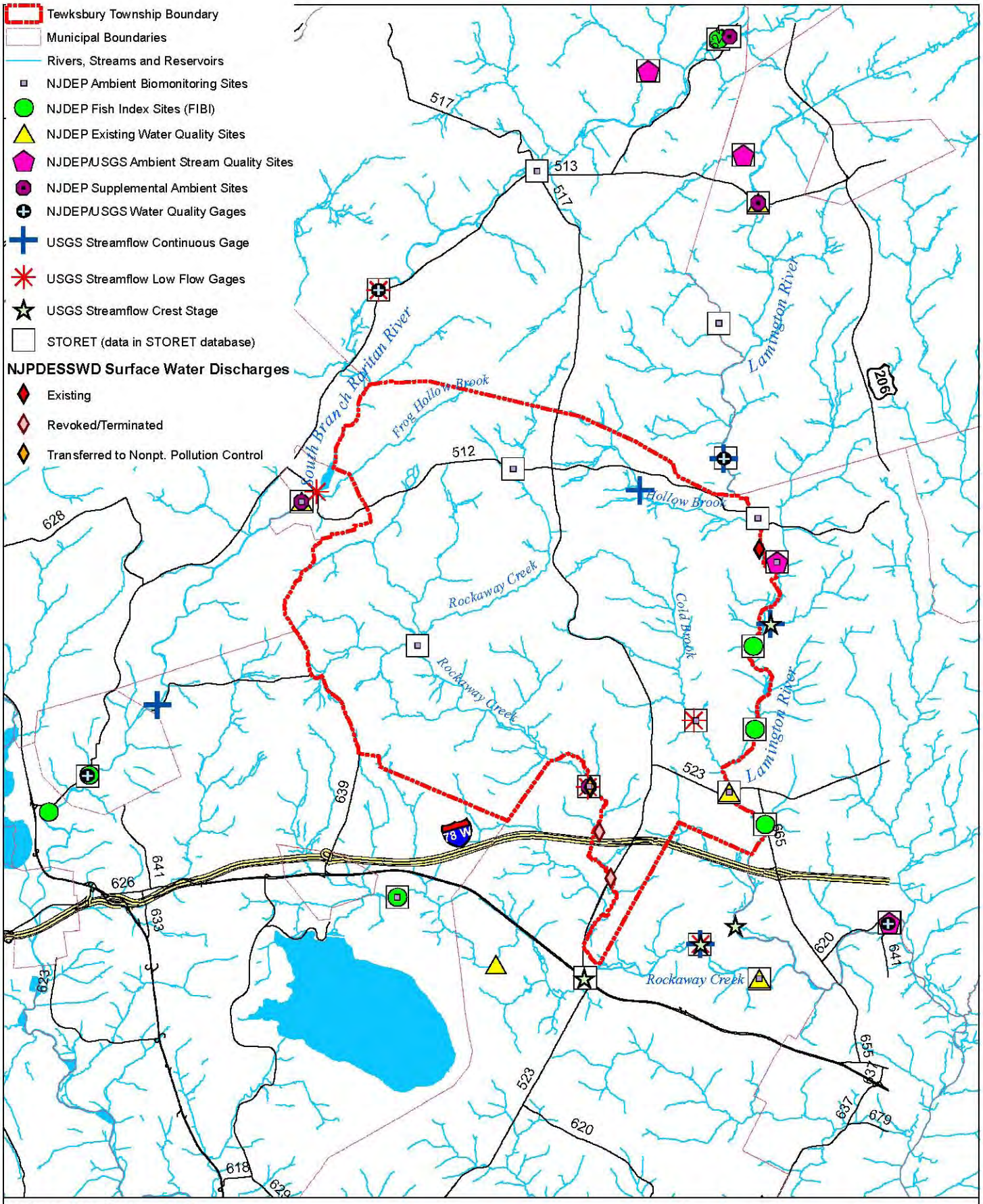
Tewksbury's Stormwater Management Plan was adopted in March 2005. A Stormwater Control Ordinance was adopted in February 2006. The Township will be requiring long-term operation and maintenance of all BMPs through the stormwater control ordinance. Written reminders will be issued to people responsible 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.
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 0.5 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

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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)

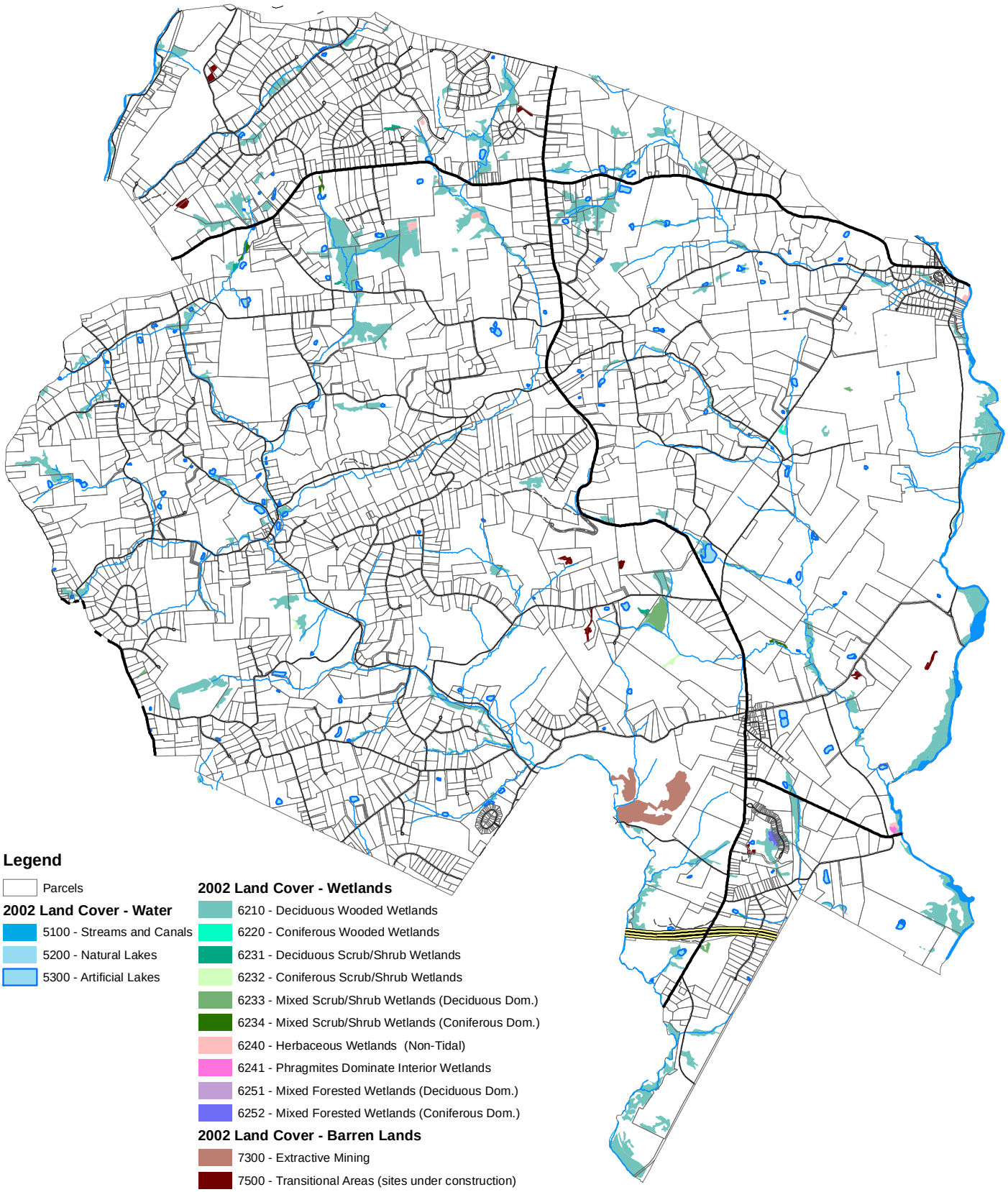
Data Sources: See Appendix B.
Note: Map accuracy is limited to the accuracy and scale of the original data sets; see Appendix B.
Disclaimer: This map was developed using NJDEP and Hunterdon County GIS digital data, but this secondary product has not been verified by NJDEP or Hunterdon County and is not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

N

0 0.25 0.5 1 1.5 Miles

Figure 7a: Land Cover from 2002 Aerial Photos (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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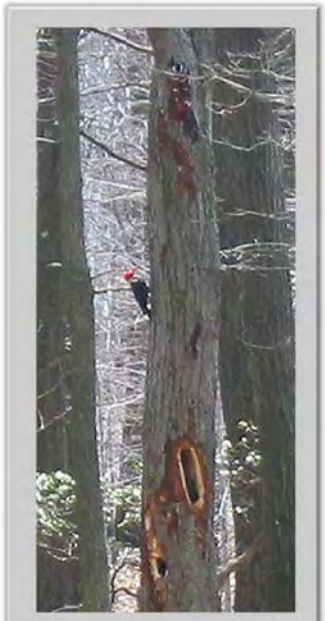
0 0.25 0.5 1 1.5 Miles

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).

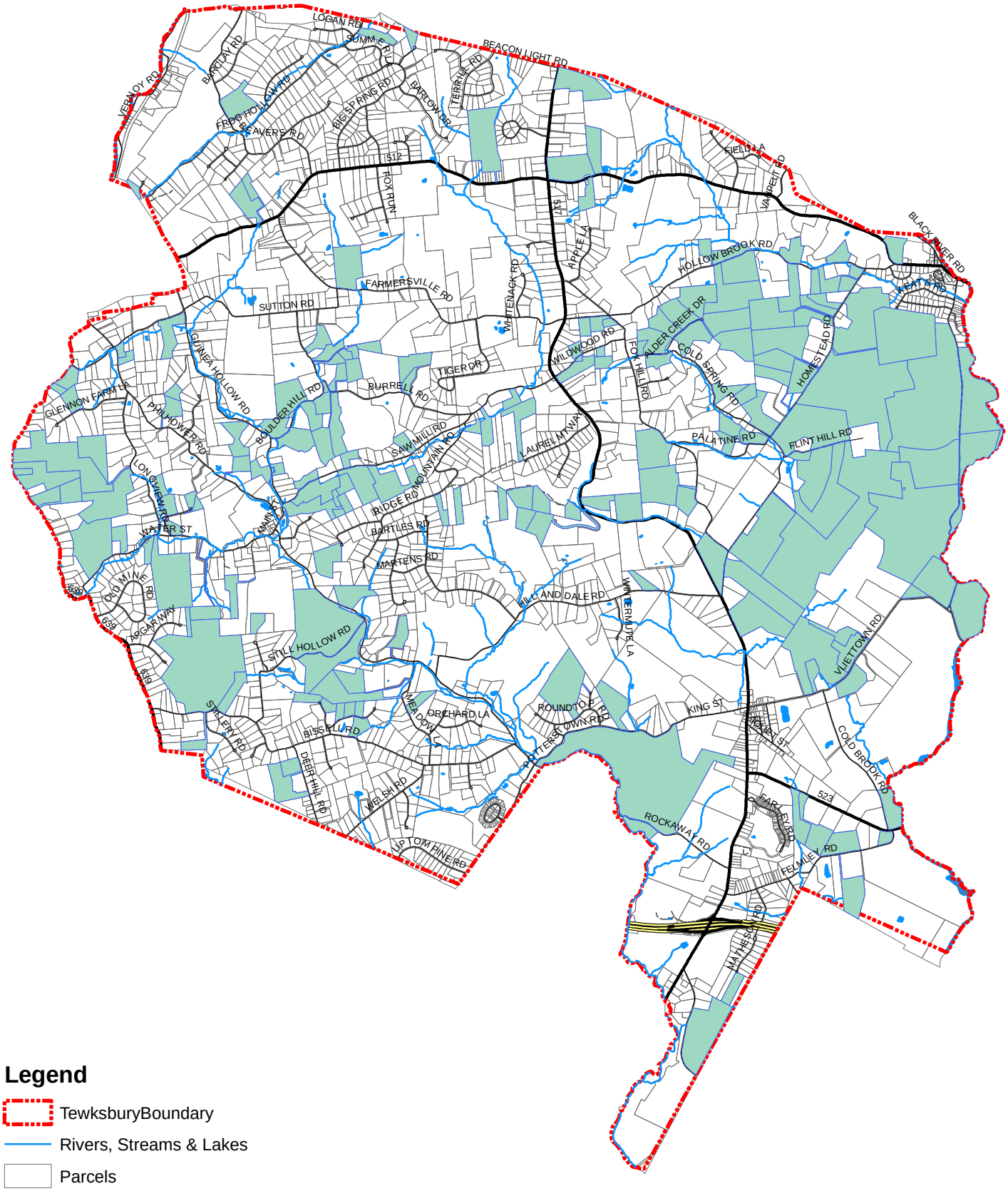
No serious insect or disease problems were noted in the report, with the exception of Dutch elm disease, which is resulting in elm mortality. Some tulip poplar mortality was attributed to the 1999 drought. Tewksbury's forests are at a low risk for forest fire (slightly higher risk in the Piedmont section 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

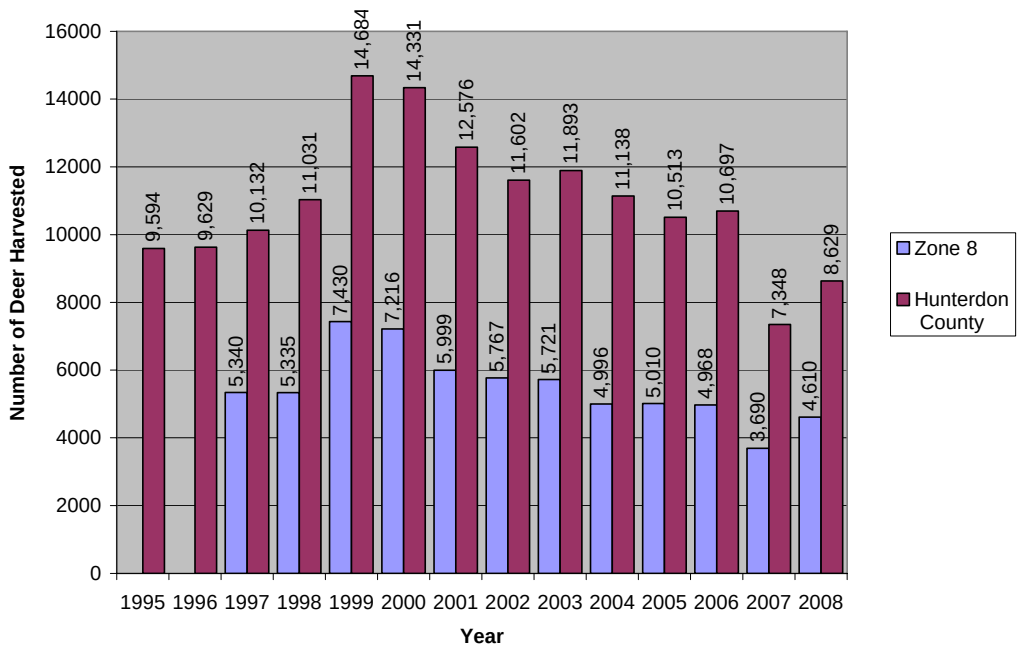
For comparison, NJDEP's hunting figures[20] for Hunterdon County show that an average for the period 1995-2006 of 27 deer per square mile are *taken* by hunters each year (see **Table 7.2**), therefore populations are well over the ecological carrying capacity. For the past twelve years, Hunterdon County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

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

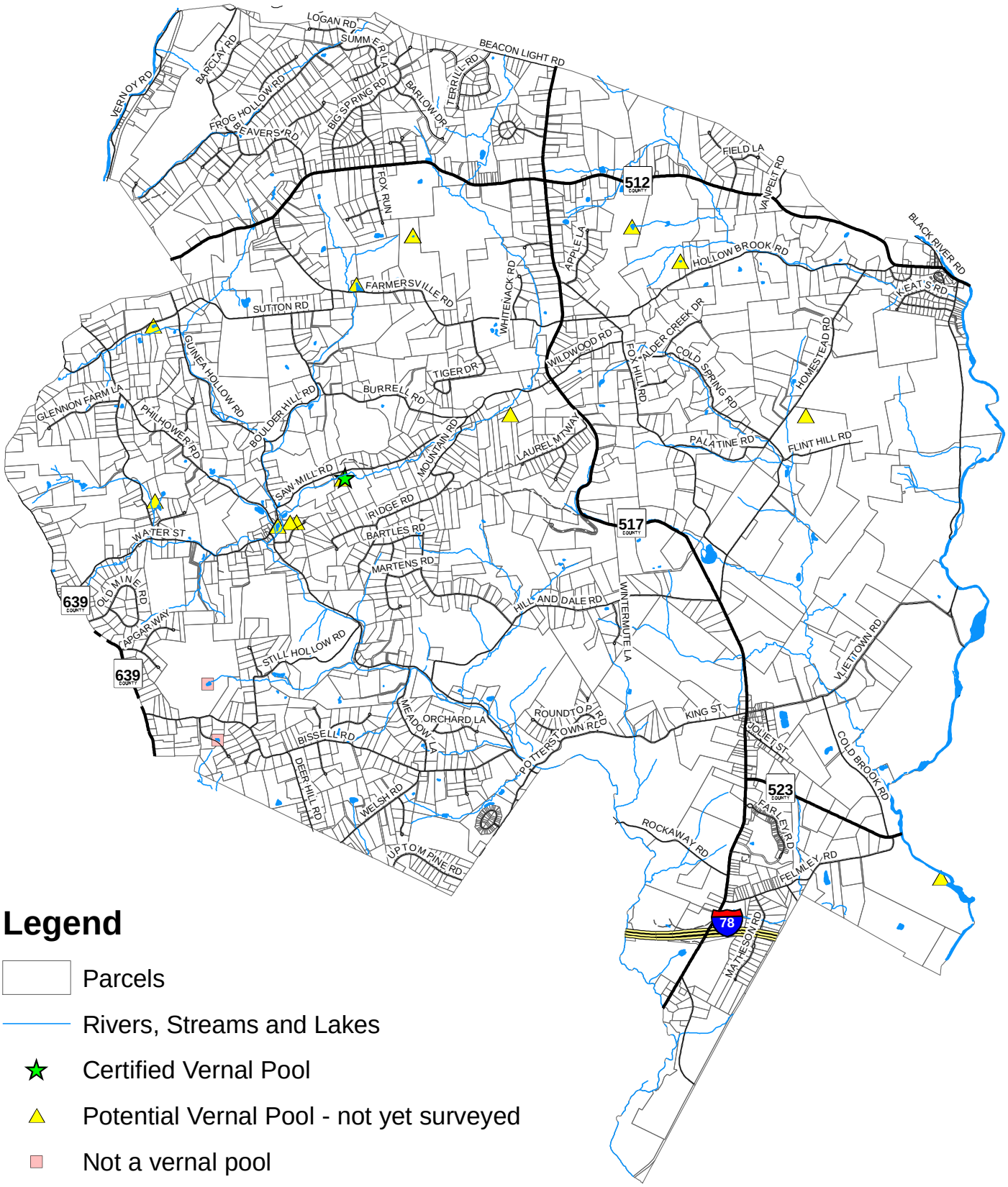
Vernal pools are defined as confined depressions, either natural or man-made, that maintain ponded water for part of the year, have no permanent outflow, and are devoid of breeding fish populations. These temporary wetlands provide habitat to many species of amphibians, several of which breed exclusively 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

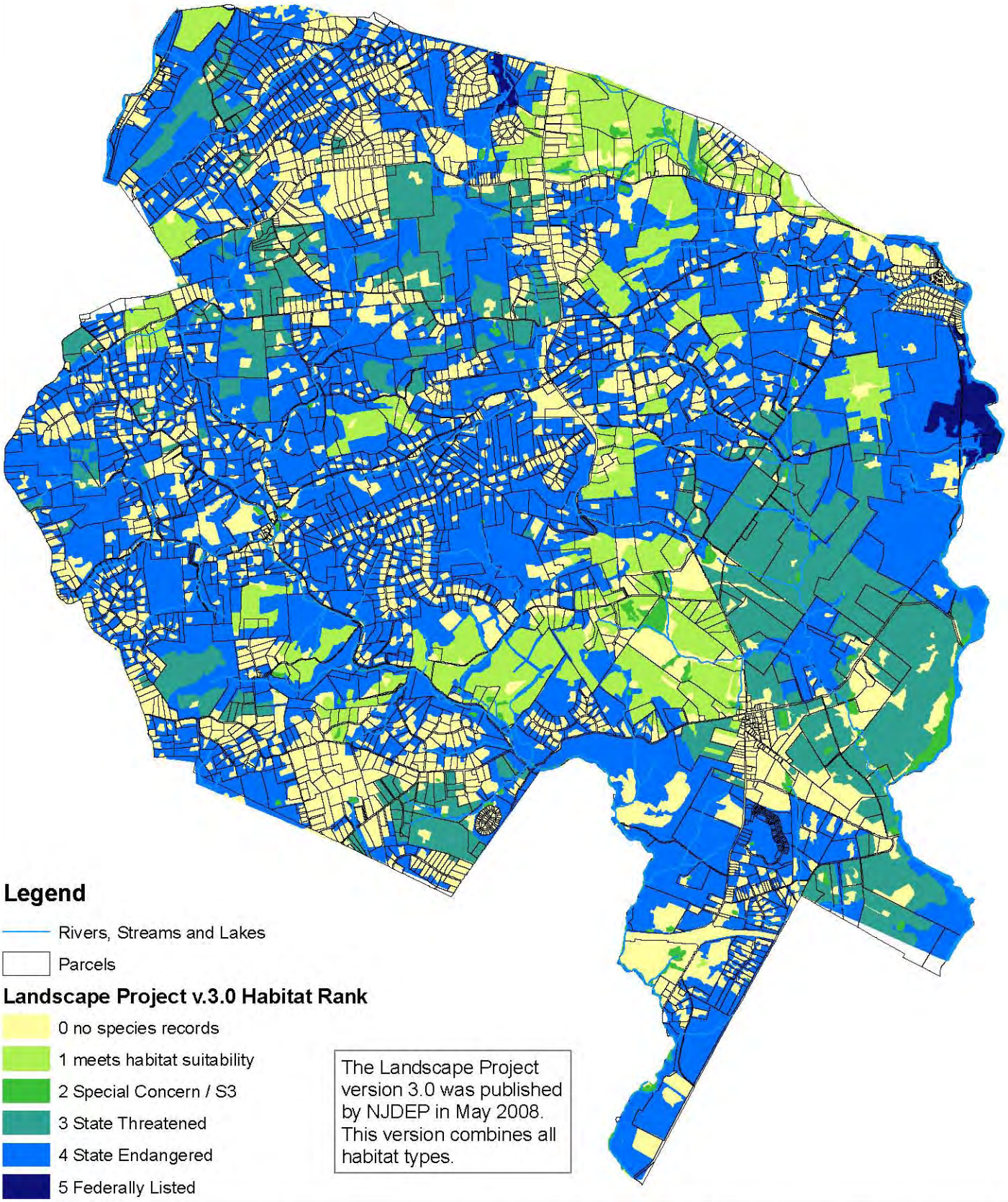
A search of NJDEP Division of Parks and Forestry *Natural Heritage Database* in November 2007 revealed the documented presence of 5 special concern plants in Tewksbury Township (see **Tables 7.5** for code definitions and **Table 7.8** for list**).** These include 2 endangered vascular plants, 2 imperiled 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.



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 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				

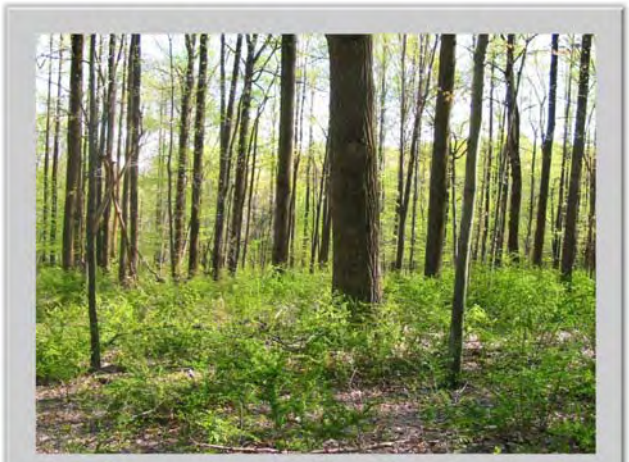
F. Invasive Exotic Species

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."

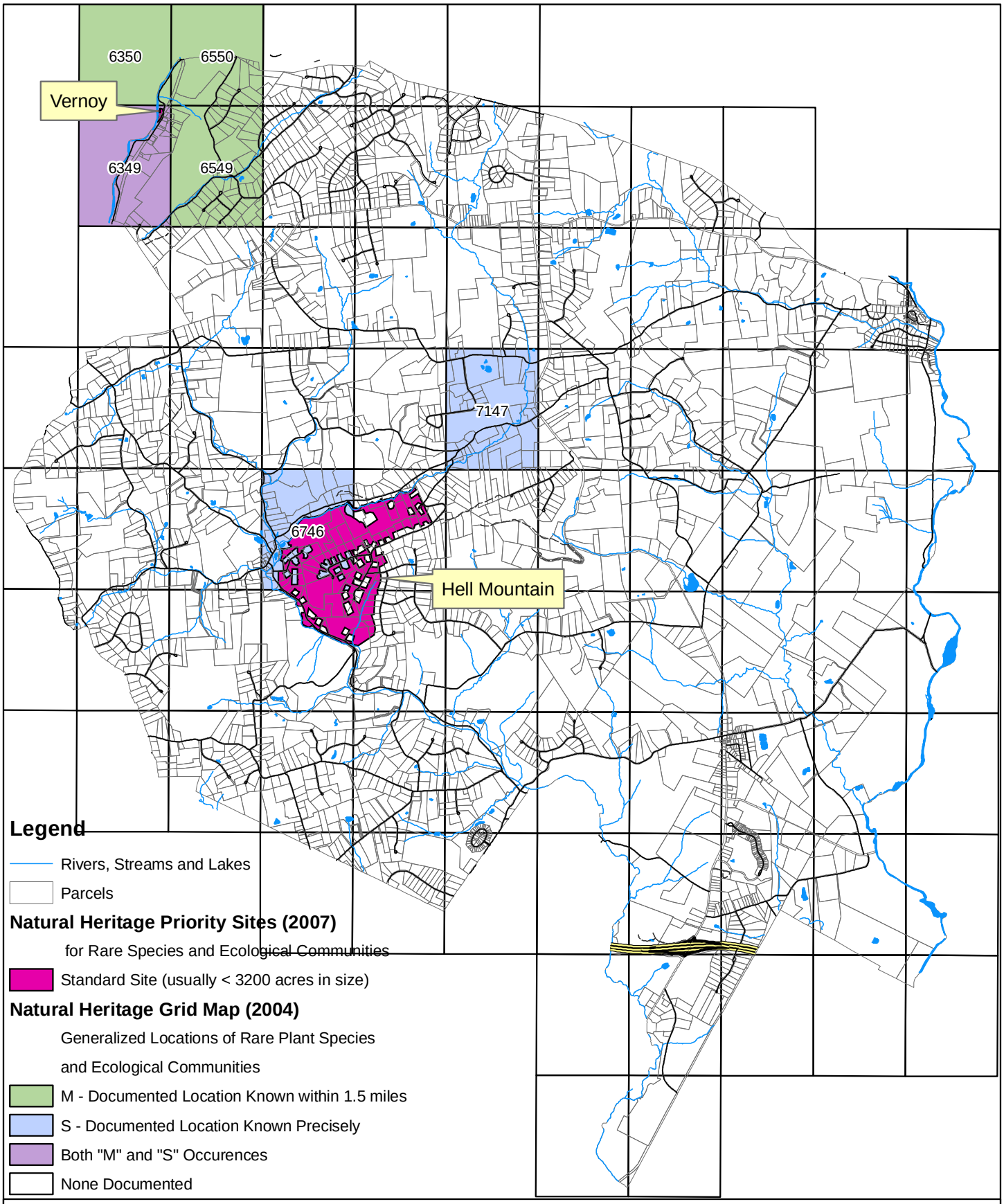
Native plants can be susceptible to exotic diseases, which they have not evolved resistance to. The chestnut blight fungus was an accidental introduction that destroyed all mature chestnut trees, once one of the dominant trees in the New Jersey landscape. Another introduced fungus, Dutch elm disease,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

N

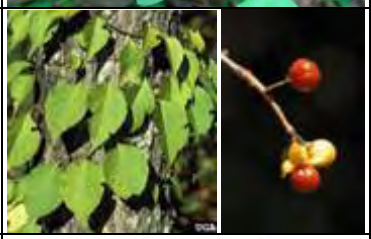
0 0.25 0.5 1 1.5 Miles

Figure 7f: Natural Heritage Priority Sites & Grid Map

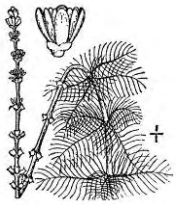
Tewksbury Township ERI, 2009
Prepared by Kratzer Environmental Services

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

Natural Heritage Program (NJDEP Division of Parks and Forestry):
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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

Endangered, Threatened and Special Concern Species
Cornel Lab of Ornithology, All About Birds: http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/

NJDEP Conserve Wildlife Newsletter: http://www.njfishandwildlife.com/ensp/cwnewslt.htm

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