TOWNSHIP of VERONA

ENVIRONMENTAL RESOURCE INVENTORY UPDATE

COUNTY of ESSEX

THE LAND CONSERVANCY
OF NEW JERSEY

December 20, 2018

ENVIRONMENTAL RESOURCE INVENTORY – 2018 UPDATE

for

Township of Verona

County of Essex

Prepared December 20, 2018 by:

The Land Conservancy of New Jersey
An accredited land trust
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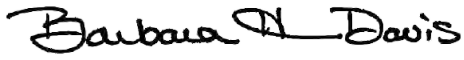

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Township of Verona

County of Essex

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Kevin Ryan, Mayor
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Jack McEvoy, Council Member

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Gloria Machnowski, Chairperson and Webmaster
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COVER PHOTOGRAPH: Verona Park
Photo Credit: Steven J. Neale, Township of Verona
Director of Administration and Economic Development

The information and maps presented in this report are intended for preliminary review and cannot substitute for on-site testing and evaluations. The maps for the Environmental Resource Inventory Update *were developed using NJDEP Geographic Information System digital data.*

EXECUTIVE SUMMARY

The Township of Verona is situated between the First and Second Watchung Mountains in north-central Essex County. It is divided by the Peckman River, a tributary of the Passaic River. Hilltop Reservation is the newest of the County parks, and is located along the Second Watchung Mountain in the Township. Eagle Rock Reservation is in the lower corner of the municipality along the First Watchung Mountain. Centered in Verona is beautiful Verona Park, home to Verona Lake and boathouse.

In 1999 the Township of Verona completed its Natural Resource Inventory with March Associates Landscape Architects, PC. In 2016, Verona Township received Bronze Certification through the Sustainable Jersey program. Highlighted in its application are the activities of the municipality to support and protect its natural resources, including the sale of rain barrels, anti-idling campaign, and the installation of solar panels at the municipal and private buildings. Updating the 1999 Natural Resource Inventory will mirror the efforts of the Green Team through Sustainable Verona and the governing body to highlight the community's natural and cultural resources with the most current scientific data. New Jersey is the first state in the nation to have a comprehensive sustainability program for municipalities that links certification with strong state and private financial incentives, and a fully resourced program of technical support and training.

Verona Township is a residential community, with recreational lands offering a variety of activities including field sports and scenic walking paths. Local municipal parks and county facilities offer an array of recreational and environmental amenities for residents. The historic landscape is well documented and the Township recently completed an inventory of historic sites with Barton Ross & Partners LLC (June 2017). The Township is bordered by Cedar Grove, Montclair, and West Orange Townships, and by Essex Fells and North Caldwell Boroughs.

The Environmental Resource Inventory (ERI) Update is based on available data from federal and state resources, as well as municipal resources, including the 1999 Natural Resources Inventory. Documentation of the natural resource base – the geology, hydrology, ecology, and wildlife – conveys the scope and condition of the resources upon which the Township relies. Extensive mapping and tables detailing the Township's environmental resource base are included within the ERI Update. Sections include information on geology, topography, slopes, hydrology and water resources, soils, flooding, wetlands, wildlife habitat, historic resources, air, and climate change. The ERI Update will assist the community as it makes decisions regarding future planning and development.

The preparation of an updated Environmental Resource Inventory will help meet the Township's goal of being a sustainable community. The Environmental Commission will add new material to the ERI as it becomes available. Knowledge of the natural resources will allow Verona Township's officials and citizens to make informed decisions as they strive to preserve and promote the character of the Township and to create a sustainable community within its landscape.

GEOLOGY

Verona Township is located in north-central Essex County. (*Map 1. Base Map*) It is bounded by Cedar Grove Township, Montclair Township, West Orange Township, Essex Fells Borough, and North Caldwell Borough. It is home to Verona Lake (located within Verona Park) and the Peckman River.

Physiographic Provinces

New Jersey's landscape is divided into four distinct regions, each characterized by unique geologic processes and landforms known as physiographic provinces. Physiographic provinces classify landscapes based on terrain texture, rock type, and geologic structure and history. These attributes play an important role in determining the natural resources of an area. In New Jersey, beginning in the northwest and proceeding to the southeast, these provinces are identified as the Valley and Ridge, Highlands, Piedmont, and Coastal Plain Provinces. Verona Township is located in the Piedmont Province.

The Piedmont Province covers 1,600 square miles, which is roughly 20% of the state, and all of Essex County. The Piedmont Province falls to the east of both the Valley and Ridge Province and the Highlands Province. Its width varies from 16 miles at the border of New York to over 30 miles by the Delaware River. This province is mostly underlain with "slightly folded and faulted sedimentary rocks of Triassic and Jurassic age (240 to 140 million years old) and igneous rocks of Jurassic age."[1] The Piedmont Province's surface is generally low rolling hills marked with sudden, steep ridges, which extend across the state and includes the Palisades in the east.

Geologic History of Verona

Note: The following section was provided by Verona Township Environmental Commission member Walter Steinmann, a local expert in geology trained at Colgate University. References to specific locations are his direct observations. References used are included in the Literature Cited.[2]

The geology of Verona is uniquely influenced by two geological forces that occurred approximately 150 million years apart. The first was the breakup of the supercontinent Pangea, 200 million years ago, when Africa separated from North America during the Upper Triassic and Lower Jurassic. The second influential geological period affecting the Township's topography was the advance and retreat of the Wisconsin period of glaciation. This retreat occurred approximately 10,000 years ago. These two geological events shaped Verona's topography today.

Two mountain ridges, 660 feet above sea level, volcanic in origin, flank the eastern side (Orange Mountain Basalt Formation) and western side (Preakness Basalt Formation) of Verona. The Peckman River eroded through the softer brownish- red siltstone and sandstone rock of the softer formation (Feltville Formation) taking a north course between the ridges and forming an eroded valley (400 feet above sea level) between the more resistant mountains. This gives Verona a prominent hogs back ridge mountain formation topography. This unique topography can lead to large amount of mass wasting on the slopes and heavy flooding in the low valley areas during heavy precipitation.[3]

The hogs back ridge type mountain formation was due to the evolution of a rift valley system from the breakup of Pangea, similar to what is occurring today in the East African rift valley of Kenya. During the Jurassic, volcanic activity occurred creating three distinct lava flow episodes (two of which are found in Verona). During quiet volcanic periods, deposition of sand and mud from the higher elevations, to the west, occurred forming a layer cake sequence of volcanic and eroded materials. Huge amount of pressure from the continued deposition over the millions of years cause the eroded material to form into sandstone and siltstone. Sometime later, the area subsided to the west (along the Ramapo fault) causing the sequence of deposits to tilt downward to the west. Due to the differentiation in erosion rates of the harder basalt and the softer sandstone, distinct ridges formed, with an eroded valley between them.

The second geological event occurred during the Wisconsin Glaciation period, approximately 75,000 years ago, to 11,000 years ago. The ice reworked the landscape by moving and reworking large amount of glacial material to form numerous glacial deposits of consolidated and unconsolidated till in many areas of the Township. This area is covered with ground moraine. Deposits of clay found at the bottom of the glacial lakes are found near the Forest Avenue section of the Township, at a depth of two feet. Large erratics were pushed by the ice and left as the ice retreated. One of these is White Rock found on Hill Top. Two erratic of gneiss boulders are found in Verona Park near the south end, immediately off the walkway. Others are scattered throughout the Township. Another type of formation found in Verona is a sand kame is located at the northern end of town along the west side of Fairview Avenue. Blockage of the outlet of a stream in the valley by the retreating glacier created ancient glacial Verona Lake, that probably extended the whole valley to a depth of as much as one hundred feet. This lake may have lasted a thousand years until the ice melted back for the outlet to connect with the Passaic River.

Bedrock Geology

The geology of Verona can be classified into two layers: bedrock geology, which is consolidated, underlying rock that extends deep into earth's crust; and surficial geology, the unconsolidated sedimentary materials overlaying bedrock formations, and is the parent material for soils. The properties of these layers:

> "determine the physical extent of aquifers and the chemical quality of water they yield. They also control how groundwater recharges and moves through the aquifers, how contaminants seep into and move through soil and groundwater, and where natural hazards like radon, sinkholes, and seismic instability may occur. Finally, these properties establish where geologic resources such as sand, gravel, peat, clay, quarry rock, and mineral ores are located. Geologic properties also determine the suitability of an area for the use of septic systems, the management of stormwater and surface runoff, and the stability of foundations for buildings, bridges, tunnels, and other structures."[4]

Essex County, where Verona lies, is on a sedimentary bedrock of siltstone, shale, sandstone, and conglomerate, as well as an igneous and metaphoric bedrock of basalt.[5] Verona Township is situated between basaltic lava flows that have tilted. The area between the two lava flow episodes contains sedimentary rock from erosion of higher elevation. The difference in erosion rates of hard

basalt and soft sedimentary gives the Township its unique topography. The area where Verona is located is between 200 to 180 million years old.[6]

The underlying bedrock geology of Verona Township consists of four different geologic formations. Of the four, the Orange Mountain Basalt (Jo) holds the majority; it is 57% (1,015 acres) of the Township. It extends immediately west of the Peckman River to the eastern boundary of Verona. The Feltville Formation (Jf) is 26% (466 acres) of the Township, and covers the mid-section of Verona. The Preakness Basalt (Jp) is 17% (298 acres) of the western portion of the Township. Preakness Gabbroid (Jpg) are intermittent sections located within the Preakness Basalt and comprise 1% (17 acres) of the Township. *Map 2. Bedrock Geology* depicts the distribution of the bedrock types within Verona, and *Table 1* shows the frequency of occurrence for each formation.

Table 1. Bedrock Geology in Verona Township

Abbreviation	Geologic Name	Lithology	Acres[a]	Percent
Jo	Orange Mountain Basalt (Lower Jurassic)	Basalt, fine-grained to aphanitic, dark-greenish-gray, composed mostly of calcic plagioclase and augite[7]	1,014.55	56.53%
Jf	Feltville Formation (Lower Jurassic)	Mostly fine-grained, feldspathic sandstone, coarse siltstone, and silty mudstone, brownish-red to light-grayish-red[8]	465.58	25.94%
Jp	Preakness Basalt (Lower Jurassic)	Dark-greenish-gray to black, very-fine-grained, dense, hard basalt composed mostly of intergrown calcic plagioclase (An55-60) and clinopyroxene (pigeonite and augite)[9]	298.06	16.61%
Jpg	Preakness Gabbroid (Lower Jurassic)	Dark-gray, coarse- to very coarse-grained composed of clinopyroxene grains up to 0.5 in. long and plagioclase grains up to 1.0 in. long[10]	16.66	0.93%
		Total:	1,794.85	100.00%

Source: NJGS Bedrock Geology 2015, NJDEP

[a] Acreage calculations in the *ERI Update* are completed using the digital mapping software, ArcGIS 10.6. The acreages may vary slightly from table to table, depending on the source data used to complete the calculations. According to the New Jersey GIS database, Verona Township is 1,796 acres (*New Jersey Geographic Open Data http://njogis-newjersey.opendata.arcgis.com/*). This varies slightly from what is reported in the *2009 Master Plan* (2.79 square miles, or 1,786 acres) and by the *U.S. Census* (2.76 square miles, or 1,766 acres).

Surficial Geology

Surficial geology is the unconsolidated materials overlaying the bedrock formations. Verona's surficial geology is more varied than its bedrock geology, with seven different geologic types spread throughout the Township. The largest type present is the Rahway Till (Qwtr), which covers 36% (653 acres) of the Township. This is followed by the Rahway Till, Scattered Bedrock Outcrop (Qwtr, sbo) which covers 32% (578 acres) of the Township. The third most prevalent type is the Late Wisconsinan Glacial Delta Deposits (Qwde) which holds about 29% (518 acres) of the Township. The Ice-Contact Deposits (Qwic) covers 1% (21 acres) of the Township, and the remaining three types are all under 1%. *Table 2* details the surficial geology of Verona Township and the *Surficial Geology Map* (*Map 3*) depicts the surficial geology features in the Township.

Table 2. Surficial Geology in Verona Township

Abbrev.	Geologic Name	Lithology	Age	Acres	Percent
Qwtr	Rahway Till	Clayey silt to sandy silt with some to many pebbles and cobbles and few boulders; reddish brown, reddish yellow, yellowish brown, brown. As much as 100 feet thick, generally less than 40 feet thick.	late Pleistocene, late Wisconsinan	653.36	36.37%
Qwtr, sbo	Rahway Till, Scattered Bedrock Outcrop[11]	Combination of Rahway Till and Scattered Bedrock Outcrop SBO: Surficial materials are generally less than 10 feet thick		578.36	32.20%
Qwde	Late Wisconsinan Glacial Delta Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 150 feet thick	late Pleistocene, late Wisconsinan	518.55	28.87%
Qwic	Ice-Contact Deposits	Sand, pebble-to-cobble gravel, few to some boulders, minor silt; yellowish brown to reddish brown. As much as 150 feet thick.	late Pleistocene, late Wisconsinan	20.77	1.16%
Ebo	Extensive Bedrock Outcrop	Surficial materials are generally absent[11]		14.44	0.80%
Qal	Alluvium	Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown,	Holocene and late Pleistocene	8.99	0.50%

Table 2. Surficial Geology in Verona Township

Abbrev.	Geologic Name	Lithology	Age	Acres	Percent
		brown, gray. As much as 20 feet thick.			
Qs	Swamp and Marsh Deposits	Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick	late Pleistocene and Holocene	1.81	0.10%
			Total:	1,796.28	100.00%

Source: NJGS Surficial Geology 2016, NJDEP

GEOGRAPHY AND TOPOGRAPHY

Verona's elevation ranges from 300 to 699 feet above sea level, with the lowest point in the Township running along the Peckman River. The high points are located along the western border of the Township and are 600-699 feet above sea level. Verona Township is bounded by the First and Second Watchung Mountain ranges.[12] The Second Watchung Mountain forms the western boundary of the Township, where Hilltop Reservation is located. Peckman River is the valley between the two ranges, with elevations between 300 and 400 feet. The First Watchung Mountain forms the eastern boundary with Eagle Rock Reservation at its base. *Table 3* details the acres in each elevation category, and *Map 4* illustrates the topography of Verona Township.

Table 3. Elevation of Verona Township

Elevation (feet)	Acres	Percent
300-399	553.21	30.80%
400-499	652.84	36.35%
500-599	427.68	23.81%
600-699	162.13	9.04%
Total:	1,795.86	100.00%

Source: NJDEP

Limiting the disturbance of steep slopes is important in preventing soil loss, erosion, excessive stormwater runoff, and the degradation of surface water, as well as maintaining the natural topography and drainage patterns of the land. Disturbing the natural vegetation, topography, and drainage patterns of steep slopes often increases the quantity and speed of runoff and can cause erosion, soil creep, slumping (sections of soil shifting down and outward on the slope), and landslides. The combination of unstable slopes and greater runoff means that more water and sediment (silt) enter streams during precipitation events. Increases in water volume entering streams can increase flooding downstream. In addition, an increase in runoff entering streams means less water is percolating through the soil and back into the groundwater. This percolation helps replenish drinking water supplies, and provides a base flow for streams during drier periods in the area. The increased water runoff also carries larger loads of sediment compared to predevelopment conditions. Excess sediments in streams can harm aquatic life, accelerate the filling of ponds and wetlands, and diminish a stream's aesthetic appearance.

Verona Township adopted a Steep Slope Ordinance in 2016. Article XXI titled "Regulation of Steep Slopes" was added to Chapter 150 of the Code of the Township of Verona to regulate the degree of disturbance of areas of steeply sloping terrain in order to limit soil loss, erosion, excessive stormwater runoff, the degradation of surface water and to maintain the natural topography and drainage patterns of land. Disturbance of steep slopes results in accelerated erosion processes from stormwater runoff, soil loss, changes in natural topography and drainage patterns, increased flooding potential, fragmentation of forest and habitat areas, and compromised aesthetic values.[13]

SOILS

Soils Overview

Soils play a critical role in the environment. They support an area's vegetation, absorb rainwater, and provide habitat. The physical and chemical properties of soils reflect a large number of variables, including the parent material (bedrock), climate, vegetative cover, animal activities, slopes and drainage patterns, and time. New Jersey's fairly complex bedrock geology, history of glaciations, abundant precipitation, and patterns of human use has led to complex patterns of soil distribution.[14]

Soil can shape a landscape through the plants it supports and the water it absorbs. Vegetation, supported by a variety of soils, can provide shelter for animals and food for people. In this way, everything from our food supply to the stable foundations of our homes depend upon soil.[15] The components of soil can vary greatly depending on the parent material, the climate of the region, human and animal activity, and water and drainage patterns. Soil health is the ability of soil to sustain plants, animals, and people, shaping its surrounding ecosystem. Within soil are living organisms, including fungi, bacteria, and microbes. Their health, and thus, the health of the soil, is determined by nutrients, rainwater, and human-influenced pollutants.[16]

Soils Classifications

The official Soil Survey for Essex County was updated in 2007 by the Natural Resources Conservation Service (NRCS), an agency of the United States Department of Agriculture (USDA). The soils maps and tables in this Environmental Resource Inventory Update are based on the data from that official survey.

The NRCS Soil Survey plots soils by map units.[17] The Soil Survey names each map unit based on the characteristics of the dominant soils within that unit. These map unit names identify the soils by their *soil series* classification(s). Each map unit name has an associated abbreviation that offers a shorthand version of the naming/classification system. This abbreviation system identifies the soil types by steepness, stoniness, and frequency of flooding as follows:

- Capital letters at the end of the abbreviation indicate the slope
  "A" being less steep and "E" being steeper
  An example is the Boonton series, which includes BouB, BouC, and BouD
- Small letters following these capital letters indicate stoniness
  "a" "b" or "c" indicate the degree of stoniness: stony, very stony, and extremely stony
  An example of this is the Haledon silt loam series, where HanBc indicates extremely stony
- Small letter "t" at the end of an abbreviation indicates "frequently flooded"
  An example of this is UcDAt, Udifluvents, 0 to 3 percent slopes, frequently flooded

The Soil Survey also categorizes each map unit as one of four map unit types: consociations, complexes, associations, and undifferentiated groups. The soils in Verona Township fall into two groups: consociation and complexes.

Consociations (Cn) are named for the dominant soil. In a consociation, delineated areas use a single name from the dominant component in the map unit. Dissimilar components are minor in extent. Consociations represent 27% (479 acres) of Verona Township's total area. An example of this soil type in Verona Township is the Boonton Loam Soil Series.

Complexes (Cx) consist of two or more dissimilar components that occur in a regularly repeating pattern. The total amount of other dissimilar components is minor in extent. Complexes represent 73% (1,317 acres) of Verona Township's total area. An example of this soil type in Verona Township is the Peckmantown complex.

Appendix A includes the complete list of soils in Verona Township.

Major Soil Series

Soils with similar profiles are a soil series. The three most prevalent soil types in Verona Township are the Boonton-Urban land, Boonton-Loam, and Peckmantown-Urban Land Soil Series. They account for 75% (1,349 acres) of the total land area. Water and Urban Land are not considered soil series and are excluded.

Boonton-Urban Land accounts for 45% of the Township, or approximately 801 acres.

Peckmantown-Urban Land accounts for 20% of the Township, or 364 acres of land.

Boonton-Loam accounts for 10% of the Township, or approximately 184 acres of land.

Map 5. Soil Series and *Table 4* identify the major soil series, and their acreage in Verona Township.

Table 4. Major Soils Series in Verona Township

Soil Series	Acres	% of Township
Boonton - Urban land, Boonton substratum complex, 8 to 15 % slopes	800.69	44.58%
Peckmantown - Urban land, Peckmantown substratum complex, 8 to 15 % slopes	363.76	20.25%
Boonton loam, 8 to 15 % slopes, extremely stony	184.22	10.26%
Udorthents, Peckmantown substratum, 0 to 8 % slopes	148.51	8.27%
Yalesville - Urban land, Yalesville substratum complex, 8 to 15 % slopes	95.20	5.30%
Urban land, Yalesville substratum - Yalesville - Rock outcrop complex, 0 to 8 % slopes	48.46	2.70%
Haledon - Urban land, Haledon substratum complex, 0 to 8 % slopes	40.79	2.27%
Haledon silt loam, 8 to 15 % slopes, extremely stony	31.81	1.77%
Peckmantown silt loam, 8 to 15 % slopes, extremely stony	19.35	1.08%
Less than 1% of Township:		
Water	12.98	0.72%
Hasbrouck silt loam, 0 to 8 % slopes, extremely stony	12.83	0.71%
Yalesville loam, 0 to 8 % slopes, extremely stony	11.28	0.63%

Table 4. Major Soils Series in Verona Township		
Soil Series	**Acres**	**% of Township**
Holyoke silt loam, 0 to 15 % slopes, very rocky	11.13	0.62%
Knickerbocker fine sandy loam, 3 to 8 % slopes	8.21	0.46%
Natchaug muck, 0 to 2 % slopes	2.55	0.14%
Udifluvents, 0 to 3 % slopes, frequently flooded	2.36	0.13%
Horseneck sandy loam, 0 to 3 % slopes	1.89	0.11%
Pits, sand and gravel	0.12	0.01%
Total:	1,796.13	100.00%
Source: Essex County Soil Survey 2007		

Soil Descriptions

Boonton Series

The Boonton soil series is the most prevalent type in Verona Township. Its parent material is loamy basal till that comes from basalt, and the Boonton Series itself is well drained. It is mostly composed of red and brown shale, sandstone, basalt, and granitic gneiss.[18] Boonton Soil Series totals 801 acres in Verona. Boonton Loam Soil Series totals 184 acres in Verona.

- *Geographically Associated Soils:* Haledon, moderately well drained Boonton, and Yalesville are associated soils to the Boonton series.
- *Drainage and Saturated Hydraulic Conductivity:* Overall, the series is moderately well drained, with slow to rapid runoff. The series has a perched water table.
- *Use and Vegetation:* Many Boonton soils are in urbanized, as well as some undeveloped sites such as wooded fields, which are comprised of oaks, red maple, white ash, hickory, gray birch, and dogwood trees.

Peckmantown Series

The Peckmantown series is deep, well drained, and formed in stratified sediments.[19] Peckmantown series accounts for 383 acres of soil in Verona: 364 acres of Peckmantown - Urban Land and 19 acres of Peckmantown silt loam.

- *Geographic Setting*: Peckmantown soils rest on nearly level to moderately steep slopes, found on deltas and lacustrine fans with a slope range of 0 to 15 percent. The soil formed in glaciolacustrine materials comes mostly from basalt, red sandstone, and granitic gneiss. The climate area for Peckmantown series is humid.
- *Geographically Associated Soils*: Boonton, Horseneck, Hinckley and Knickerbocker soils are also found nearby.
- *Drainage and Saturated Hydraulic Conductivity*: Peckmantown series is well drained, with a surface permeability that is moderately rapid.

- *Use and Vegetation*: Peckmantown soils are often found in highly urbanized areas, with a few undeveloped areas, as well, which included white pine, Norway spruce, black cherry, oaks, and red maple.

Udorthents

Udorthents consist of areas which have been transformed by earth moving, including grading, cut and fill, residential development, commercial and industrial buildings, cemeteries, and recreational areas. This soil typically has human artifacts and ash from coal mixed in, and generally is comprised of loamy material in the upper sections of the soil, and sandy-to-loamy material in the lower part. In Verona, Udorthents total 149 acres, and are part of the Boonton, Haledon, and Peckmantown substratum, with a 0-8% slope.

Yalesville Series

The Yalesville series is moderately deep, well drained, and formed in a loamy till. This series is nearly level to moderately steep, and found on hills and ridges with a slope range of 0-50%. Yalesville soil totals 106 acres in Verona Township: 95 acres of Yalesville – Urban Land and 11 acres of Yalesville loam.

- *Geographic Setting*: Yalesville soils are nearly level to moderately steep, found on hills and ridges, and formed in acid till from red sandstone, shale, conglomerate, and basalt.
- *Geographically Associated Soils*: Associated soils include Bash, Berlin, Branford, Cheshire, Ellington, Hartford, Holyoke, Ludlow, Manchester, Menlo, Penwood, Watchaug, Wethersfield, and Wilbraham.
- *Drainage and Saturated Hydraulic Conductivity*: Yalesville series is well drained with surface runoff that is negligible to very high. Its saturated hydraulic conductivity is moderately high or high when in the solum, and high in the substratum.
- *Use and Vegetation*: Many areas used for Yalesville soil are cleared and in hay, pasture, silage corn, vegetables, nursery stock, and orchards, as well as some wooded or community areas. Vegetation includes white, red, and black oak, red maple, hickory, gray birch, white pine, and hemlock.

Urban

Urban land is defined by areas altered by structures so that the soil is not viable for vegetation without extensive reclamation. This soil's parent material is a surface covered by pavement, concrete, or buildings, which are underlain with disturbed and natural soil. Urban land in Verona is 49 acres, and found in the Yalesville, Boonton, and Peckmantown substratum with 0-8% slope.

Haledon Series

Haledon soil is deep and poorly drained and found in uplands and low positions, formed through glacial till.[20] There are 41 acres of Haledon-Urban Land and 32 acres of Haledon Silt Loan Soil Series in Verona Township.

- *Geographic Setting*: Haledon soils are found at slope bases and shallow drainageways. The soil is composed primarily of basalt, red sandstone and shale, and granitic gneiss with lesser amounts of quartzite and gray sandstone and shale.
- *Geographically Associated Soils*: Similar soils include Boonton, Rockaway, and Holyoke, which are all usually higher in the landscape.
- *Drainage and Saturated Hydraulic Conductivity*: The series is somewhat poorly drained, with a perched high water table within 30 cm of the surface in the winter and spring.
- *Use and Vegetation*: This soil is used most often in wooded or idle fields, and for housing and urban development. Vegetation is oak and maple, with some birch and ash.

Hasbrouck Series

The Hasbrouck series has deep, poorly drained soils, and is found in depressions on uplands.[21] This series and the soils in it usually form from eroded and redeposited glacial materials. In Verona Township there are 13 acres of Hasbrouck Silt Loam.

- *Geographic Setting*: Hasbrouck soils can be found in level or gently sloping depressions and drainageways, as well as places that are adjacent to narrow floodplains of minor streams on uplands. The soils were formed in eroded glacial materials on till of Wisconsin Age, which is made of red shales, red sandstone, and basalt.
- *Geographically Associated Soils*: Similar soils include Boonton, which is well to moderately well drained, as well as Haledon which is somewhat poorly drained.
- *Drainage and Saturated Hydraulic Conductivity*: This soil is poorly drained, with negligible to high runoff and moderately rapid to moderate permeability.
- *Use and Vegetation*: Hasbrouck Soil is often used in wooded areas with gentle slopes. Vegetation includes red maple, ash, pin oak, and swamp white oak.

Holyoke Series

Holyoke series soil is shallow and well drained-somewhat excessively drained.[22] It comes from a thin mantle of till that derives from basalt and red sandstone, conglomerate, and shale. Holyoke silt loam totals 11 acres in Verona Township.

- *Geographic Setting*: Holyoke soils can be found on nearly level or very steep ground, and located on bedrock controlled hills, changed through glacial action.
- *Geographically Associated Soils*: Associated soils include Boonton, Branford, Broadbrook, Cheshire, Enfield, Haledon, Hartford, Ludlow, Manchester, Meno, Narragansett, Watchung, Wethersfield, Wilbraham, and Yalesville.
- *Drainage and Saturated Hydraulic Conductivity*: Holyoke soils is well drained and somewhat excessively drained, and its surface runoff is medium to very rapid. The saturated hydraulic conductivity is moderately high to very high.
- *Use and Vegetation*: This soil is in areas that are mostly forested, and can be used for orchards, cultivated crops, hay, or pastures. Vegetation includes red, white, black, and chestnut oak, hickory, red maple, red cedar, hemlock, white pine, and gray and black birch.

Knickerbocker Series

The Knickerbocker series is deep and well-to-somewhat excessively drained, with soils formed in sandy glacio-fluvial deposits.[23] This series is found at nearly level to steep soils on lake plains and terraces. The Knickerbocker soil series totals 8 acres in Verona Township.

- *Geographic Setting*: Knickerbocker soils are nearly level-to-steep, and found on lake plains and terraces. They form in stratified sandy deltaic or fluvial deposits.
- *Geographically Associated Soils*: Associated soils include Castile, Elmridge, Elnora, and Walpole, as well as the Hoosic, Riverhead, and Windsor competing soils.
- *Drainage and Saturated Hydraulic Conductivity*: Knickerbocker soil is well or somewhat excessively drained, with low-to-high potential surface runoff.
- *Use and Vegetation*: Most areas have been cleared, and in turn used for orchard, corn, potatoes, hay or vegetable crops. In steeper areas, this soil is found in idle or wooded places, containing sugar maple, oak and hickory.

Natchaug Series

The Natchaug series are deep, very poorly drained, formed in woody and herbaceous organic materials, and found in depressions on lake plains, outwash plains, till plains, moraines, and flood plains.[24] Natchaug muck totals 3 acres in Verona Township.

- *Geographic Setting*: Natchaug soils are found in depressions on lake plains, outwash plains, moraines, till plains, and flood plains. These soils form in woody and herbaceous organic materials.
- *Geographically Associated Soils*: Associated soils are Catden, Freetown, Leicester, Ridgebury, Timakwa, and Whitman.
- *Drainage and Saturated Hydraulic Conductivity*: Natchaug soils are poorly drained, and have a high water table range from 1 foot above the surface to 30 centimeters below the surface. Runoff is negligible or very low, and the saturated hydraulic conductivity is moderately high or high in the organic layers and moderately low-to-high in the loamy material. Some areas in the series are subject to frequent flooding from September through June.
- *Use and Vegetation*: More series areas are used for wildlife or woodland, and sometimes for pasture. Vegetation includes red maple, skunk cabbage, and sphagnum moss.

Udifluvents

Udifluvents are 2 acres in Verona, classified as frequently flooded. They are on floodplains along streams and rivers.[25]

Horseneck Series

The Horseneck series has deep, moderately well drained soils from glaciofluvial deposits.[26] These deposits come from granitic materials on outwash plains, deltas, and lake basins. Horseneck sandy loam totals 2 acres in Verona Township.

- *Geographic Setting:* Horseneck soils are found at level-to-gently sloping areas on outwash plains, deltaic deposits, and in glacial lake basins, found at higher elevations.
- *Geographically Associated Soils*: These soils include Riverhead, Pompton, Passaic, Boonton, Haledon, Rockaway, Preakness, Parsippany, and Great Piece.
- *Drainage and Saturated Hydraulic Conductivity*: In general, Horseneck is moderately well drained with low-to-medium runoff. The groundwater table is within 40 inches of the surface in winter and spring.
- *Use and Vegetation*: Most areas with Horseneck soil is woodland, residential, or developing industrial land, with a small portion for farmland. Vegetation includes birch, oak, maple, and sweetgum.

Pits

Pit soil series consists of less than 1 acre in Verona and is classified as sand and gravel.

Soil Characteristics

Hydric Soils

According to the Natural Resources Conservation Service, "A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part." Hydric soils are an important element of wetland areas and naturally support wetland vegetation. If a soil is classified as "hydric," Federal/State Wetlands Law may restrict land use due to the relationship of hydric soils to wetlands and wetland preservation.[27] Soils in Verona Township that have a hydric rating are Hasbrouck soil loam (HctBc) and Natchaug muck (NazA).

Agricultural Soils

Prime Farmland is defined by the United States Department of Agriculture (USDA) as land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, and oilseed crops.[28] This classification of soil accounts for 1% (19 acres) of the land in Verona Township. Areas of Prime Farmland in Verona Township are along Verona Lake and the Peckman River. (*Map 6. Agricultural Soils*)

Farmland soils of Statewide Importance contain soils that are also highly productive under the right circumstances but not considered Prime Farmland and account for 0.12% (2 acres) in Verona Township.

Farmland of Unique Importance can be used for the production of specific high value food and fiber crops (for example: cranberries, fruits, and vegetables) but are not considered Prime Farmland. These soils account for 2.5 acres in Verona. *Table 5* details the agricultural potential of soils in Verona Township.

Table 5. Soil Rated for Agricultural Use		
Farmland	**Acres**	**% of Township**
Prime Farmland	18.68	1.04%
Farmland of Statewide Importance	2.15	0.12%
Farmland of Unique Importance	2.55	0.14%
Not Prime Farmland	1,772.76	98.70%
Total:	1,796.13	100.00%
Source: Essex County Soil Survey 2007		

Erodibility

Soils can be categorized by their susceptibility to erosion, the natural process by which wind, moving water, ice, and gravitational forces cause soil and particulate materials to be displaced. While erosion of exposed bedrock occurs over an extended time scale, soil erosion can occur more acutely with more immediate consequences. The consistency of the soil is one factor determining its erodibility potential, with dense, compact, clayey soils being less susceptible and looser loamy soils, with varying levels of clay and sand, being more susceptible. A measure of this susceptibility is the K-factor. The K-factor looks at the soil texture and composition as well as the permeability to determine a number between 0.02 (less susceptible) and 0.69 (more susceptible) that demonstrates the erosion potential for a particular soil.

Soil erodibility for the soils located in Verona is found in *Appendix B.* This table includes the following factors for erosion:

> **Erosion factor Kw:** Erodibility of the whole soil. The estimates are modified by the presence of rock fragments.
> **Erosion factor Kf:** Erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.
> **Erosion factor T:** Estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

The higher the K value, the more susceptible the soil is to sheet and rill erosion by water. In Verona Township, the soil K-factors range from 0.05 to 0.64.

Topographic Protection (Wind)

According to the Natural Resource Conservation Service (NRCS), the soils of Verona Township are subjected to erosion by wind. Wind erosion most often affects soil on bare lands, where sheer force of wind detaches particles protruding from the soil surface. A conservation measure that can minimize damage due to wind erosion is maintaining a surface cover. Wind erosion is measured by group and index. Wind erodibility groups consist of soils that have similar properties that affect their susceptibility to wind erosion. Soils in group 1 are most susceptible to wind erosion, while soils in group 8 are less susceptible to wind erosion. Wind erodibility index is a numerical value that measures the susceptibility of soil to wind erosion. This value is measured in tons per acre per year that is expected to be lost to wind erosion. (*Appendix B*)

Limitations for Use

Other characteristics of soil that determine suitability for development, including its capacity to support foundations without corrosion, limits for septic systems, and hydrological characteristics such as tendency towards ponding and flooding, a shallow water table or potential for frost heave, can contraindicate development. The NRCS Soil Survey states, "Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes soil poorly suited to basements or underground installations." Limitations for use include the following characteristics:

Depth to restrictive layer is the vertical distance from the soil surface to the upper boundary of the restrictive layer. The restrictive layer is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. Though not shown in this table, information on the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation, can be obtained for specific soil types.

Drainage refers to the relative wetness of the soil under natural conditions as it pertains to wetness due to a water table. Drainage classes refer to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Drainage classes range from excessively drained (water is removed very rapidly and the soils are commonly coarse-textured or shallow) to very poorly drained (water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season and unless artificially drained, most crops cannot be grown).

Capacity [of most limiting layer] to transmit water refers to the ease with which pores in a saturated soil transmit water. This capacity is considered in the design of soil drainage systems and septic tank absorption fields.

Depth to water table indicates a range of expected depth to a saturated zone in the soil, known as a "water table," that occurs during several months in most years. A saturated zone that lasts for less than a month is not considered a water table.

Flooding is the temporary inundation of an area caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

- "None" means that flooding is not probable. The chance of flooding is nearly 0% in any year. Flooding occurs less than once in 500 years.
- "Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1% in any year.
- "Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1-5% in any year.

- "Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5-50% in any year.
- "Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in any year but is less than 50% in all months in any year.
- "Very frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50% in all months of any year.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. Frequency is expressed as none, rare, occasional, and frequent.

- "None" means that ponding is not probable;
- "Rare" that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 to 5% in any year);
- "Occasional" that it occurs, on the average, once or less in two years (the chance of ponding is 5-50% in any year); and
- "Frequent" that it occurs, on the average, more than once in two years (the chance of ponding is more than 50% in any year).

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained.

Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the

combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

Septic limitations refer to effectiveness of a soil type to manage a septic tank absorption field. Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tile or perforated pipe. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. The most important soil properties that determine septic limitations are saturated hydraulic conductivity (Ksat), depth to a water table, ponding, depth to bedrock or a cemented pan, and flooding. Stones and boulders, ice, and bedrock or cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. All of the rated soils in Verona Township are classified by the NRCS as "very limited," which indicates that the soil has at least one feature that is unfavorable for such use, with the expectation of poor performance and high maintenance.[29] (*Appendix C*)

Soil Limitations for Building Site Development

Verona Township has soils that are rated by the NRCS Web Soil Survey as having no limits, some limits, or many limits on their ability to support dwellings with or without basements and small commercial buildings. (*Appendix D*)

For the purpose of these ratings, dwellings are defined as single-family houses of three stories or less and small commercial buildings are structures that are fewer than three stories high and do not have basements. For dwellings without basements and small commercial buildings, the foundation is "assumed to consist of spread footing of reinforced concrete built on undisturbed soil at a depth of 2 feet or at a depth of maximum frost penetration, whichever is deeper." For dwellings with basements, the foundation is "assumed to consist of spread footings of reinforced concrete built in undisturbed soil at a depth of about 7 feet." The ratings for dwellings are based on the soil properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding and flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Properties that affect excavation and construction costs are depth to a water table, ponding and flooding, slope, depth to bedrock or cemented pan, hardness of bedrock or cemented pan, and the amount and size of rock fragments.[30] The ratings are as follows:

> **Not Limited:** indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected.
> **Somewhat Limited:** indicates that the soil has features that are moderately favorable for specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
> **Very Limited:** indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

See *Appendix D* for the breakdown of these ratings for each soil type and their total acreage found throughout the Township.

Limitations for Recreational Use

Camp areas require preparation, which including shaping and leveling parking and tents, stabilizing roads and frequently used areas, and installing sanitary facilities and utility lines. Areas for camping often incur foot traffic and some motor traffic. Picnic areas incur heavy foot traffic, and limited motor traffic, as there are parking spots outside park areas. Playgrounds need level soil that is free of stones and that can stand heavy foot traffic. *Appendix E* identifies the major soils in Verona and their limitations for recreational land. The value columns indicate a value from 0.01 to 1, with a larger value indicating more limitations. There are multiple values, each relating to the limiting factors.

HYDROLOGY

Watersheds

A watershed is defined as a topographic area in which water runoff drains to a specified body of water, such as a lake or stream.[31] Considering natural resource management through a watershed-based approach is considered by state and national agencies to be the most appropriate unit for managing complex environmental problems.

Verona Township falls within two Watershed Management Areas (WMAs). The majority of Verona Township is part of WMA 4, which is comprised of the Lower Passaic River and the Saddle River. This covers 97% of the Township, while the remaining 3% belongs to WMA 6, or the Upper Passaic, Whippany, and Rockaway Rivers.

Every WMA is composed of multiple watersheds and sub-watersheds. The United States Geological Survey (USGS) has mapped and identified watersheds using hierarchical numbering systems. This system identifies watersheds using hydrological unit code (HUC) consisting of up to 14 digits for the smallest watersheds. The HUC14 watersheds for Verona Township are identified on *Map 7* and listed in *Table 6*.

Table 6. HUC14 Watersheds

WMA	WMA name	Sub-Watersheds	Acres	Percent
4	Lower Passaic and Saddle	Peckman River (above Cedar Grove Reservoir tributary)	1644.36	91.55%
4	Lower Passaic and Saddle	Peckman River (below Cedar Grove Reservoir tributary)	80.12	4.46%
4	Lower Passaic and Saddle	Second River	15.56	0.87%
6	Upper Passaic, Whippany, and Rockaway	Passaic River Upper (Pine Brook bridge to Rockaway)	52.77	2.94%
6	Upper Passaic, Whippany, and Rockaway	Canoe Brook	3.31	0.18%
		Total:	1,796.13	100.00%

Source: NJDEP HUC 14 Watershed 2006

Surface Water

Surface water is water that collects on the ground or in a stream, river, lake, wetland or ocean. There are two surface water bodies in Verona Township: the Peckman River and Verona Lake. Verona Lake was formed when the Peckman River was damned for a grist mill.[32] (*Figure 1*)

Figure 1. Verona Lake
Photo Credit: Steven J. Neale, Director of Administration & Economic Development, Verona Township

New Jersey's Surface Quality Standards (SWQS) (N.J.A.C. 7:9) classify Fresh Water 1 (FW1) as the highest level of classification, which is defined as:

> "those fresh waters, as designated in N.J.A.C. 7:9B-1.15(j), that are to be maintained in their natural state of quality (set aside for posterity) and not subjected to any manmade wastewater discharges or increase 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)."[33]

The general classification for other freshwaters in the State is Fresh Water 2 (FW2). The presence of trout in a stream means that the waters are relatively free of chemicals or biological contaminates, and is used to further designate uses. A stream can be classified as Trout Production (TP), Trout Maintenance (TM), or Non-Trout (NT):

- *Trout Production* waters are designated "for use by trout spawning or nursery purposes during their first summer."
- *Trout Maintenance* waters support trout throughout the year.
- Waters classified as *Non-Trout* do not support trout, either because of their physical nature or due to biological or chemical characteristics ((SWQS) (N.J.A.C.7:9B)).

The waterbodies (Peckman River and its tributaries) of Verona Township are classified as Fresh Water 2 (FW2) waterbodies. (*Map 8*)

Surface water quality is affected by point sources and non-point sources of pollution as well as erosion and sedimentation. Point source means any discernible, confined, and discrete fissure,

container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are or may be discharged.[34] This includes discharges from sewage treatment plants and factories, stormwater runoff, illegal dumping, and malfunctioning underground storage tanks and septic tanks. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

In contrast to point source pollution, non-point source pollution comes from many different sources. As rainfall or snowmelt moves over and through the ground, it picks up and carries natural and human-made pollutants (such as fertilizers, herbicides, and motor oil) and deposits them into surface and ground water. The effects of pollutants on specific waterways can vary but eventually all are manifested into negative outcomes for drinking water supplies, recreation, fisheries, and wildlife. One of these effects is eutrophication, which, in freshwater systems, is the addition of substances, either human-made or natural, to a water body affecting the primary productivity of that body of water. Nitrates and phosphates promote excessive algae growth. These "blooms" can have negative effects on the ecosystem. This can include clouding of the water which limits sunlight penetration and stops the growth of plants deeper in the water. Additionally, eutrophication can lead to anoxia, a condition where a water body has depleted levels of oxygen – a result of the decomposition of dead phytoplankton.

Water quality can also be negatively impacted by sedimentation, which is the transportation and deposition of eroded materials. A primary cause of sedimentation is development near streams and on steep slopes that reduce vegetative cover and results in exposed soil. The vegetative cover can typically absorb the impact of raindrops, but when it is removed, the exposed soil easily becomes eroded. The eroded soil can then be transported to surface waters where it could contaminate and increase the turbidity of the water, effectively blocking sunlight to plant species and negatively affecting the health of the aquatic ecosystem.

Aquifer Recharge

An aquifer is an underground formation of permeable rock or unconsolidated materials that can yield significant quantities of water to wells or springs. The rate of recharge is not the same for all aquifers, and that must be considered when pumping water from a well. Pumping too much water too fast draws down the water in the aquifer and eventually causes a well to yield less and less water and even run dry.

Aquifers are typically equated to the type of geologic formation in which they exist. Aquifers in New Jersey are classified as either bedrock or surficial. Bedrock aquifers consist of rock formations while surficial aquifers are formed from unconsolidated materials such as sand or gravel or glacial sediment. Bedrock aquifers in the Piedmont contain water in fractures within the rock while surficial aquifers contain water primarily in the spaces between sand and gravel particles.

Verona Township, due to its location between the Second and First Watchung Mountains, is underlain by the Basalt bedrock aquifer and the Brunswick bedrock aquifer. The Brunswick Aquifer comprises of about 32% (572 acres) of the Township. The Basalt encompasses about 68% (1,224 acres) of Verona. (*Map 9* and *Table 7*)

Table 7. Bedrock Aquifers in Verona Township			
Name	**Rank**	**Acres**	**Percentage**
Brunswick Aquifer	C	572.27	31.86%
Basalt	D	1,223.86	68.14%
	Total:	1,796.13	100.00%
Source: NJGS Aquifers of New Jersey 1998, NJDEP			

Surficial aquifers in New Jersey are those water-bearing formations which are both greater than 50 feet thick (New Jersey law requires well casing of no less than 50 feet) and are significantly different, hydrogeologically, than the underlying aquifer. Surficial aquifers are most prevalent in northern New Jersey where bedrock consists of consolidated fractured bedrock overlain by thick sequences of unconsolidated glacial sediments. In the coastal plain "bedrock" consists of unconsolidated sediments (usually of Cretaceous or Tertiary age). Most of the younger surficial sediments are hydrogeologically connected to the underlying water table aquifer and are therefore considered part of that aquifer. If the surficial sediments are of a sufficient thickness and are underlain by a confining unit, i.e., not hydrogeologically connected to the underlying aquifer, then it may be considered a surficial aquifer. Essex County falls within this area where the surficial sediments are of limited area which meet the requirements above and are not considered to be an aquifer in the commercial sense of the word and will not be mapped, however they may provide enough water for localized domestic supply.

Public Water Supply and Wellhead Protection

The 1986 Federal Safe Drinking Water Act Amendments (*Section 1428, P/L. 93-523, 42 USC 300 et seq*) directed all states to develop a Well Head Protection Program (WHPP) Plan for both public community (CWS) and public non-community (NCWS) water supply wells. A component of the WHPP is the delineating of Well Head Protection Areas. This delineation is the first step in defining the sources of water to a public water supply in order to prevent and clean up groundwater contamination

Wellhead Protection Areas (WPAs) are delineated for both public community and non-community wells. The delineations for these wells are two, five, and twelve year tiers. Each tier represents the horizontal extent of ground water captured by a well pumping at a specific rate over those periods of time. Verona Township has two community water supply wells, both located on the western side of town (north of Bloomfield Avenue and west of Fairview Avenue). Several surrounding towns also have wells, including North Caldwell Borough and Cedar Grove Township. *Map 10* depicts the wellhead protection and the locations of the public community water supply wells located in Verona Township and the surrounding area.

According to Verona Township's Annual Water Quality Report (2016), water in the Township is derived from groundwater wells that the Township owns and operates as well as treated surface water purchased from the Passaic Valley Water Commission (PVWC).[35] The well water is withdrawn from the Feltville aquifer. The PVWC gets their water from the Wanaque Reservoir. In case of an emergency, there are also drinking water connections with both Essex Fells and the New Jersey American Water Company.[35]

Riparian Zones

In order to better protect the public from hazards of flooding, preserve the quality of surface waters, and protect wildlife and vegetation, the NJDEP has adopted Flood Hazard Area Control Act Rules (N.J.A.C. 7:13) in order to incorporate more stringent standards for development in flood hazard areas and riparian zones.[36] A riparian zone is land and vegetation with and adjacent to surface waters. Riparian areas in the Piedmont include all open waters, flood prone areas, and wildlife corridors (300-foot corridors along each stream bank). Activity within the regulated area of the flood hazard area and the riparian zone may be restricted if it includes or results in one or more of the following:

- The alteration of topography through excavation, grading, and/or placement of fill;
- The clearing, cutting, and/or removal of vegetation in a riparian zone;
- The creation of impervious surface;
- The storage of unsecured material;
- The construction, reconstruction, and/or enlargement of a structure; and
- The conversion of a building into a private residence or a public building.

In most areas of New Jersey, Category 1 waters require a 300-foot buffer, while other surface waters, such as those classified as FW2-NT are subject to only a regulated 50-foot riparian zone, measured from the top of the bank, along both sides of all waters.

WETLANDS

Wetlands are an important natural resource that contributes significantly to an area's social, economic, and environmental health. Among the services they provide are filtration of chemicals, pollutants, and sediments in water; flood control; critical habitat for wildlife; and recreation and tourism. The NJDEP defines a freshwater wetland as "an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation; provided, however, that the Department, in designating a wetland, shall use the three-parameter approach (that is, hydrology, soils, and vegetation) enumerated in the 1989 Federal Manual."[37] (*N.J.A.C. 7:7A*) NJDEP has adopted this manual as the technical basis for identifying and delineating wetlands. Verona Township is home to wetland areas, typically following the stream corridors throughout the town.

The NJDEP regulates virtually all activities in a wetland, including removing vegetation and filling and placing obstructions. Depending on the environmental value of a particular wetland, there may also be a transition area, or buffer, around the wetland that will require a waiver issued by the NJDEP for any activity within that zone. A wetland containing endangered species habitat would require a 150-foot wide transition area, whereas a small wetland in a ditch might not require any transition area at all. Most freshwater wetlands require a 50-foot transition area. Wetlands in New Jersey are classified into three different values: exceptional resource value, ordinary resource value, or intermediate resource value:

Exceptional Resource Value Wetland

- Dischargers into FW-1 water and FW-2 trout producing waters and their tributaries;
- Is a present habitat for threatened or endangered species; or
- Is a documented habitat for threatened or endangered species, and remains suitable for breeding, resting, or feeding by the species during the normal period these species would use the habitat.

Ordinary Resource Value Wetland

- A freshwater wetland which does not exhibit any of the characteristics of an Exceptional Resource Value Wetland which is:
    - An isolated wetland, as defined at *N.J.A.C. 7:7A-1.4*, which:
        - Is smaller than 5,000 square feet
        - Has the uses listed below covering more than 50% of the area within 50 feet of the wetland boundary. In calculating the area covered by a use, NJDEP will only consider a use that was legally existing in that location prior to July 1, 1988, or was permitted under this chapter since that date:
            - Lawns
            - Maintained landscaping
            - Impervious surfaces
            - Active railroad right-of-way
            - Graveled or stoned parking/storage areas and roads

- A drainage ditch
- A swale or
- A detention facility that was uplands at the time it was created regardless of the wetland resource classification of the wetlands under these rules, or classification of the body of water, as FW-1 or FW-2 trout production, to which it discharges.

Intermediate Resource Value Wetland

- A freshwater wetland of intermediate resource value is any wetland not defined as exceptional or ordinary

According to the NJDEP 2012 Land Use/Land Cover Data, there are 19 acres of wetlands within Verona Township. *Map 11* shows the locations of wetlands in Verona. *Table 8* presents a summary of wetlands by type. The dominant type of wetland in Verona is deciduous wooded wetlands, comprising 79% of the Township's wetlands. Though this information is based on NJDEP mapped wetlands, unmapped wetlands, which are still subject to NJDEP regulation, may exist in Verona. Wetlands would require a professional delineation before a regulated activity could occur in or around them.

Table 8. Wetlands in Verona Township

Type	Acres	Percent
Managed Wetland in Built-up Maintained Rec Area	4.00	20.63%
Deciduous Wooded Wetlands	15.39	79.37%
Total:	19.39	100%

Source: Land Use/Land Cover 2012, NJDEP

VEGETATION

Since 1986, the NJDEP has mapped land use within the state through their Land Use/Land Cover (LU/LC) data sets. Areas are delineated using color infrared images. The latest update of this data occurred in 2012. The NJDEP also maps critical habitat for imperiled and priority species through the Landscape Project, which is a proactive, ecosystem-level approach to the long-term protection of these habitats, rare plant species, and ecological communities through the Natural Heritage Database.

Land Cover

The NJDEP identifies six LU/LC categories: agriculture, barren land, forest, urban, and wetlands. Forested areas represent approximately 15% of Verona Township's land cover, providing critical habitat for wildlife. Wetlands account for approximately 1% and urban land represents 83% of Verona Township's land cover. Together, wetlands, rivers, and streams provide riparian corridors which are a different type of habitat for wildlife species. *Table 9* shows the percentage of acreage covered by each land cover type and *Map 12* shows their distribution in the Township.

Table 9. Land Use

Land Use Type	Acres	Percent
Urban	1481.79	82.50%
Forest	262.53	14.62%
Water	19.51	1.09%
Wetlands	19.39	1.08%
Barren Land	12.90	0.72%
Total:	1,796.13	100.00%

Source: NJDEP Land Use/Land Cover 2012

Forest Types

Forested lands in Verona Township include the following classifications as depicted in the NJDEP LU/LC mapping:

Deciduous – This category includes forested lands that contain deciduous tree species. Deciduous trees are those which lose their leaves at the end of the growing season. These trees remain leafless throughout the winter and sprout new leaves the following spring. The average height of the stand is at least 20 feet. A forest stand must have at least 75% canopy coverage from deciduous trees species to be placed in this category. In Verona Township, there are 254 acres of deciduous forest.

> *Deciduous Forest, >50% Crown Closure:* This category contains deciduous stands with crown closure greater than 50%. Crown closure is the percentage of forest area occupied by the vertical projections of tree crowns. Crown closure percentages provide a reasonable estimate of stand density. The majority of the deciduous forests in New Jersey are in this category.

Deciduous Forest, 10-50% Crown Closure: This category contains deciduous forest stands that have crown closure greater than 10% but less than 50%.

Brush/Shrubland – When vegetation is less than 20 feet high, the area is categorized as brush/shrubland. The following types have been identified in Verona Township totaling 9 acres.

Deciduous Brush/Shrubland: This category contains natural forested areas with deciduous species less than 20 feet in height. An area must have greater than 25% brush cover to be placed in this category. This category can also contain inactive agricultural areas that have grown over with brush.

Mixed Deciduous/Coniferous Brush/Shrubland: This category contains natural forested areas less than 20 feet high with a mixture of coniferous and deciduous trees.

Old Field: This category includes open areas that have less than 25% brush cover. The predominant cover types are grasses, herbaceous species, tree seedlings, and/or saplings. Old Fields are distinguished from inactive farmland by the amount of brush cover. If a field contains few woody stems (<5%), it should be placed in the inactive farmland category. An area should be placed in the Old Field category if the amount of brush cover requires extensive brush removal before plowing. In some cases, it may not be established that the previous use was agriculture

According to the 2012 LU/LC data, approximately 263 acres, or 15% of Verona Township is classified as forested, with 88% of the forest classified as Deciduous Forest with >50% Crown Closure. The second most prevalent category is Deciduous Forest with 10-50% Crown Closure. The final three, Old Field with <25% Brush Covered, Deciduous Brush/Shrubland, and Mixed Deciduous, Coniferous Brush, and Shrubland, are all under 5 acres. *Table 10* breaks down the forested land classifications.

Table 10. Forested Land Classifications

Classification	Acres	% of Category	% of Verona Township
Deciduous Forest (10-50% Crown Closure)	23.25	8.90%	1.29%
Deciduous Forest (>50% Crown Closure)	230.75	87.90%	12.85%
Old Field (<25% Brush Covered)	4.20	1.60%	0.23%
Deciduous Brush/Shrubland	1.75	0.70%	0.10%
Mixed Deciduous/ Coniferous Brush/Shrubland	2.57	2.57%	0.14%
Total:	262.52	100.00%	14.62%

Source: Land Use/Land Cover 2012, NJDEP

Tree Protection Ordinance

Verona Township has a municipal ordinance, adopted in 1964, to protect trees from "unregulated and uncontrolled destruction." Section 136 of the Verona Township Code prohibits anyone from destroying or removing "two or more trees with a diameter in excess of four inches, measured one foot above the ground, growing upon any unimproved lot or tract of land within the Borough."[38]

Verona's tree ordinance applies to unimproved lots, upon which no structure has been constructed. The majority of tree ordinances in Essex County apply to both improved and unimproved lots. Removal of trees may result in increased soil erosion, decreased soil fertility, increased dust and mosquito presence, and depreciation of property value. Trees have a high return on investment due to ecosystem services. Trees and greenspace provide direct and indirect benefits, such as reducing stormwater runoff, reducing air and water pollution, reducing energy costs and use associated with heating and cooling, reducing the urban heat island, protecting roadways and reducing the amount of asphalt sealers required, reducing noise pollution, and providing carbon storage and sequestration.

Shade Tree Commission

Verona Township created a Shade Tree Commission, which advises the Township on the protection of the municipal trees. The commission works closely with the Department of Public Works with regard to tree maintenance. Chapter 44 of the Verona Township Code outlines the duties of the Shade Tree Commission.[39] Chapter 171 of the Verona Township Code details the regulations put in place by the commission. Regulations include tree planting regulations, tree removal processes, construction in conflict with trees, and placement of substances injurious to trees.[40]

In 2017 and 2018, the Shade Tree Commission and the Environmental Commission published press releases concerning the Emerald Ash Borer (EAB) a devastating insect pest to ash trees and the White Fringe Tree. At this point in time, there are no natural controls in North America. The insect was detected in Montclair in 2016 and has reached Verona Township. Tree experts recently confirmed that some ash trees in Verona show signs and symptoms of an EAB attack. Most of the ash trees in town are on private property and wooded lots. In Verona Township there are very few ash trees as street trees. The New Jersey State Forest Service recommends that any pesticide treatments to save ash trees from EAB should be done sooner rather than later, as treatments are most effective prior to EAB infestation.[41]

Natural Heritage Priority Sites

The State of New Jersey is home to a wide range of different ecosystems, some large and dominating, others less pronounced and more vulnerable to development. The NJDEP identifies and maps areas which are considered unique ecosystems and are known as the Natural Heritage Priority sites (NHP). Verona Township does not contain any Natural Heritage Priority sites.

WILDLIFE

Critical Habitat

Verona Township consists of primarily suburban residential neighborhoods and local business districts. It is home to several large public parks including Hilltop Reservation, Eagle Rock Reservation, and Verona Park which may have habitat suitable for threatened and endangered species. The NJDEP Landscape Project (*Version 3.3 2017*) ranks patches of habitat using a numeric system (0 through 5) for the purpose of identifying habitat which may be suitable for threatened and endangered species. Habitats identified as Rank 3 through 5 are considered environmentally significant by the NJDEP. The following is a description of each rank:

> **Rank 5** is assigned to species-specific patches containing one or more occurrences of wildlife listed as endangered or threatened pursuant to the Federal Endangered Species Act of 1973.
>
> **Rank 4** is assigned to species-specific patches with one or more occurrences of State endangered species.
>
> **Rank 3** is assigned to species-specific patches containing one or more occurrences of State threatened species.
>
> **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).
>
> **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 do not intersect with any confirmed occurrences of such species.
>
> **Rank 0** is assigned to species-specific patches that do not contain any species occurrences and do not meet any habitat-specific suitability requirements.

According to the NJDEP *Landscape Project*, Verona contains patches of Rank 1, Rank 2 (species of special concern), and Rank 3 (state threatened species). (*Map 13* and *Table 11*) These patches generally follow where trees and foliage are located, and the large public open spaces.[42]

Table 11. Critical Habitat in Verona Township

Rank	Acres	% of Township
0	1,436.77	79.99%
1	206.28	11.48%
2	58.72	3.28%
3	94.36	5.25%
4	0	0%
5	0	0%
Total:	1,796.13	100.00%

Source: NJDEP Landscape Project 2017

Threatened and Endangered Species

Verona Township is home to three state threatened species and four state species of special concern. (*Table 12*)

Table 12. State Threatened and Species of Special Concern in Verona Township

Common Name	Scientific Name	Class	Landscape Project Rank	New Jersey Status	Habitat Type
Barred Owl	*Strix varia*	Aves	3	State Threatened	Forest/Wetland
Veery	*Catharus fuscescens*	Aves	2	Special Concern	Forest/Wetland
Brown Thrasher	*Toxostoma rufum*	Aves	2	Special Concern	Forest/Wetland
Red-shouldered Hawk	*Buteo lineatus*	Aves	2	Special Concern	Forest/Wetland
Osprey	*Pandion haliaetus*	Aves	3	State Threatened	Water
Great Blue Heron	*Ardea herodias*	Aves	2	Special Concern	Water
Wood Turtle	*Glyptemys insculpta*	Reptilia	3	State Threatened	Forest/Wetland
Source: NJDEP Landscape Project (3.3)					
Eastern Box Turtle	*Terrapene Carolina carolina*	Reptilia		Special Concern	Forest/Wetland
Bald Eagle (non-breeding)	*Haliaeetus leucocephalus*	Aves		State Threatened	Forest/Wetland
Source: Observed by members of the Verona Township Environmental Commission in 2018					

Figure 2. Bald Eagle flying above H. B. Whitehorne Middle School

Photo Credit: Sarah O'Farrell, Verona Township Environmental Commission

Potential Vernal Habitat

Verona Township is home to a large potential vernal habitat within the Hilltop Reservation. (*Map 14*) Vernal habitats, also known as vernal pools, are natural wetland depressions that fill with water during the rainy season in the fall and remain ponded until the dry weather in early summer causes them to dry out. Vernal pools provide habitat for a wide variety of amphibians, reptiles, invertebrates, and many species of wetland vegetation, but cannot support a fish population because of the pools brief dry period. Certain wildlife species, referred to as "obligate" vernal pool breeders, have evolved with reliance upon these fish-free breeding sites and cannot successfully produce elsewhere. Other wildlife species, referred to as "facultative" vernal pool species, also take advantage of vernal habitats for breeding and/or feeding purposes, but are not limited to performing these functions solely in vernal pools. The NJDEP defines a vernal habitat in the Freshwater Wetlands Protection Act Rules (*N.J.A.C. 7:7A-1.4*) as a wetland that meets the following criteria:

1. The wetland must consist of or contain a confined basin or depression without a permanently flowing outlet;
2. The pool must feature evidence of breeding by at least one obligate or two facultative vernal habitat species (these species are identified in *N.J.A.C. 7:7A, Appendix 1*);
3. The area must maintain ponded water for at least two continuous months between March and September of a normal rainfall year; and
4. The area must remain free of fish populations throughout the year, or it must dry up at some time during a normal rainfall year.

Wetland areas featuring a confined basin depression exhibiting the hydrologic and biological criteria established above are said to meet certification requirements, and may be referred to as "certified vernal habitats," or simply "vernal habitat areas." The NJDEP maps both certified "vernal habitat areas" and "potential vernal habitat areas" using New Jersey's Landscape Project. The mapping depicts a 300-meter radii circle over the estimated center of both "certified" and "potential" vernal habitats. The 300-meter buffer is intended to account for the varying sizes of individual pool, the likely presence of adjacent wetland areas, and – significantly – the adjacent dispersal habitats typically utilized by many resident amphibian species. The Landscape Project defines its mapping of vernal habitats as follows:

> *Potential vernal habitat areas* – These are areas identified as possibly containing a vernal pool that meets the criteria of a "vernal habitat" pursuant to N.J.A.C. 7:7A-1.4. These sites have been field inspected and have been found to meet the physical characteristics of a vernal habitat, but for which biological criteria have not yet been measured, as well as sites that have not been checked by NJDEP staff.
>
> *Vernal habitat areas* – These are areas that contain pools that have been field-verified by the NJDEP and have been determined to meet both physical and biological characteristics of a vernal habitat in accordance with N.J.A.C. 7:7A-1.4. The Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A) protects vernal habitats as wetland areas requiring a 50 foot buffer, or a 150 foot buffer if the pool supports a State Threatened or Endangered Species.

Table 13 lists obligate and facultative fauna species found in vernal habitats. Some of these species *may be* present, but none are *confirmed* to be present in Verona Township. Descriptions of the 71 species of reptiles and amphibians found in New Jersey, including the obligate and facultative vernal pool species, can be found on the NJDEP Division of Fish and Wildlife website.[43]

Table 13. Obligate and Facultative Fauna Species Found in Vernal Habitats in New Jersey

Obligate Species	*Facultative Species*	
Marbled Salamander***	Snapping Turtle	Upland Chorus Frog
Blue-spotted Salamander*	Eastern Mud Turtle	Northern Cricket Frog
Jefferson Salamander***	Spotted Turtle***	New Jersey Chorus Frog
Eastern Tiger Salamander*	Eastern Painted Turtle	Bull Frog
Wood Frog	Red-spotted Newt	Green Frog
Eastern Spadefoot Toad	American Toad	Southern Leopard Frog
Fairy shrimp (order *Arnostraca*)	Fowler's Toad***	Four-toed Salamander
	Pine Barrens Tree frog**	Northern Spring Peeper
	Northern Gray Tree frog	Long-tailed Salamander**
	Southern Gray Tree frog*	Wood Turtle**

** State Endangered; ** State threatened; *** Special concern*
Source: NJDEP

LAND USE

Verona Township is a 2.79 square mile suburban community. Using the digital orthophotography compiled by the NJDEP Land Use/Land Cover mapping, a comparison can be developed as to how land use has evolved in the Township between 1986 and 2012. (*Table 14*) Over the 26-year period, urban land use has increased slightly, with a corresponding decrease in forested land.

Table 14. Land Use/Land Cover Comparisons

	1986		2012	
Type	*Acres*	*Percent*	*Acres*	*Percent*
Urban	1,469.77	81.83%	1,481.79	82.50%
Forest	283.34	15.78%	262.53	14.62%
Barren Land	3.92	0.22%	12.90	0.72%
Water	14.05	0.78%	19.51	1.09%
Wetlands	25.05	1.39%	19.39	1.08%
Total:	1,796.13	100.00%	1,796.13	100.00%

Source: Land Use/Land Cover 1986, Land Use/Land Cover 2012, NJDEP

Urban Land – According to the NJDEP Land Use/Land Cover mapping, urban land is, "characterized by intensive land use where the landscape has been altered by human activities… Urban categories can include residential; commercial and service; industrial; transportation, communication and commercial complexes; mixed urban or built-up; other urban and recreational lands."[44] Currently, 68%, or 959 acres, of the urban land is residential, single unit, medium density in Verona Township. *Table 15* presents a breakdown of the urban classifications in Verona.

Table 15. Urban Land Classifications

Classification	Acres	% of Category	% of Verona Township
Residential, Single Unit, Medium Density	958.70	67.98%	53.38%
Commercial/Services	151.53	10.74%	8.44%
Residential, High Density or Multiple Dwelling	77.46	5.49%	4.31%
Recreational Land	61.97	4.39%	3.45%
Residential, Single Unit, Low Density	51.40	3.64%	2.86%
Athletic Fields (Schools)	31.03	2.20%	1.73%
Other Urban or Build-Up Land	30.27	2.15%	1.69%
Transportation/Communication/Utilities	18.29	1.30%	1.02%
Industrial	15.85	1.12%	0.88%
Residential, Rural, Single Unit	12.17	0.86%	0.68%
Mixed Urban or Built-Up Land	1.07	0.08%	0.06%
Stormwater Basin	0.60	0.04%	0.03%
Total:	1,410.35	100.00%	78.52%

Source: Land Use/Land Cover 2012, NJDEP

Forest – Forestland includes any lands covered by woody vegetation other than wetlands. These areas are capable of producing timber and other wood products, and of supporting many kinds of outdoor recreation. Forestland is an important category environmentally because it affects air quality, water quality, wildlife habitat, climate, and many other aspects of the ecological area. The forested areas are primarily within the public parks and stream corridors. (*Map 12* and *Table 10*)

Barren Land – In Verona Township, barren land is identified by the NJDEP as transitional areas, including residential, commercial, and industrial areas under construction, and abandoned structures. In Verona, these areas can be found along the North Caldwell border. (*Map 12*)

Water – All areas within the landmass of New Jersey that are periodically water covered are included in this category. Water represents 19.5 acres of Verona Township, with 15 acres identified as Verona Lake, as seen in *Table 16*. The remaining 4.5 acres consists of streams, notably the Peckman River.

Table 16. Water Classifications

Classification	Acres	% of Category	% of Verona Township
Verona Lake	14.88	76.26%	0.83%
Verona Park Bridge	0.09	0.47%	0.01%
Streams and Canals	4.54	23.27%	0.25%
Total:	19.51	100.00%	1.09%

Source: Land Use/Land Cover 2012, NJDEP

Wetlands – Wetlands are defined as areas saturated by ground and surface waters at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. Verona's wetlands are associated with Verona Lake, the Peckman River, and its tributaries. (*Table 8* and *Map 11. Wetlands*)

Preserved Open Space – Preserved open space represents 11% of the Township's land area. Verona's preserved public lands includes Eagle Rock Reservation, Hilltop Reservation, Verona Park, Linn Drive Park, Everett Field, and Kip's Castle. (*Table 17* and *Map 1*)

Grove Park is a municipal park located at 42 Grove Avenue in Verona. The Township bought the 1.33 acre lot in 1975. The property has a significant historical value. In the early 1800's this lot was the site of Personett's Grove, from which Grove Avenue got its name. This was later the homestead of Dr. Henry B. Whitehorne, the namesake of Verona Township's middle school. The woods at 42 Grove Avenue are now home to many kinds of wildlife, including a family of foxes and wild turkeys. Vegetation includes skunk cabbage, jack-in-the-pulpits, native sycamore, black cherry, hickory, tulip poplar and red maple trees. The park was established in 2015, when the Verona Environmental Commission, the Junior Womans Club of Verona and the Verona Historical Society joined together to create this nature preserve and historic park.[45]

Table 17. Preserved Open Space			
Classification	**Acres**	**% of Category**	**% of Verona Township**
County Open Space	156.14	78.48%	8.69%
Municipal Open Space	42.80	21.52%	2.38%
Total:	198.94	100.00%	11.08%
Source: NJGIN Tax Assessor Database 2018			

AIR

Air Quality

The air quality in Verona Township is monitored by the New Jersey Department of Environmental Protection (NJDEP). The NJDEP uses regional collection stations, which help determine if the regional standards meet national standards established by the Clean Air Act. It is important to closely and accurately monitor the quality of the air, as it can vary daily when accounting for weather and traffic. Because of this daily variance, the collection stations carefully measure pollutant concentrations and background levels to determine the extent to which the regional population is exposed, as well as the overall impact of such pollutants on people and the environment. This daily variance also means the information from the stations is collected in real time, and then condensed into reports every year to ensure National and State Clear Air Standards are met.[46]

National Clean Air Standards

In 1970, the federal government passed the Clean Air Act, setting standards to be met throughout the country. The Act was amended in 1990, with focus on four areas of pollution: acid rain, urban air pollution, toxic air emissions, and stratospheric ozone depletion. The amendment also introduced a permits program and strengthened enforcement.[47]

Under the Act, it is the responsibility of the US Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for six common pollutants (ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, fine particulates, and lead) and the responsibility of each state to develop State Implementation Plans (SIPs) to attain and maintain these standards. In New Jersey, that role is assigned to the NJDEP Division of Air Quality (DAQ) and its Bureau of Air Monitoring (BAM), which monitors the State's ambient air monitoring network.

The EPA uses the National standards to designate an area as "in attainment" or "in nonattainment," depending on whether or not they meet the standards. When a state is in nonattainment, they need to develop a plan to demonstrate how they will meet the air quality standards. Once attainment is met, a maintenance plan is required to ensure this accountability continues.[48]

New Jersey Air Quality

The State uses the air quality data from its air monitoring network to determine which areas are in compliance with NAAQS as well as overall trends in air pollution levels. The NJDEP produces yearly reports but also provides real-time reporting through its Air Quality Index website.[49] Although there are monitoring sites throughout the state, each site measures a limited set of pollutants; no one site tracks them all.

The six pollutants for which standards have been set by the EPA, ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter, and lead, are known as *criteria pollutants*. Over the period of 1990-2010, total emissions of these air pollutants have decreased by more than 41% nationally.[50]

The 2016 NJDEP Air Quality Report notes that New Jersey has decreased its pollution levels due to state, regional, and national initiatives[51]. The EPA's air trends indicate that the Northeast region of the United States, including New Jersey, has been in attainment for carbon monoxide for the past decade.[52] Additionally, there has been a 54% decrease in carbon monoxide emissions from 2000 to 2016.[53] The regional standards for nitrogen dioxide have had a 28% decrease from 2000 through 2016, and have stayed under the National Standard during that entire time.[54] The Northeast's ozone levels in this timeframe, however, have been close above and below the National Standards, even with a 15% decrease.[55] Particulate matter, which is 10 micrometers or smaller, has been under the National Standards during the 2000-2016 timeframe, and has shown a 31% decrease for the Northeast.[56] Particulate matter under 2.5 micrometers has not always been under the National Standards. It first went under the standards in 2006, and then stayed under from 2008 and on, showing a 45% decrease in the Northeast.[57] Sulfur dioxide for the Northeast has stayed below the National standards in 2004 primarily, and then stayed below the standards from 2006 on, with an 83% decrease.

The Air Quality Index, which rates air quality based on NAAQS, indicates that in 2016 New Jersey exceeded the standards wherein AQI was over 100. A score of 50 to 100 is considered a moderate level of concern. AQI pollutants include ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. There were 26 days in 2016 when New Jersey exceeded the standards, and these days were reported "Unhealthy for Sensitive Groups," such as children, elders, and those with asthma. Two of the days exceeding the standards were classified "Unhealthy," exceeding 150 on the AQI rating. These two days had high ratings due to a large wildfire in Canada exacerbating the ozone levels. *Figure 2* illustrates the Air Quality Index.

Air Quality Index Levels and Associated Health Impacts

AQI Level of Health Concern	Numerical Value	Meaning	Color Code
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.	Green
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Yellow
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Orange
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Red
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.	Purple
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.	Maroon

Figure 3. Air Quality Index (NJDEP 2016)

Regional/Local Statistics

The data collected at the mobile and stationary sources helps determine a town's compliance with the standards set by the Clean Air Act. Collection station monitors vary depending upon at which site they're found. The East Orange station was one of the closest to Verona, but was shut down in 2016, so does not supply the most current data. The Newark Firehouse monitoring station, the closest station to Verona and still in operation, is one of the few stations in New Jersey that reports ozone, particulate matter, carbon dioxide, sulfur dioxide, and nitrogen dioxide, while most stations report only some of these pollutants. The monitoring station in Paterson is used to measure particulate matter. Other sites include the Jersey City Firehouse, which monitors particulate matter, and Elizabeth Lab, which monitors particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. *Figure 3* shows the location of New Jersey's Air Monitoring Sites.

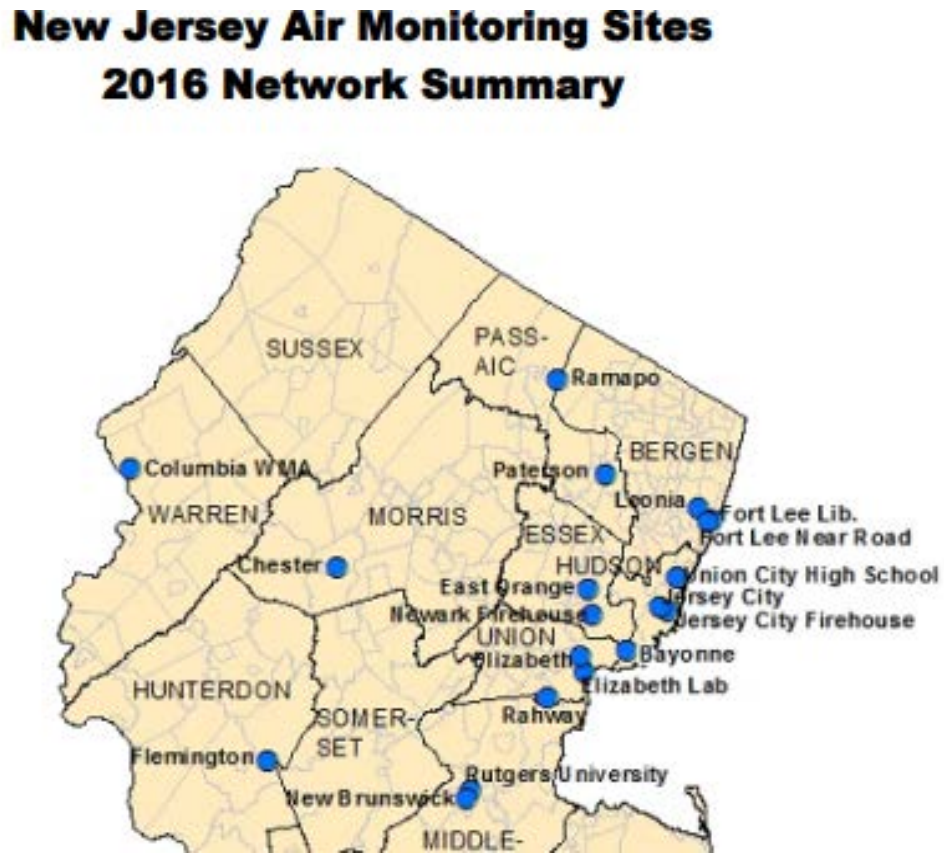


Figure 4. New Jersey Air Monitoring Sites (2016)

Criteria Pollutants

Criteria pollutants are those that take precedence in the NAAQS. They have more severe primary and secondary health effects on people and the environment, and include carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter. They are carefully monitored, and if exceeded, effort is placed into lowering emissions and exposure.

Ozone

Ozone (O_3) is defined by the NJDEP *2015 Ozone Summary*[58] as a gas that consists of three oxygen atoms. Ozone occurs naturally in the upper atmosphere where it offers protection from harmful ultraviolet rays. However, when found at ground level, ozone can have serious adverse health effects. Ground-level ozone is formed through a chemical reaction that requires nitrous oxides (NO_x), volatile organic compounds (VOCs), and the presence of heat and sunlight. As a result of the sunlight and heat necessary for ground-level ozone production, measurements are taken between April 1 and October 31.

The EPA revised NAAQS for ozone in 2008, having determined that the previous standard of 0.08 parts per million (ppm) maximum daily 8-hour averages did not sufficiently protect public health and was lowered to 0.075 ppm. In October 2015, the 8-hour standard was lowered further to 0.070 ppm and went into effect in 2016. Attainment of the NAAQS is determined by taking the average of the fourth highest daily maximum 8-hour average concentrations that are recorded each year for three years.

There are primary and secondary standards for ground-level ozone. Primary standards ensure health protection for the public, especially pertaining to at-risk groups including asthmatics, the elderly, and children. Secondary standards protect the surrounding environment, including tree and crop damage, for which ozone pollution results in $500 million in reduced crop production every year in the United States.

New Jersey standards are based on one-hour averaging, with primary standards set at 0.12 ppm and secondary standards set at 0.075 ppm. They are not as stringent as the revised NAAQS. To date, the effort to lower ozone concentrations has focused on reducing emissions of VOCs. However, improvements have leveled off in recent years, especially with respect to maximum 8-hour average concentrations. According to the NJDEP report, significant further improvements will require reductions in both VOCs and NO_x. Levels of NO_x in New Jersey are largely affected by emissions from regional upwind sources outside of New Jersey.

Statewide, New Jersey is classified as a "marginal" ozone non-attainment area for NAAQS, with an overall score between 0.062 and 0.073 ppm for the three year average.[b] The highest 8-hour daily maximum reached 0.092 at the Bayonne Monitoring Station (approximately 21 miles from Verona Township). The ozone monitoring stations closest to Verona Township reported levels exceeding 0.070 ppm for 2016, but below 0.12 ppm per hour. The EPA's air quality index notes that there were 150 days in 2016 and 139 days in 2017 when the pollutant was ozone.[59]

Newark Firehouse's data for 2016 reports a 1-hour daily maximum of .094 ppm and an 8-hour average daily maximum of .071 ppm. In New Jersey, 2016 also includes the fourth-highest statewide 8-hour maximum average concentration reported since 1986, at 0.076 ppm. *Figure 4* shows the trends across the state in ozone concentration since 1990.

[b] Although the standards have reduced to 0.070 in 2016, the data collected is from 2015 and is based off the 2015 standard

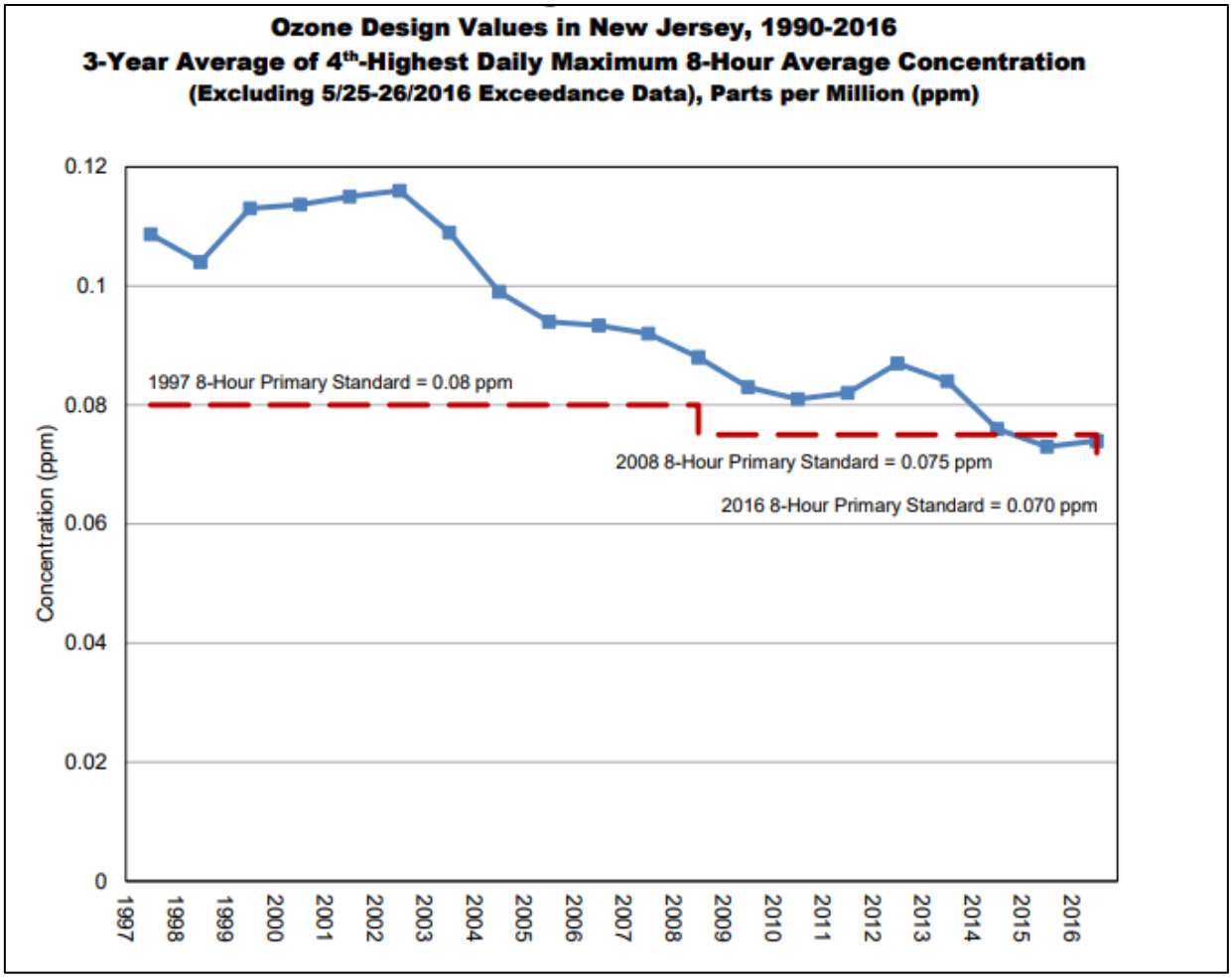


Figure 5. Ozone Levels in New Jersey, 1990-2016

The EPA reviews which areas have or have not attained NAAQS, and then classifies the degree of non-attainment. In 2012, the EPA classified New Jersey as a non-attainment area. For Northern New Jersey, where Verona is located, the area was classified as moderate in 2016. In 2016, Essex County had three days that exceeded the 0.075 ppm standard for ozone.

Sulfur Dioxide

NJDEP's *2015 Sulfur Dioxide Summary*[60] defines sulfur dioxide (SO_2) as "a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO_2 gases can be formed when fuels containing sulfur are burned, or when gasoline is extracted from oil." Most of the sulfur dioxide released into the air comes from electric utilities, followed by fossil fuel combustion, industrial processes, non-road equipment, and on-road vehicles. Sulfur dioxide can be harmful to people (primarily children, the elderly and asthmatics) and the environment when it reacts with other gases and particulates in the air to form sulfates. These sulfates are a primary cause of reduced visibility in the eastern United States. Sulfur dioxide can also combine with other substances in the atmosphere to form acid rain, which damages forests, crops, aquatic environments, and decays building materials. There are several standards for monitoring SO_2,

ranging from 1-hour to annual averaging. The State has both primary and secondary standards. The primary standard is a 12-month standard based on any twelve-month average recorded during consecutive years. The state's secondary standards are 3-hour, 24-hour, or 12-month averages. New Jersey's standards differ slightly from national standards, as shown in *Table 18.*

Table 18. National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide

parts per million (ppm); parts per billion (ppb); micrograms per cubic meter ($\mu g/m^3$)

Averaging Period	Standard Type	New Jersey	National[a]
12–month average	Primary	80 $\mu g/m^3$ (0.03 ppm)	---
12–month average	Secondary	60 $\mu g/m^3$ (0.02 ppm)	---
24–hour average	Primary	365 $\mu g/m^3$ (0.14 ppm)	---
24–hour average	Secondary	260 $\mu g/m^3$ (0.10 ppm)	---
3–hour average	Secondary	1300 $\mu g/m^3$ (0.5 ppm)	0.5 ppm
1–hour average[b]	Primary	---	75 ppb

a-National standards are block averages rather than moving averages
b-To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppm

Source: NJDEP 2015 Sulfur Dioxide Summary

Regulations requiring the use of low sulfur fuels in New Jersey have been effective in lowering SO_2 concentrations. No monitoring sites in New Jersey exceeded primary or secondary SO_2 standards in 2016. (*Figure 5*) The last year an exceedance of the national 3-hour, 24-hour, or 12-month SO_2 standards was recorded in the state was 1980. Sulfur dioxide levels in the United States have themselves decreased, with regulations stopping sulfur emissions from fuels, such as gasoline, by 90%.

Carbon Monoxide

According to the NJDEP *2015 Carbon Monoxide Summary*[61], carbon monoxide (CO) is a colorless, odorless, poisonous gas formed when carbon in fuels are not entirely burned. The primary creators of carbon monoxide emissions are on-road and off-road vehicles, with boilers, incinerators, and forest fires also contributing. The symptoms of exposure are headaches and nausea, with those who have cardiovascular disease being the most affected.

Although there are no national secondary standards, New Jersey has set its secondary standards at the same level as its primary standards and uses a different measuring metric than national standards (see *Table 19*). In addition, New Jersey standards are not to be exceeded more than once in any 12-month period.

2016 Sulfur Dioxide Concentrations in New Jersey
Daily Maximums and 99th Percentile 1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)			2014-2016 Design Value[a]
	Highest Daily Maximum	2nd-Highest Daily Maximum	99th %-ile Daily Maximum	
Bayonne	12	9	4	6
Brigantine	8.1	6.3	5.3	6
Camden Spruce St.	167	81	11	12
Chester	8	5	5	8
Columbia	8	8	8	30
Elizabeth	6	5	4	5
Elizabeth Lab	25	13	7	12
Jersey City	5	5	4	6
Newark Firehouse	6.5	5.5	3.8	6

Figure 6. 2016 Sulfur Dioxide Concentrations in New Jersey

Table 19. National and New Jersey Ambient Air Quality Standards of Carbon Monoxide

milligrams per cubic meter (mg/m3); parts per million(ppm)

Averaging Period	Type	New Jersey	National
1-Hour	Primary	40 mg/m^3 (35 ppm)	35 ppm
1-Hour	Secondary	40 mg/m^3 (35 ppm)	----
8-Hour	Primary	10 mg/m^3 (9 ppm)	9 ppm
8-Hour	Secondary	10 mg/m^3 (9 ppm)	----

Source: NJDEP 2015 Carbon Monoxide Summary

Because on-road vehicle emissions are a major contributor of CO levels, there is a variation throughout the day, with the highest peaks around 7 to 8 am, and another, lower but more extended rise between 4 and 8 pm. According to the 2015 NJDEP report,

> "carbon monoxide levels have improved dramatically over the past 39 years. The last time the CO standard was exceeded in New Jersey was in January of 1995. The entire state was officially declared as having attained the CO standard on August 23, 2002." (NJDEP 2015 CO report)

In New Jersey, there are seven monitoring stations for CO, and the Newark Firehouse station, closest to Verona, is part of the EPA National Core Multipollutant Monitoring Network (NCORE), and measures carbon monoxide levels down to the hundredth parts per million (ppm). *Figure 6* displays the carbon monoxide concentrations across New Jersey from 1990 until 2016.

Figure 7 shows the various monitoring sites readings for 1-hour averages taken in 2016. The Newark Firehouse 1-hour average highest concentration is 3.73 ppm for 2016 and Elizabeth is at 2.30 ppm. New Jersey's carbon monoxide levels have been in compliance with NAAQS standards for over 20 years, as reported by the NJDEP. New Jersey officially attained carbon monoxide standards in 2002, with reduction efforts coming from cleaner cars.

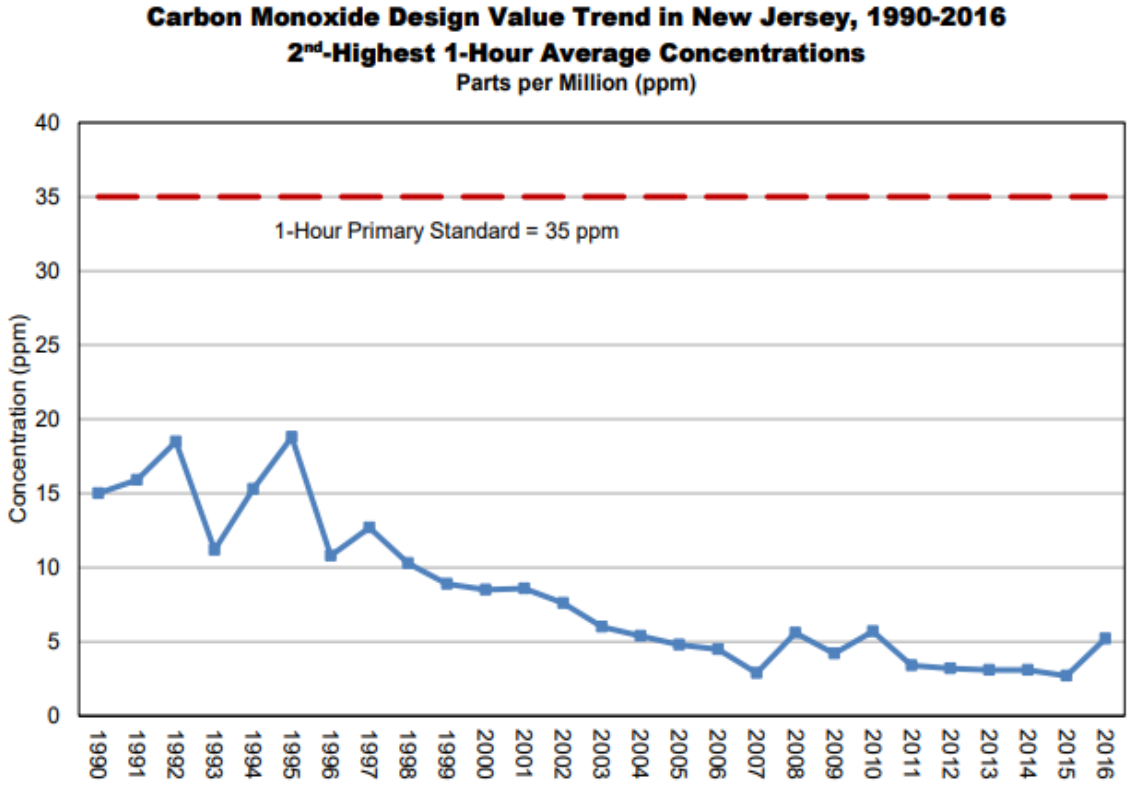


Figure 7. Carbon Monoxide Trend in New Jersey, 2000-2016

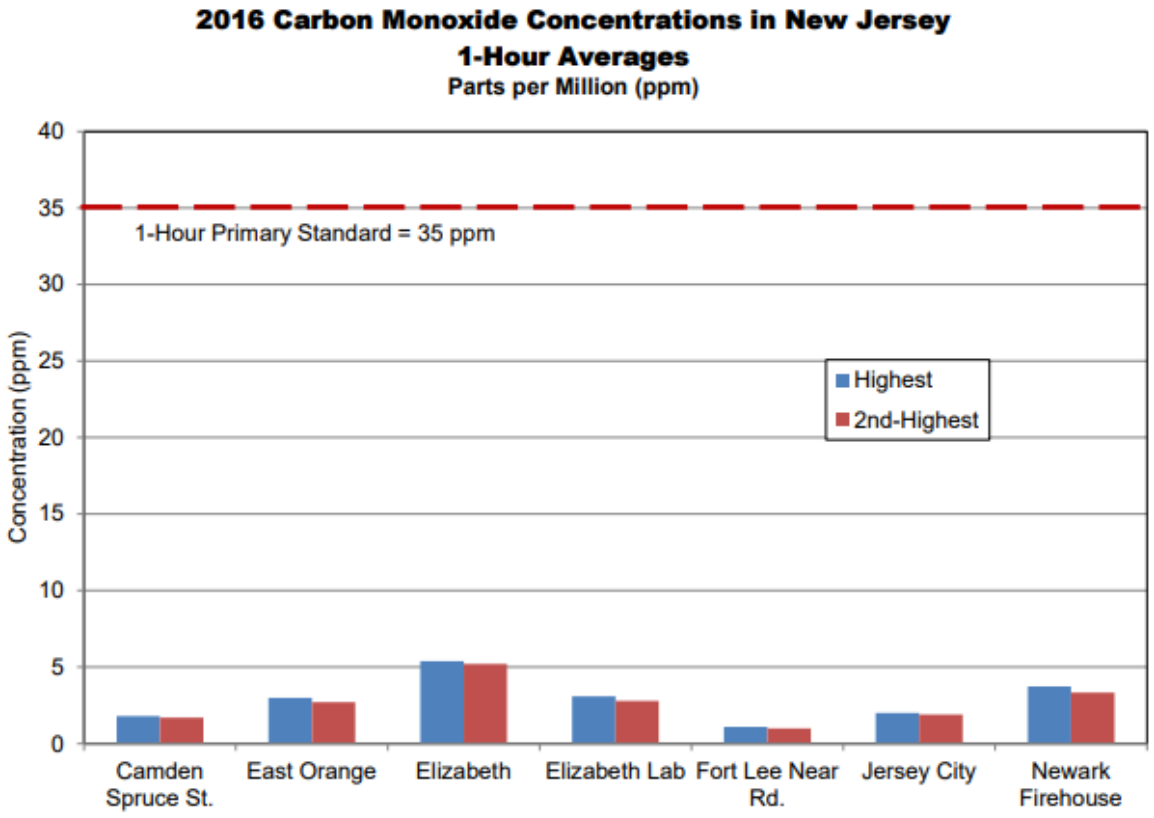


Figure 8. One-Hour Averages for CO Concentrations in New Jersey (2016)

Nitrogen Dioxide

According to the NJDEP *2015 Nitrogen Dioxide Summary*[62], nitrogen dioxide (NO_2) is a reddish-brown, highly reactive gas that is formed in the air through the oxidation of nitric oxide (NO). When it reacts with other chemicals, it can form ozone, particulate matter and other contributors to acid rain and haze. Oxides of nitrogen (NO_x) are combinations of gases comprising mostly of NO_2 and NO. They are emitted from fuel-related sources, which include vehicle exhaust, the burning of coal, natural gas and oil, industrial processes such as welding, household gas stoves, and heaters. NO is released into the atmosphere as NO_x but easily converts to NO_2.

NO_2 can aggravate or cause respiratory illness and prolonged exposure can permanently damage the lungs. Along with NO, NO_2 can irritate the eyes, nose, throat and lungs, and cause nausea and tiredness. The environmental effects of nitrogen oxides can include changes in the composition of the flora in wetland and terrestrial ecosystems, acidification of freshwater bodies, eutrophication of estuarine and coastal waters, increases in levels of toxins harmful to fish and other aquatic life, and decreased visibility.

The levels for the national and state standards are the same; however, national standards are based on calendar year averages, while state standards apply to any 12-month period (See *Table 20. National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO2*)**.** The

majority of NO_2 emissions come from vehicle exhaust, therefore, the highest levels occur during the morning and afternoon rush hours. Levels are also higher in winter than in summer.

Table 20. National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO_2)
parts per million (ppm); micrograms per cubic meter ($\mu g/m^3$)

Averaging Period	Type	New Jersey	National
12-month average	Primary	100 $\mu g/m^3$ (0.053 ppm)	
Annual average	Primary		0.053 ppm (100 $\mu g/m^3$)
12-month average	Secondary	100 $\mu g/m^3$ (0.053 ppm)	
Annual average	Secondary		0.053 ppm (100 $\mu g/m^3$)
1-hour average	Primary		0.100 ppm (190 $\mu g/m^3$)

Source: NJDEP 2015 Nitrogen Dioxide Summary

NO_2 concentrations in New Jersey have fallen steadily since 1975 when the average concentration was 0.040 ppm. Neither the statewide nor the individual station averages have exceeded the health standard of 0.053 ppm, although the highest reporting stations in 1975 came close. The Fort Lee Near Road, Elizabeth Lab, and Bayonne stations have all exceeded the State or National Standards for 1-hour concentrations, however they do not violate the NAAQS which is based off of the 98th percentile. In 2016, none of the stations in New Jersey exceeded the annual or 1-hour levels for the national standards. (*Figure 8*) Newark Firehouse reported the highest daily maximum 1-hour concentration at 0.095 ppm.

Particulate Matter

Particulate matter[63] can be any manmade or natural particles found in the air, such as dust, dirt, smoke, sea salt, and liquid droplets. At any size, these particles can affect the environment. The total of all particles, of whatever size, is referred to as "Total Suspended Particulates" (TSPs). Particles less than 10 micrometers in diameter (PM_{10}) are called "Inhalable Particulates" because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers ($PM_{2.5}$), called "Fine Particulates," are believed to pose the greatest health risk. NAAQs for both Inhalable Particulates (PM_{10}) and Fine Particulates ($PM_{2.5}$) are set at the same level for both primary (health) and secondary (environmental welfare) standards. At the greatest risk are children, the elderly, and individuals with heart and lung diseases, such as asthma.

The EPA abandoned standards for TSPs in favor of the smaller PM_{10} and $PM_{2.5}$ particulates, however New Jersey still maintains TSP standards, as shown in *Table 21*. For $PM_{2.5}$ standards, an annual concentration for a given site is calculated by averaging the annual mean concentrations for the three most recent consecutive calendar years, in this case 2013-2015. Similarly, the 24-hour concentration for a given site is calculated by averaging the 98th percentile 24-hour concentrations for each year for the same 3-year period. For PM_{10} standards, the concentrations are simply calculated as the annual mean and the highest 24-hour average PM_{10} concentrations. (See *Table 21*)

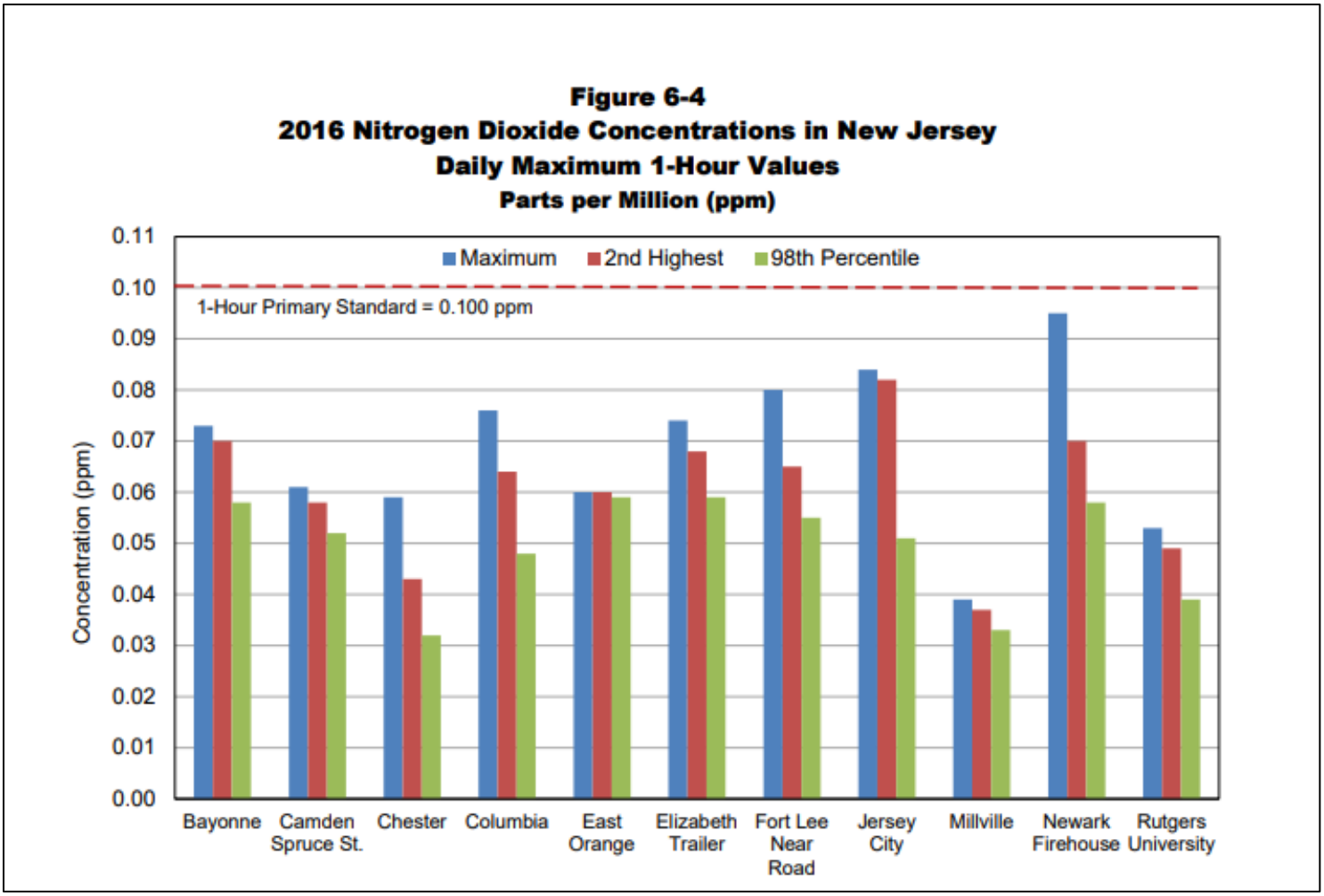


Figure 9. Daily Maximum Values for Nitrogen Dioxide in New Jersey (2016)

Table 21. Particulate Matter – 2015 National and New Jersey NAAQs

micrograms per cubic meter (µg/m^3)

Pollutant	Averaging Time	Type	Level
Fine Particulate ($PM_{2.5}$)	Annual	Primary	12.0 µg/m^3
	Annual	Secondary	15.0 µg/m^3
	24-Hour Average	Primary & Secondary	35 µg/m^3
Inhalable Particulate (PM_{10})	24-Hour Average	Primary & Secondary	150 µg/m^3

Source: NJDEP 2015 Particulate Summary

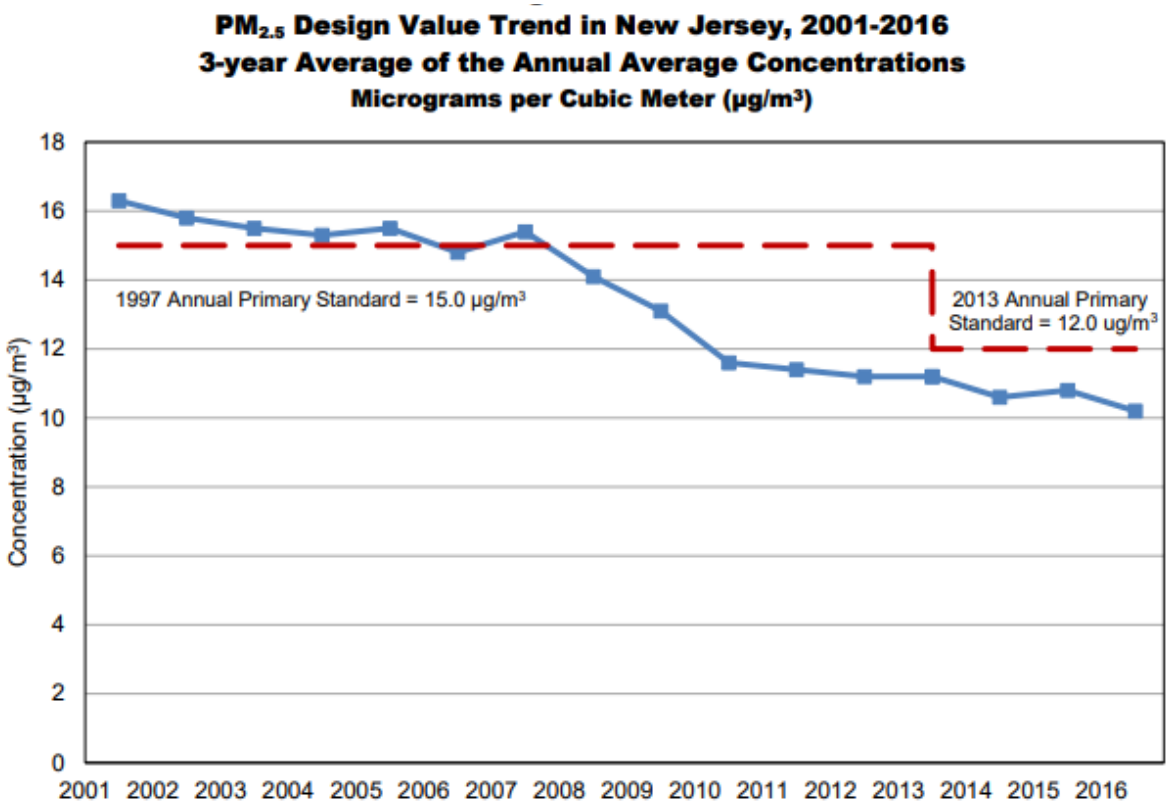


Figure 10. $PM_{2.5}$ levels in New Jersey (2001-2016)

Recently, New Jersey's $PM_{2.5}$ levels have been in decline, and are now in compliance with the NAAQS. *Figure 9* shows the annual average concentration for $PM_{2.5}$ from 2001-2016. Because of consistent low concentrations across the state, Newark Firehouse is one of three monitoring stations for particulate matter, and samples of PM_{10} are taken there every three days. In New Jersey, there are 21 $PM_{2.5}$ monitoring sites and three for PM_{10}, which use three types of monitors for particulates. The EPA's air quality index notes that there were 144 days in 2016 and 80 days in 2017 where the pollutant was $PM_{2.5}$.[64]

Five stations are involved in the national Chemical Speciation Network (CSN), which determine the amount of the chemical analytes in a sample. No sites violated the standards in 2016, either the annual standard of 12.0 µg/m^3 or the 24-hour standard of 35 µg/m^3. Newark Firehouse's mean concentration from filter-based monitors was 8.31 µg/m^3, with its highest being 28 µg/m^3. Newark Firehouse's continuous monitors indicated an annual mean of 8.73 µg/m^3 and a highest 24-hour concentration of 26.3 µg/m^3. The Firehouse's PM_{10} concentrations for 2016 indicate an annual mean of 14 µg/m^3 with a high of 59 µg/m^3. The NJDEP reports a noticeable decline in particulate matter since 1999. In 2014, Essex County had the highest amount of days for counties in New Jersey with $PM_{2.5}$, a total of 1.7, but decreased it to zero in 2015 and maintained in 2016.[65]

Lead

Lead is a hazard to the health of humans and the environment, whether the source is lead in the air, in paint on walls, in our water, or in the soil. When taken into the body, lead circulates via the blood and accumulates in the bones. It affects the oxygen carrying capacity of the blood and can negatively affect the nervous system, kidneys, immune system, reproductive, developmental and cardiovascular systems. It most commonly causes neurological effects in children and cardiovascular effects in adults. On a secondary level, lead from the air or water bodies may accumulate in soils and sediments, adversely affecting biodiversity.

According to the EPA, taking lead out of on-road motor vehicle gasoline has been the primary reason for a decline of lead in the air. Between 1980 and 2010 the EPA reported an 89% decrease in national average. Contributors to lead in the air today include ore and metals processing and leaded aviation fuel. In 2008, the NAAQS level was set at 0.15µg/m^3 for a rolling three month average. As of 2013, in accordance with the new 2008 standard there are 21 areas nationwide that are in non-attainment with the closest locations being in central Pennsylvania.[66]

The NJDEP has data for New Jersey stations monitoring lead in the air from 1990 to 1995-1996. Although some stations exceeded NAAQS levels in the early 1990's, all were below the standards by 1996. New Jersey has not exceeded the standard for lead since the 1970s, and is now an attainment area under 1.5 µg/ µg/m^3 of lead.

Air Toxics

Almost 200 air toxics have been identified on the list of Hazardous Air Pollutants (HAPs) maintained by the EPA. The EPA issues a National-Scale Air Toxics Assessment (NATA), which the NJDEP adapts to evaluate the types and amounts of air toxics people are exposed to in New Jersey. NJDEP compares the estimated NATA air concentrations to their chemical-specific health benchmarks and divides the modeled air concentration by the health benchmark to get a risk ratio. If the risk ratio for a specific chemical is greater than one, it may be of concern, increasing the risk for cancer or other negative health effects. In general, higher population densities result in greater emissions of, and exposure to, air toxics.[67]

The NJDEP has measured volatile organic compounds (VOCs) since 1989, with a station in Elizabeth established in 2000. In 2001, the NJDEP also started measuring toxic metals in Newark.[68] New Jersey's vehicles comprise 37% of their toxics, and airplanes, trains, and other non-road mobile sources are 31% of the toxics. Nonpoint sources from residential and commercial areas contribute 29% of toxics in New Jersey, and 3% come from point sources such as power plants and factories. The reference concentration used is the air concentration at which there are no health effects while being exposed to the substance on a daily basis for a lifetime.

The New Jersey DEP's four monitoring sites measure volatile organic compounds as well as carbonyls. Carbonyls include formaldehyde, acrylonitrile, and carbon tetrachloride. Newark Firehouse has a toxic metal monitoring site, and is classified as an urban residential area by the NJDEP. The closest monitoring site for VOCs and carbonyls is the Elizabeth Lab. This site reported eight pollutants that exceeded the health benchmarks.

Arsenic

Arsenic is naturally occurring and formed through human activity, and poses a significant rise for cancer when found in drinking water, cigarettes, food, industries, and air.[69] Arsenic is found mostly in drinking water, but in countries with industrial factories, arsenic can be found in the air pollution from such factories and vehicle emissions. It can be found in the Earth's crust and in the soil, water, and air, as well as found through industrial processes, like mining and smelting.[70] As such, arsenic in a weathered rock can be blown around by the wind and thus the particles can be dispersed. Arsenic is most toxic in its inorganic form, which is found in things like tobacco, since arsenic can be taken up into the roots of the plants and does not occur there naturally. [71]

Figure 10 displays the arsenic concentrations across the monitoring sites. The Elizabeth station monitored arsenic levels within $PM_{2.5}$ from 2002-2015. The benchmark has been 0.00023 µg/m^3, which Elizabeth has never been under. It stayed between the 0.0007 to 0.001 range from 2002 until 2008, and then decreased from 2009 to 2015. Arsenic is seen at higher concentrations than most other metals in New Jersey. In 2009, less than 50% of arsenic data was above the detection limit, but the annual averages remain above the benchmark.[72]

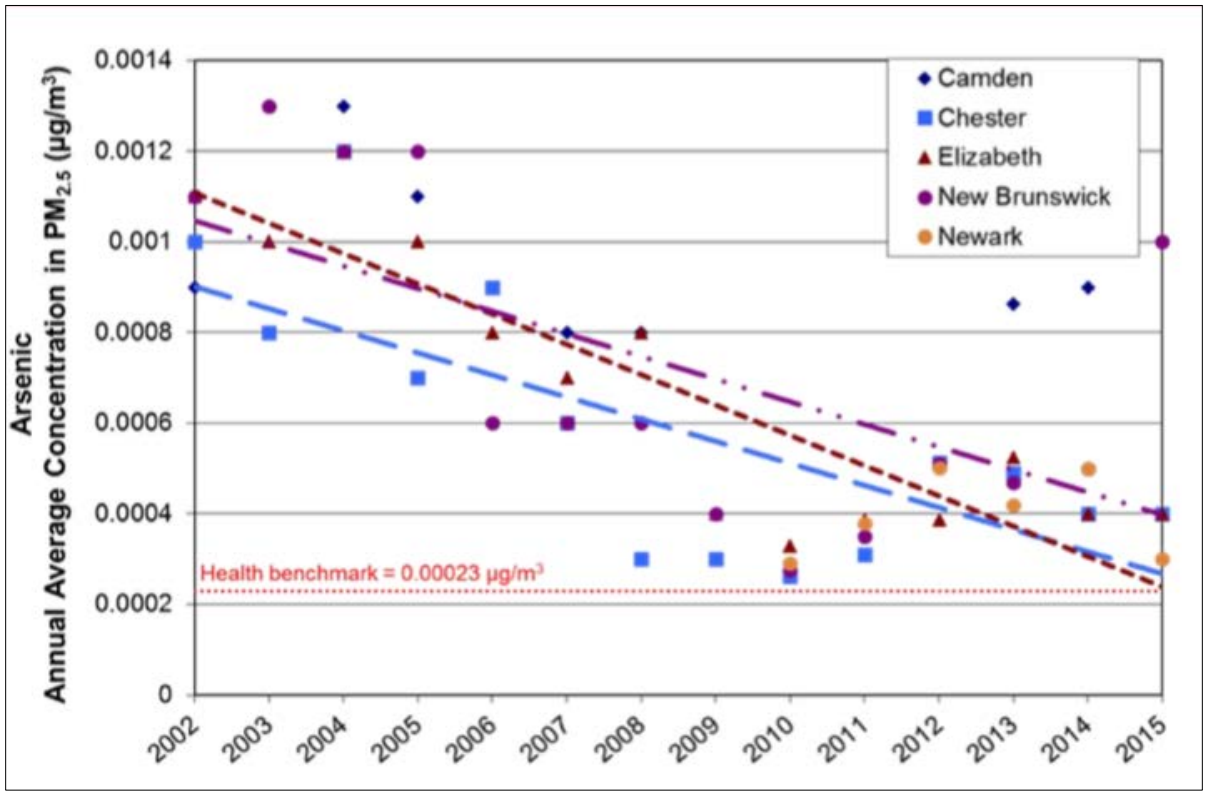


Figure 11. Arsenic Concentrations, NJDEP Air Toxics Report

Formaldehyde

Formaldehyde is used mainly to produce resins used in particleboard products and as an intermediate in the synthesis of other chemicals. The major sources of emissions to the air are forest and wildfires, stationary internal combustion engines and turbines, pulp and paper plants, petroleum refineries, power plants, manufacturing facilities, incinerators, and automobile exhaust emissions. New Jersey's main source of Formaldehyde is automobile emissions.

Figure 11 reports the annual average concentrations for formaldehyde at four reporting sites, the closest being Elizabeth. The annual average concentration in Elizabeth is 3.516 micrograms per cubic meter. The annual mean concentration in Elizabeth is 2.86 ppbv (parts per billion by volume), with a 24-hour maximum of 6.84 ppbv and a health benchmark of 0.077 µg/m^3. Formaldehyde levels in New Jersey have stayed fairly consistent and have been above the health benchmark.[73] Since 2001 until 2015, levels have remained in the 2 to 6 µg/m^3 range for Elizabeth.

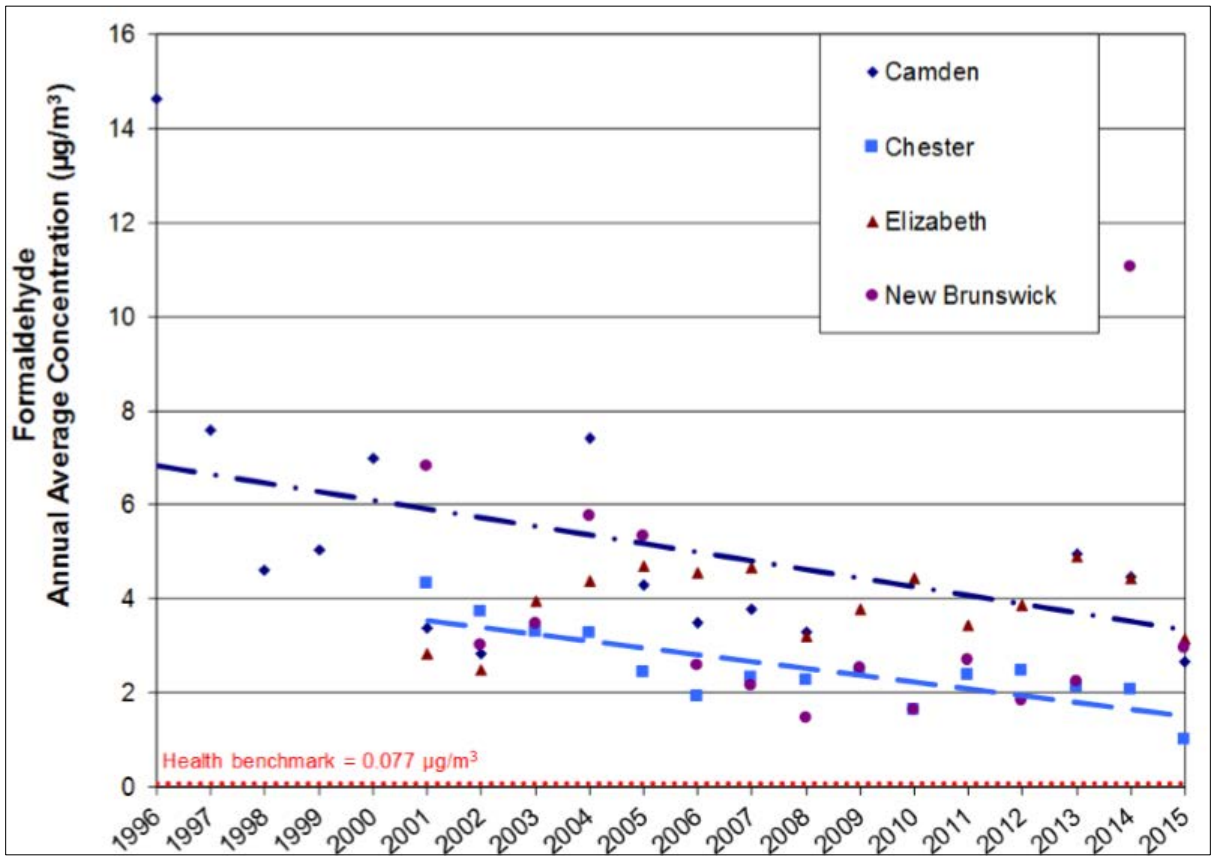


Figure 12. Formaldehyde Concentration, NJDEP Air Toxic Report

Carbon Tetrachloride

Carbon tetrachloride was widely used as a household cleaner, propellant, degreaser, refrigerant, and fumigant. Because of its toxicity and ability to deplete stratospheric ozone it has been phased out of production and use. Despite this, approximately 100 tons are annually emitted by industry in the United States. There have been no emissions reported in New Jersey, however because it degrades slowly in the environment, air levels remain fixed. Carbon tetrachloride's 2016 annual average concentration in Elizabeth was 0.620 µg/m^3. (*Figure 12*)

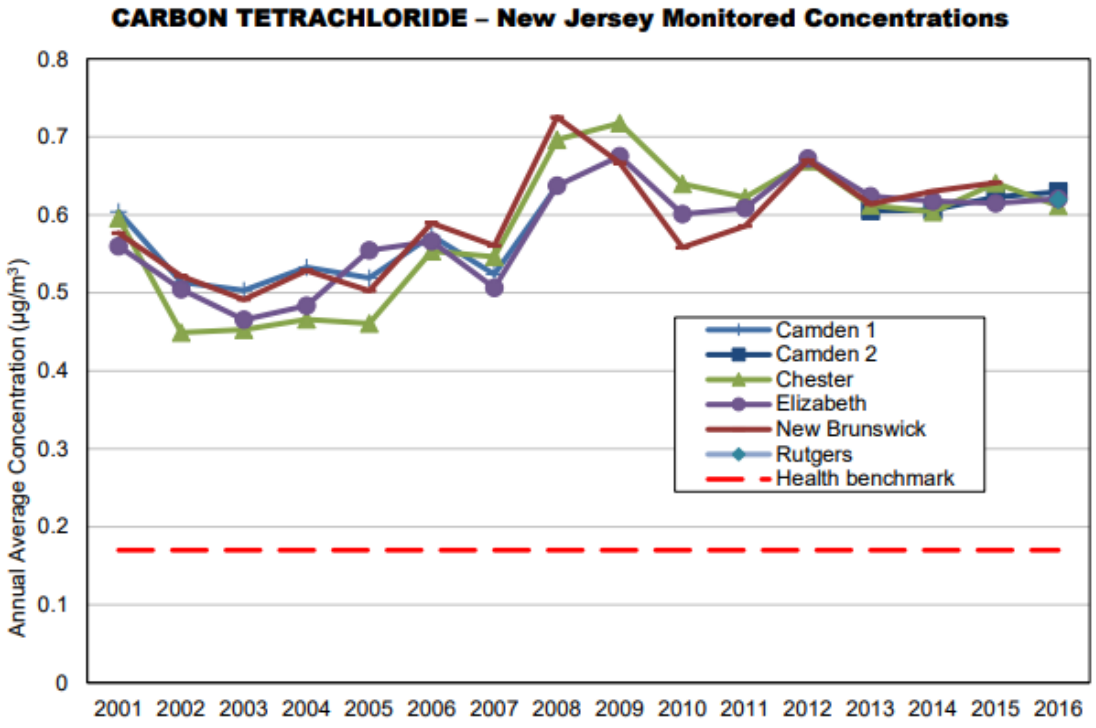


Figure 13. Carbon Tetrachloride Concentration (NJDEP Air Toxic Report)

Acrylonitrile

Acrylonitrile is a flammable gas and also a yellowish liquid, and has a smell like that of garlic or mustard. It is used to produce resins, rubbers, and acrylic fiber. When in the atmosphere, this toxic photochemically reacts with hydroxyl radicals, forming formaldehyde and at times formic acid, formyl cyanide, carbon monoxide, and hydrogen cyanide. The foremost way people are exposed to acrylonitrile is inhalation, which can cause central nervous system damage, eye and throat irritation, and death.[74] Acrylonitrile health benchmark for Elizabeth is 0.015 (µg/m^3). It was never above the detection limit at any of the four stations.

Benzene

Benzene is colorless and volatile. Benzene is a natural part of gasoline, crude oil, and cigarette smoke and is formed both through natural processes and human activities.[75] Cigarette smoke can contribute to inhaled benzene, adding 400-1800 µg/day. Driving a car has similar results; rush-

hour traffic increases intake levels to 20 µg/day. Indoor benzene concentrations are usually higher than they are in outdoor air.[76] Benzene is degraded in the upper atmosphere, and is soluble in water. Benzene concentrations were monitored in Elizabeth, with a benchmark of 0.13 µg/m^3. Like arsenic, the levels have never been below the health benchmark. From 2001 to 2015, levels for Elizabeth have remained in the 0.5 to 2.0 range.[77] (*Figure 13*)

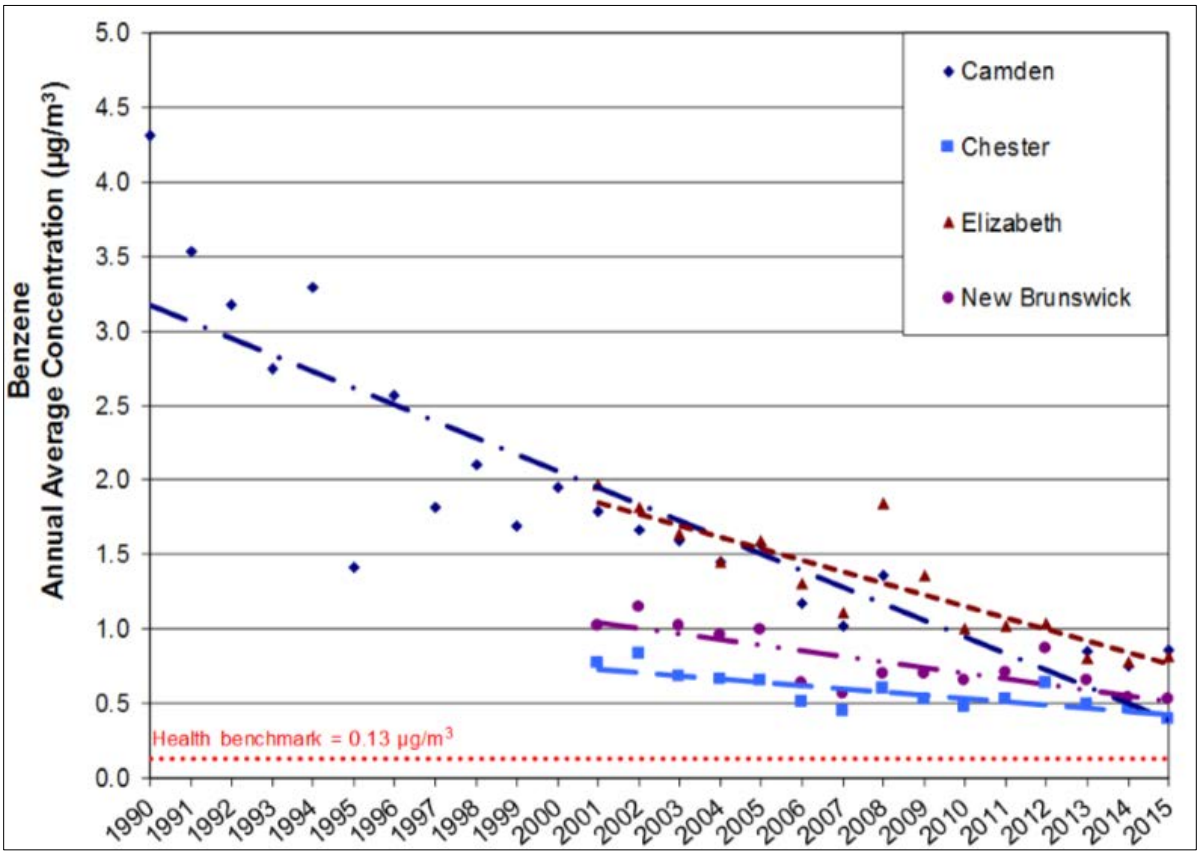


Figure 14. Benzene (NJDEP Air Toxic Report)

Butadiene

Butadiene is a colorless gas which is highly flammable, and can explode in air when heated. It is slightly soluble in water, and is used for rubbers and tires, as well as plastics. It can get into the environment from leaks during production or storage, as well as through vehicle gas fumes, incineration, cigarette smoke, and wood fires. Butadiene can also form ground-level ozone, and can enter the body through inhalation or ingestion or contaminated foods and water, as well as skin contact with petrol. Long term exposure can cause heart and lung damage, and high concentrations can cause nerve damage.[78]

Levels of Butadiene were measured in Elizabeth from 2001 to 2015, with a benchmark of 0.033 µg/m^3. In 2001, it was in the 0.25 to 0.3 range, but decreased to the 0.1 to 0.2 range throughout the rest of the timeframe. (*Figure 14*)

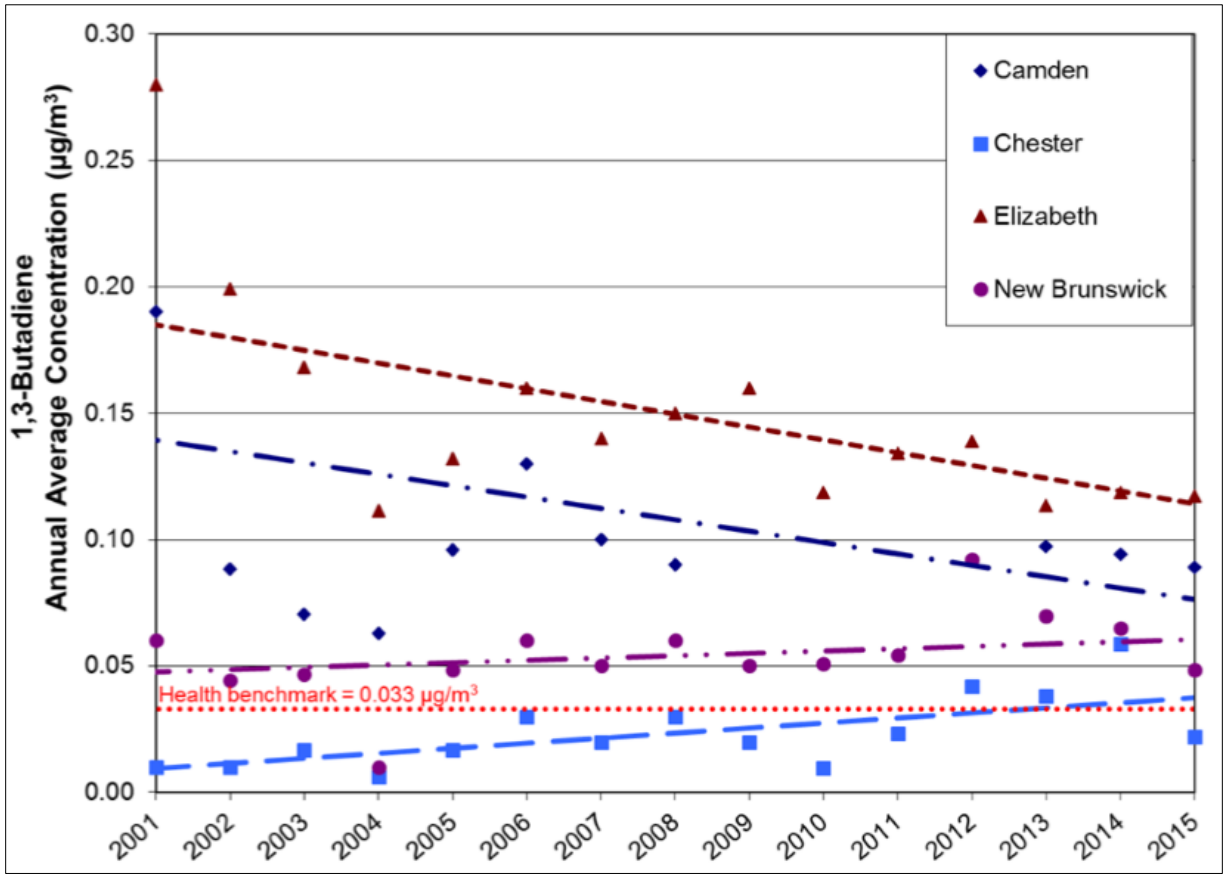


Figure 15. Butadiene (NJDEP Air Toxic Report)

Acetaldehyde

Acetaldehyde is highly reactive, and is used to make acetic acid and other chemicals. It gets into the environment from industrial plants, combustion, and tobacco. Acetaldehyde can contribute to ground-level ozone, and when inhaled or ingested can cause respiratory and nervous system problems, and even death.[79] Acetaldehyde was measured in Elizabeth with a benchmark of 0.45 µg/m^3. (*Figure 15*)

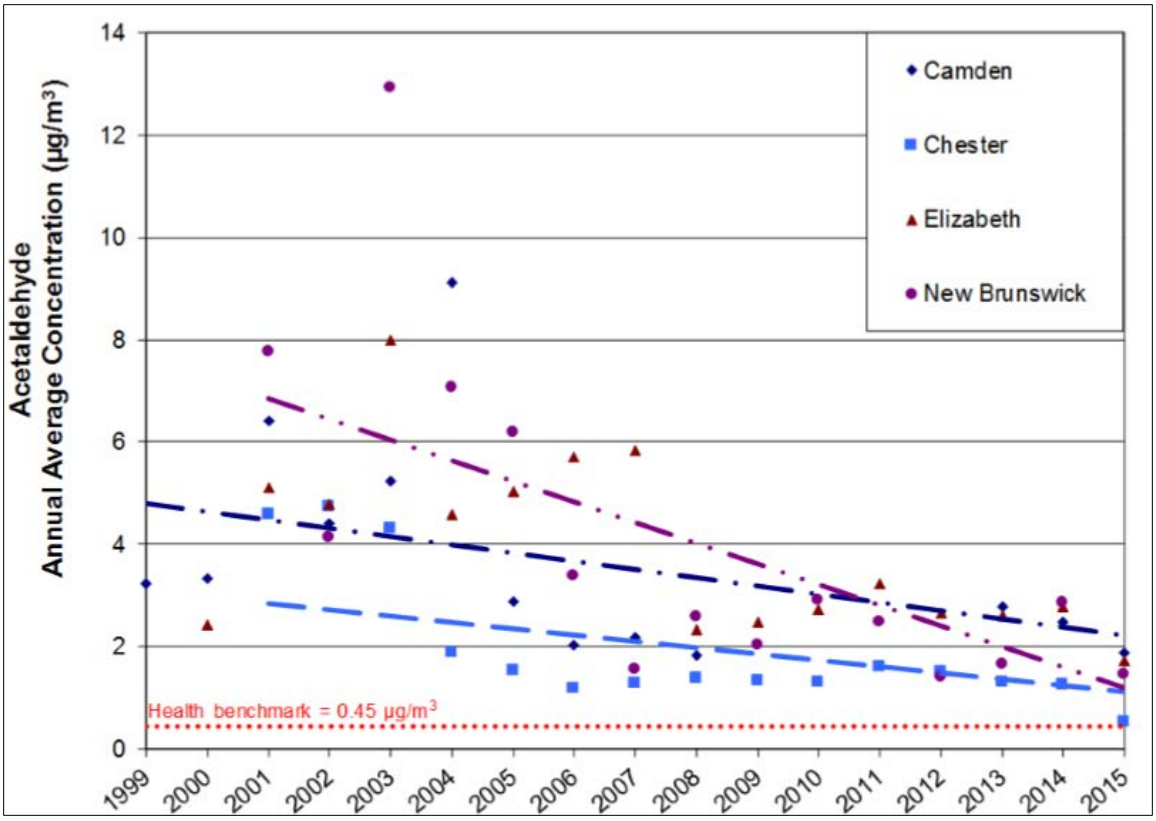


Figure 16. Acetaldehyde (NJDEP Air Toxic Report)

Sources

The source of air toxics varies for each pollutant. On-road mobile sources of air toxics emissions are vehicles, non-road mobile sources include aircraft, trains, lawnmowers and leaf blowers, boats, dirt bikes, and construction vehicles. Non-point sources of air toxics emissions include heating, fuel and pesticide use, dry cleaners, and consumer products, such as adhesives, sealants, paint, personal care, and other household products. Point sources are identified by the NJDEP as "large facilities that emit a significant amount of air pollution during manufacturing, power generation, heating, incineration, or other such activity" as well as "smaller facilities including those that are required to report their emissions under the federal Toxic Release Inventory program and the state's Community Right-To-Know program" (see *Contaminated Sites* chapter).

An additional category of contributions to emissions is background and secondary sources. Background concentrations generally cannot be sourced to current, local emissions. Secondary concentrations refer to chemicals that have been transformed in the air from an air pollutant into another chemical, which may have a different level of toxicity.[80]

According to a 2005 report, Essex County's air toxic emissions came from mobile sources and non-point sources, with a minimal contribution coming from point sources. (*Figure 16*)

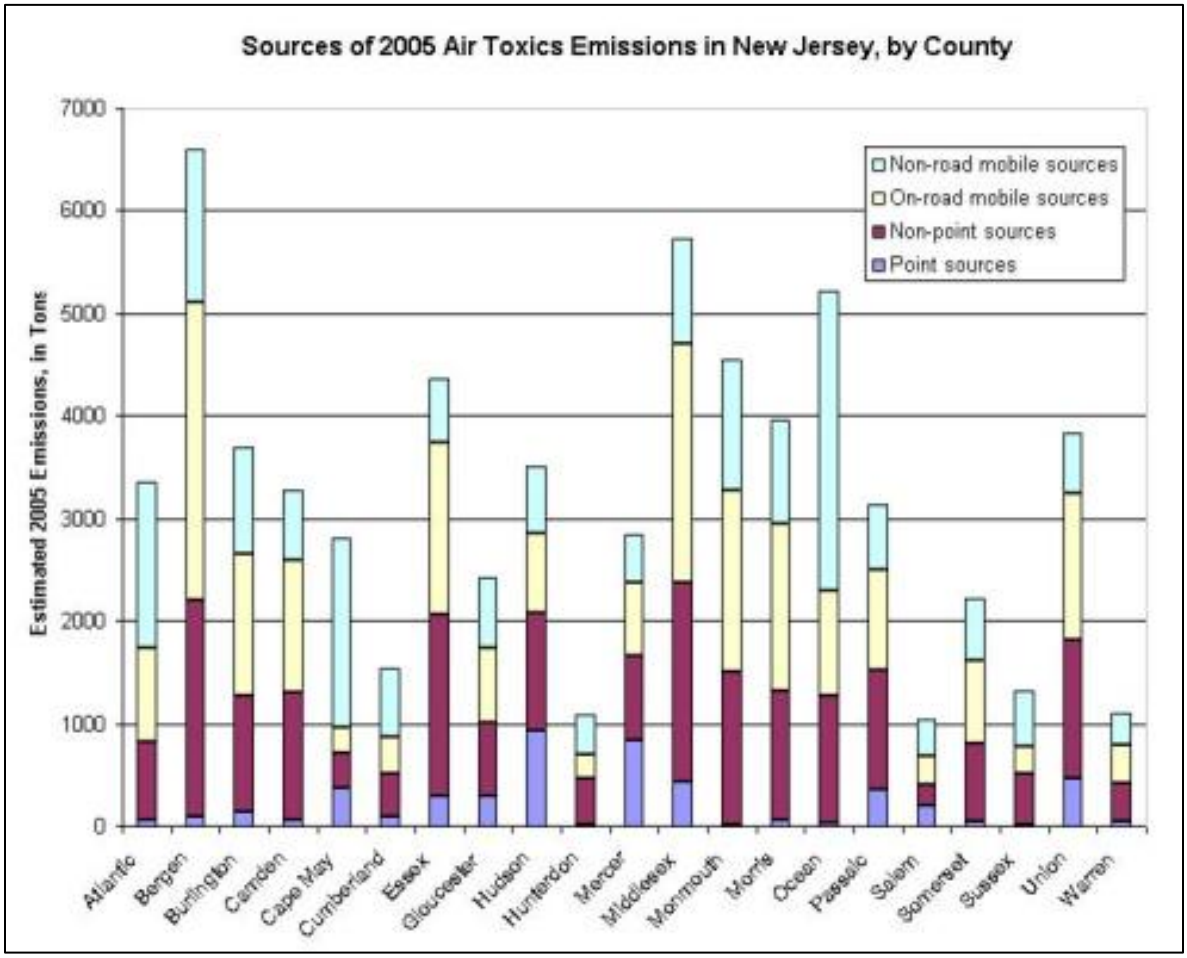


Figure 17. Air Toxic Emission Sources (NJDEP)

Radon

Radon is a naturally occurring radioactive gas. It is a byproduct of the decay of uranium and is found in soil at varying concentrations. Radon is a known health risk, causing lung cancer in smokers and non-smokers alike. Because it can accumulate in closed places such as houses, homeowners in high risk areas are encouraged to have their properties tested. Radon can also work its way into the water supply. The greatest risk of radon from drinking water is that it may escape into indoor air. Testing of drinking water supplies for uranium has been a recent development. If levels exceed the maximum set by the EPA for extended periods of time, kidney damage can occur.

In New Jersey, there is a uranium-rich geological formation, the Reading Prong, which stretches from Pennsylvania through northwestern New Jersey into southern New York. Testing of homes along this geologic formation has revealed high indoor levels of radon gas. Further testing in New Jersey, beyond the Reading Prong area, has shown additional areas where homes have elevated

radon levels.[81] In 2015, Essex County was found to have low-to-moderate potential for radon.[82] *Table 22* details the radon tier assignments for Essex County. The NJDEP uses a tier system to classify municipalities. Radon is tested by picocuries/liter, or 4 pCi/L. The NJDEP uses a measurement of greater than or equal to 4 picocuries/liter in order to classify municipalities. Municipalities in Tier 1 have a high potential for indoor radon problems. Tier 1 municipalities had at least 25 homes tested, with 25% or more homes having radon concentrations greater than or equal to 4 pCi/L. Municipalities in Tier 2 have a moderate potential for indoor radon problems. Tier 2 municipalities had at least 25 homes tested with 5 to 24% of homes containing radon concentrations greater than or equal to 4 pCi/L. Tier 3 municipalities have a low potential for indoor radon problems. Tier 3 municipalities had at least 25 homes tested, with less than 5% of homes having radon concentration greater than or equal to 4 pCi/L. Verona Township is categorized in the low-to-moderate tier, with 5% of homes with radon concentrations greater than or equal to 4 pCi/L.

Table 22. NJDEP Radon Tier Assignment: Essex County

Municipality	Sample Size	Number ≥ 4 pCi/L	% of Homes	Tier Assignment
Belleville	3724	188	5%	2
Bloomfield	6380	880	14%	2
Caldwell	1224	105	9%	2
Cedar Grove	1973	142	7%	2
Orange	1768	62	4%	3
East Orange	2272	42	2%	3
Essex Fells	611	63	10%	2
Fairfield	1049	26	2%	3
Glen Ridge	1994	150	8%	2
Irvington	2151	21	1%	3
Livingston	6548	514	8%	2
Maplewood	5067	247	5%	2
Millburn	5143	416	8%	2
Montclair	7396	609	8%	2
Newark	4902	154	3%	3
North Caldwell	1538	199	13%	2
Nutley	4212	267	6%	2
Roseland	1224	97	8%	2
South Orange	3285	259	8%	2
Verona	2696	131	5%	2
West Caldwell	2240	115	5%	2
West Orange	8907	736	8%	2

Source: NJDEP 2015 Radon Tier Assignment Report

Noise and Odors

Noise

The NJDEP, authorized by the Noise Control Act of 1971, N.J.A.C. 7:29, oversees noise control and abatement in New Jersey. The Office of Local Environmental Management (OLEM) works with County Health Departments and municipalities to monitor noise complaints and compliance. The NJDEP does not have a Noise Control Program, but the Noise Information website provides a list of contacts depending on the type of noise: aircraft, highway, commercial or industrial, or residential noise and nuisances. NJDEP has developed a model noise ordinance that can be adopted by local municipalities. The Noise Control Act allows municipalities to adopt noise control ordinances that are more stringent than the State code.[83] The provisions of Verona Township's noise ordinance are derived from the Revised Ordinances of the Borough of Verona, adopted August 20, 1963.[84]

Odors

According to the NJDEP, "odor is an air contaminant and therefore may be considered air pollution if it is present in a way that unreasonably interferes with the enjoyment of life or property." Guidelines for odor control are set forth in The Air Pollution Control Act: N.J.S.A. 26:2C-1 et seq. and N.J.A.C. 7:27-1.1 et seq. Odor complaints can be reported to the NJDEP 24 hour toll-free environmental hotline at 877-927-6337.[85] Verona Township has included limitations on odors in their zoning ordinance.[86]

Meteorology and Pollution

Meteorology plays an important role in the distribution of pollution throughout the troposphere, the layer of the atmosphere closest to the earth's surface. Atmospheric processes such as wind speed and wind direction affect the transport and dispersion of air pollution. Other weather phenomena, such as temperature, humidity, and barometric pressure influence chemical reactions and transformations in the atmosphere that affect air pollutants. By studying meteorological and air pollution data together, scientists and mathematicians have developed reasonably accurate models for predicting the fate of pollutants as they go through the stages of transport, dispersion, transformation, and removal. The Camden Spruce Street meteorological station monitors and measures temperature, relative humidity, wind speed and direction, and barometric pressure.[87]

New Jersey has nine stations to collect meteorological data. The Newark Firehouse meteorological station monitors and measures temperature, relative humidity, wind speed and direction, and barometric pressure. The mean annual temperature was 55 degrees Fahrenheit, and mean annual rain was 35.51 inches. The relative humidity was 57%, and annual average barometric pressure was 29.89 inches of mercury (Hg).[88]

CLIMATE

Prevailing Air Currents in New Jersey

According to the Office of the New Jersey State Climatologist (ONJSC) at Rutgers University, a "broad, undulating flow from west to east" dominates atmospheric circulation in the middle latitudes of North America, including New Jersey. "These 'prevailing westerlies' shift north and south and vary in strength during the course of the year, exerting a major influence on the weather throughout the State."[89] In general, most areas in New Jersey receive 25 to 30 thunderstorms per year, with fewer storms near the coast than farther inland. About five weak tornados occur each year throughout the state.

Climate Zone

New Jersey is divided into five distinct climate regions, or zones. Differences in geology, distance from the Atlantic Ocean, and prevailing atmospheric flow patterns produce distinct variations in the daily weather between each of these regions. According to the ONJSC publication, "The Climate of New Jersey," Verona is located in the Central climate zone, which runs from the New York Harbor to the Delaware River near Trenton. Due to the urban nature of this region, large quantities of pollutants are produced by a high volume of automobile traffic and industrial waste. Furthermore, the high concentration of buildings and paved surfaces helps retain more heat, thus affecting the temperature. This is commonly referred to as the "heat island effect." The Central Zone experiences approximately 15-20 days annually of 90° F or higher.[90] (*Figure 17*)

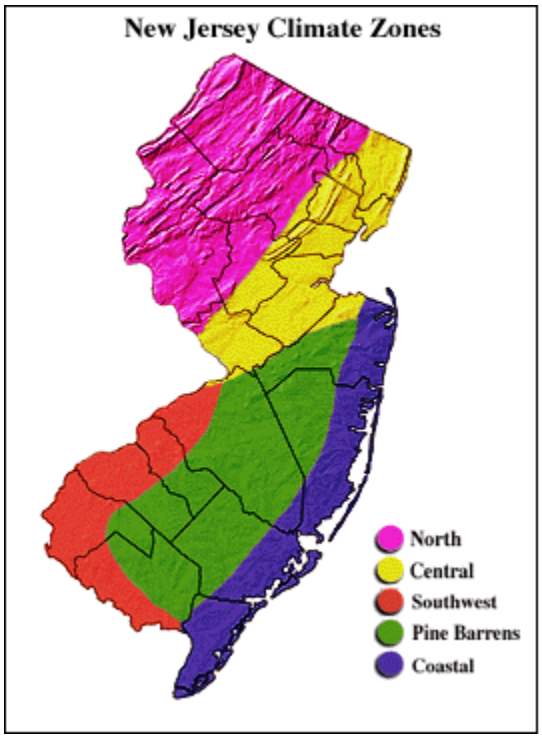


Figure 18. New Jersey Climate Zones (Office of the NJ State Climatologist)

Temperature and Precipitation

The ONJSC maintains temperature and precipitation data from monitoring stations throughout the state, with some records dating back to the 1890s. In the Central climate zone of New Jersey, where Verona lies, the asphalt, concrete, and other paved surfaces contribute to the temperature, as these paved surfaces retain heat, known as a "heat island." The northern side of this zone marks the border between freezing and non-freezing precipitation, while the southern edge has twice the amount of days with temperatures higher than 90 degrees.

State Historic Averages

Data from 1895 through 2012 for New Jersey statewide mean annual temperatures and annual precipitation along with yearly cooling and heating day totals for New Jersey from 1890 to 2012 have been collected and graphically represented to show a comparison and historic trend for the state's climate. This data is represented in *Figure 18*, *Figure 19*, *Figure 20* and *Figure 21;* which show an overall upward trend in mean temperature and precipitation for the state of New Jersey between 1895 and 2012, as well as an increase in yearly cooling degree days and a reduction in yearly heating degree days.[91] The ONJSC records an average of 163 "freeze free" days in the north, 179 in central Jersey and southern Jersey, and 217 at the coast. Essex County experienced 52 heating degree days, 20 cooling days, and 34 growing degree days.[92] The normal heating degree days, reported by the Northeast Regional Climate Center, are on a base of 65 degrees.

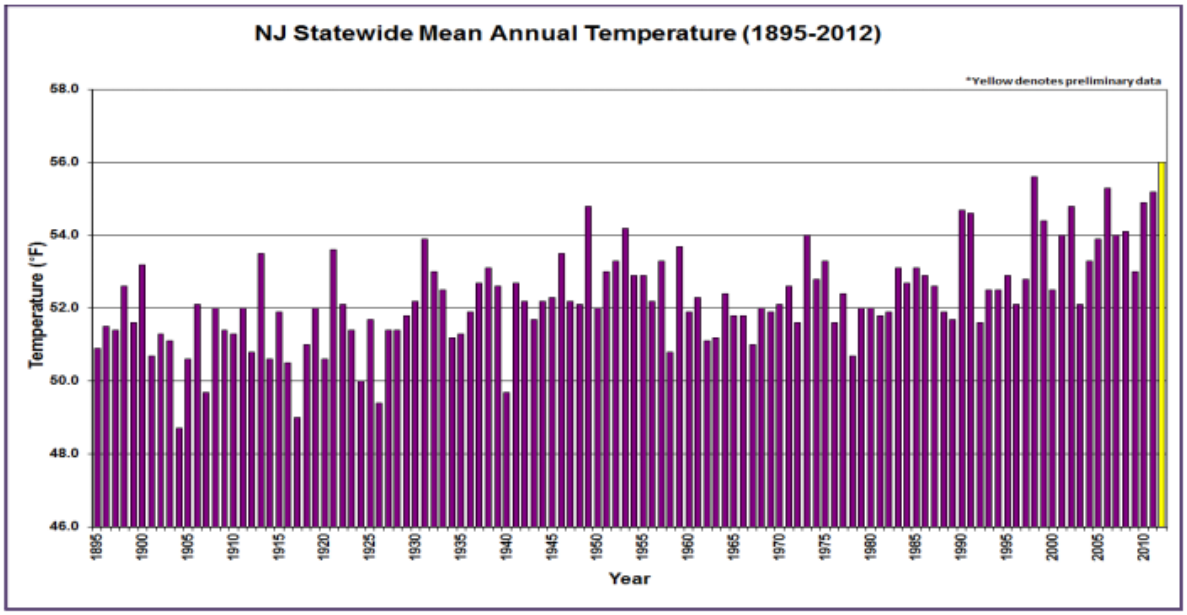


Figure 19. NJ Statewide Mean Annual Temperatures (1895-2012)

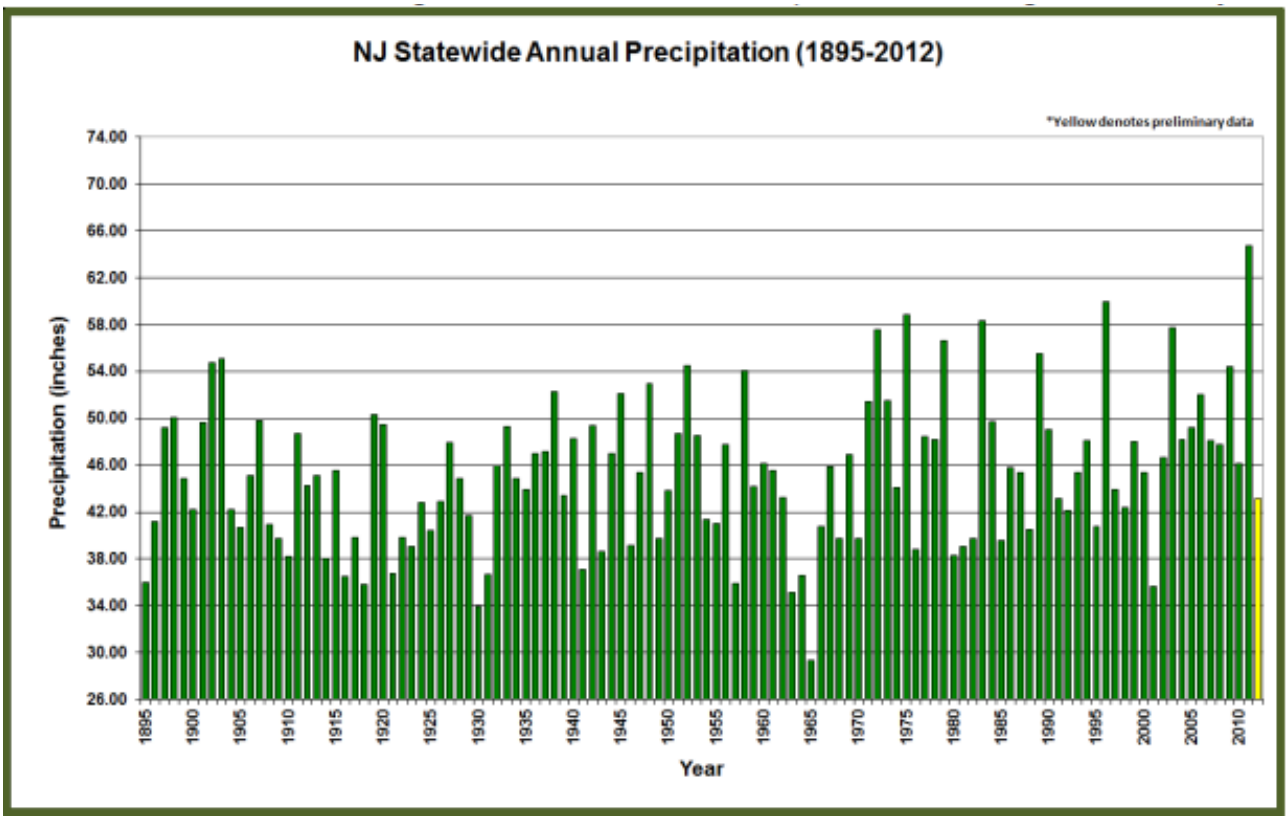


Figure 20. NJ Statewide Annual Precipitation (1895-2012)

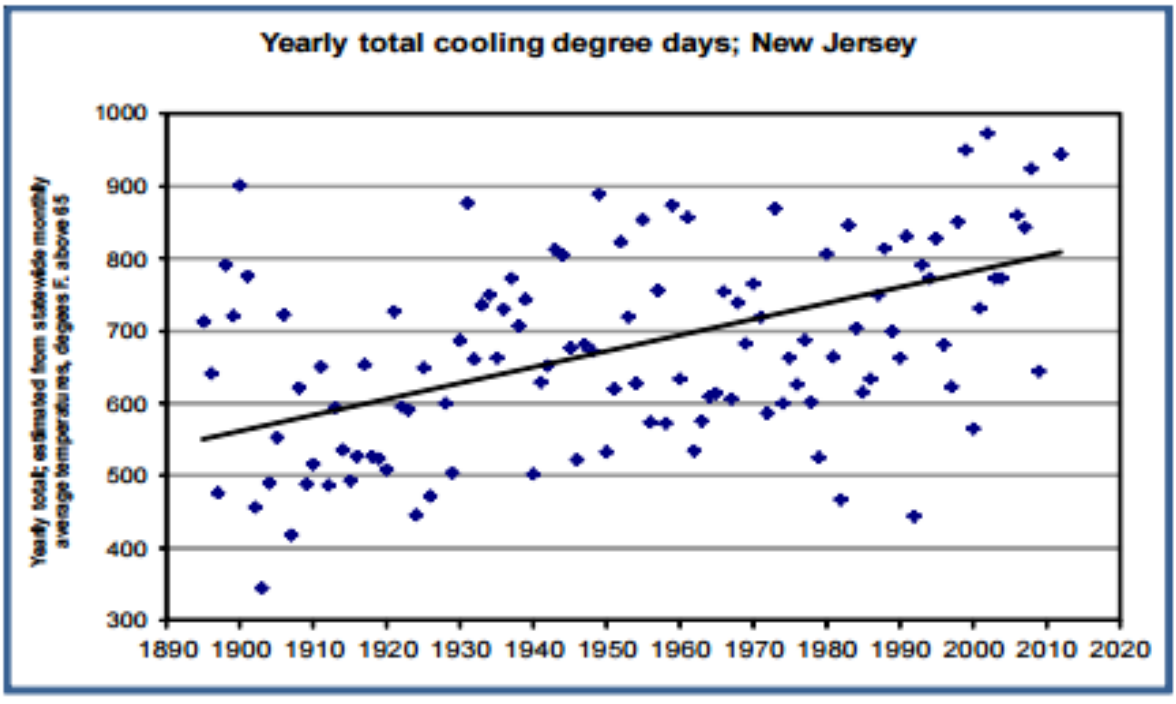


Figure 21. Yearly Total Cooling Degree Days; New Jersey

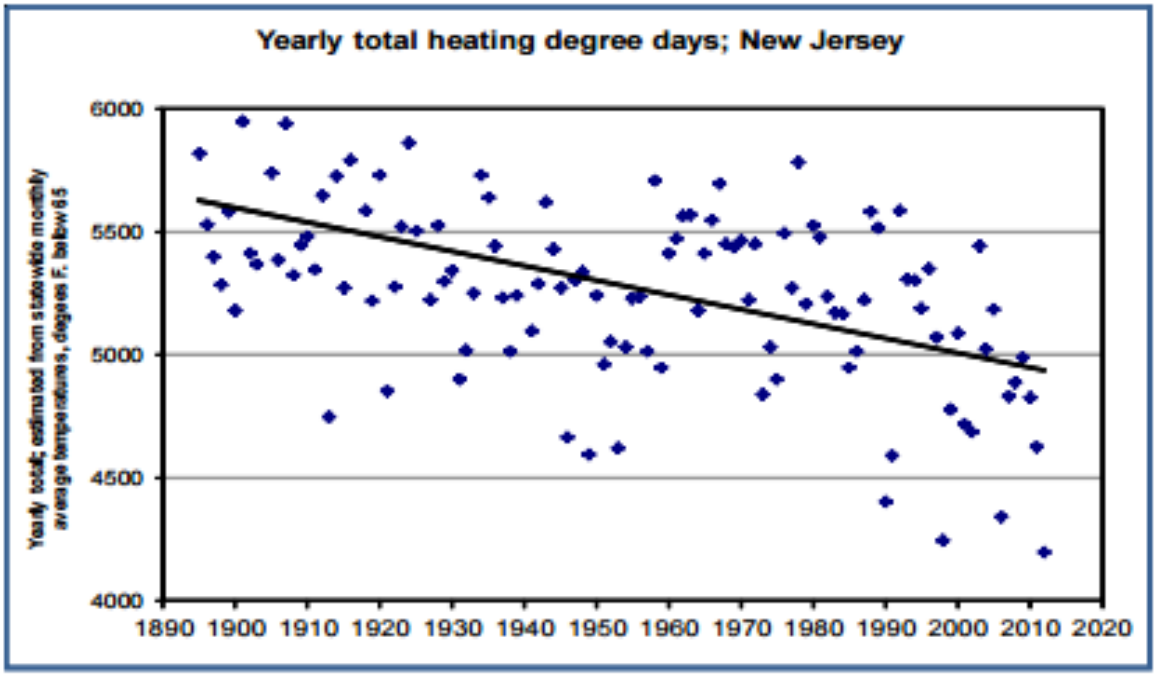


Figure 22. Yearly Total Heating Degree Days; New Jersey

Local Historic Averages

The three ONJSC reporting stations closest to Verona Township are at Caldwell Essex Airport, Canoe Brook Country Club, and Newark International Airport. These monitoring stations track a variety of climate factors, including monthly and annual temperatures and precipitation. *Table 23* includes monthly and annual temperature averages recorded at the Caldwell, Canoe Brook, and Newark monitoring stations. Each station has been monitoring temperatures for a different length of time. The historic average of annual mean temperatures for Caldwell is 53.1°F. For Newark and Canoe Brook, the historic average of annual mean temperatures is 54.5°F and 51.2°F respectively. A breakdown of average monthly temperatures is also included.

Local Historic Precipitation Averages

Table 24 details the monthly and annual averages for precipitation (in inches) at the Caldwell, Canoe Brook, and Newark monitoring stations. Historic annual mean precipitation for Caldwell is 44.82 inches. For Newark and Canoe Brook, the annual mean rates are 44.12 inches and 49.18 inches respectively. A breakdown of precipitation averages by month is also included. *Table 25* details the historic monthly and annual snowfall averages (in inches) from the Newark and Canoe Brook monitoring stations. The annual mean snowfall in Newark is 28.5 inches. The annual mean snowfall at the Canoe Brook monitoring station is 28.8 inches. The Caldwell monitoring station does not record snowfall data.

Table 23: Monthly and Annual Average Temperatures: Caldwell, Canoe Brook, and Newark Monitoring Stations

Caldwell Monitoring Station (1999-2017)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	29.9	32.2	40.4	51.6	61.7	70.4	75.5	73.8	66.7	54.9	45.0	35.2	53.1
Median	29.8	32.7	40.3	52.1	61.5	70.4	76.3	74.2	67.0	54.3	45.8	34.1	52.9
Min	22.1	19.7	34.1	46.5	56.8	67.3	70.4	70.7	63.4	52.0	40.5	28.1	50.9
Max	36.9	39.2	49.7	56.2	66.1	73.9	79.6	77.4	70.5	60.8	49.3	46.5	55.4
Canoe Brook Monitoring Station (1893-2017)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	28.7	30.2	38.7	49.5	59.6	68.9	73.8	72.2	65.1	53.7	43.2	32.9	51.2
Median	28.7	30.5	38.5	49.9	59.5	68.7	73.4	71.8	64.9	53.6	43.2	33.2	50.8
Min	18.1	15.7	30.6	43.7	52.4	64.4	69.4	66.1	59.6	47.9	37.1	21.7	48.9
Max	41.1	38.9	49.4	57.1	66.8	74.8	79.7	77.8	71.4	62.3	49.1	46.4	55
Newark Monitoring Station (1931-2017)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	31.9	33.5	41.6	52.2	62.7	71.9	77.1	75.5	68.2	57.1	46.6	36.1	54.5
Median	31.6	33.5	41.7	52.6	62.9	72.1	77.0	75.3	68.2	57.1	47.0	36.6	54.4
Min	20.9	18.6	33.9	45.8	54.3	67.5	73.1	70.1	63.6	51.8	39.9	25.6	50.5
Max	42.0	41.6	51.3	57.9	68.9	77.8	82.7	80.4	74.5	63.8	52.0	49.8	57.8

Source: Office of the New Jersey State Climatologist

Table 24: Historical Precipitation (inches): Caldwell, Canoe Brook, and Newark Monitoring Stations													
Caldwell Monitoring Station (1999-2017)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	2.77	2.58	3.69	3.80	3.42	4.51	3.98	4.43	3.85	4.08	3.11	3.99	44.82
Median	2.66	2.63	3.36	3.30	3.43	3.74	3.46	3.79	3.84	3.39	3.37	3.69	46.26
Min	1.47	0.65	0.61	1.71	1.06	1.99	0.31	1.39	0.80	0.33	0.88	1.14	29.28
Max	5.29	6.49	9.12	9.93	5.43	9.82	7.45	16.17	7.67	14.61	5.39	7.41	69.07
Canoe Brook Monitoring Station (1893-2017)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	3.58	3.03	4.21	4.06	4.27	4.25	4.59	4.75	4.49	3.86	4.05	3.94	49.18
Median	3.05	2.63	3.85	3.65	3.92	3.68	4.32	4.40	3.94	3.50	3.57	3.96	48.22
Min	0.50	0.47	0.63	0.72	0.95	0.05	0.44	0.19	0.27	0.61	0.39	0.14	32.92
Max	10.49	6.67	11.99	12.23	11.10	11.21	13.71	14.65	12.76	13.95	11.36	10.87	71.37
Newark Monitoring Station (1931-2017)													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	3.40	2.94	4.02	3.74	3.90	3.65	4.15	4.13	3.75	3.27	3.51	3.51	44.12
Median	3.15	2.73	3.65	3.16	3.71	3.56	3.91	3.46	3.33	3.00	3.06	3.65	43.62
Min	0.45	0.52	0.79	0.90	0.52	0.07	0.84	0.36	0.14	0.21	0.37	0.27	26.09
Max	10.10	6.49	11.14	11.85	10.22	10.50	19.09	18.79	10.28	13.22	11.53	9.47	69.91
Source: Office of the New Jersey State Climatologist													

Table 25: Monthly and Annual Mean Snowfall (inches): Historical Average for Newark and Canoe Brook

Newark Monitoring Station (1931-2017)													
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Annual**
Mean	0.0	0.0	0.0	0.1	0.7	5.3	8.1	8.7	4.9	0.7	0.0	0.0	28.5
Median	0.0	0.0	0.0	0.0	0.0	3.4	6.1	6.2	3.4	0.0	0.0	0.0	25
Min	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	1.9
Max	T	T	T	5.2	14.2	29.1	37.4	33.4	26.0	13.8	T	T	78.4
Canoe Brook Monitoring Station (1893-2017)													
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Annual**
Mean	0.0	0.0	0.0	0.0	0.6	4.8	7.8	9.0	5.0	0.6	0.0	0.0	28.8
Median	0.0	0.0	0.0	0.0	0.0	3.5	5.7	6.6	2.5	0.0	0.0	0.0	28
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Max	0.0	0.0	0.0	0.3	8.2	22.2	29.0	31.4	25.5	12.0	T	T	78.5

Source: Office of the New Jersey State Climatologist

Local Temperature and Precipitation Records

The National Weather Service report indicates that for Newark, the closest report area for Verona Township, the highest degree day was in July 2011 (108°F) and the coldest day was reported in 1934. The highest rainfall was reported in 2011 with nearly 70 inches of rain recorded. (*Table 26*)

Table 26. Temperature and Rainfall Records, Newark, NJ (2017)

Weather	Record Temperature	Date	2017 Record Temperature	2017 Date	2017 Average
Temperature (High)	108 degrees	07/22/2011	99 degrees	06/13/2017	64.6
Temperature (Low)	-14 degrees	02/09/1934	9 degrees	12/31/2017	48.3
Rainfall	**Single Year Record**	**Date**	**Total (2017)**	**Daily Average (2017)**	**Highest 24 Hour Total (2017)**
Precipitation (Maximum)	69.91 inches	2011	47.49 inches	0.13 inches	4.07 inches
Precipitation (Minimum)	26.09 inches	1965			

Source: National Weather Service

Extreme Phenomena

Tropical Cyclones

According to the National Oceanic and Atmospheric Administration (NOAA), tropical cyclones are rotating, organized systems of clouds and thunderstorms that originate over tropical or subtropical waters.[93] Tropical cyclones have four major levels, increasing in severity: tropical depression, tropical storm, hurricane, and major hurricane. Storms may start out as major hurricanes and weaken in strength as they travel and make landfall. The season generally runs from spring through fall, with most activity for the Mid-Atlantic States occurring in August and September. Tropical cyclones tend to bypass New Jersey due to its protective location slightly to the west of coastal outcrops to the north and south. When they do affect New Jersey, they are more apt to affect coastal areas, although a few have traveled inland.

Notable recent tropical cyclones are Hurricane Floyd in September 1999, Hurricane Irene in August 2011, and Hurricane Sandy in October 2012. According to ONJSC, approximately 7 inches of rain fell in the areas near Verona during Hurricane Irene.[94] During Hurricane Sandy in 2012, Verona received between 1 and 3 inches of rain.[95]

Other recent tropical cyclones affecting New Jersey:

2010 – Tropical Storm Hanna took an inland track.
2004 – A number of tropical storms and depressions affected the East Coast but missed inland Northern New Jersey.
2000 – A tropical depression from Hurricane Gordon affected coastal NJ.
1999 – Hurricane Bret clipped the New Jersey coast in September at a Tropical Storm level.
1996 – Hurricane Josephine downgraded to a tropical storm hit inland NJ in October.
1994 – A tropical depression traveled west and north of New Jersey.
1992 – Tropical Storm Earl traveled south and west of New Jersey.
1988 – Tropical Storm Chris traveled west to east through Northern New Jersey.
1985 – Hurricane Gloria skirted the coast of New Jersey.

For 2016, the most recent summary data available, the frequency of tropical storms was above the 1981-2010 average of 12.1, with 15 named storms forming (7 of which were hurricanes, while 8 were tropical storms). The 2016 season had an Accumulated Cyclone Energy index (duration and strength) of about 40% above the 1981-2010 average, and the highest since 2012. The 2016 season also saw Hurricane Matthew become the first Category 5 storm to form since Hurricane Felix in 2007.[96] In 2017 there were no weather-related disasters in New Jersey costing over one billion dollars.[97]

Landslides

Landslides in New Jersey have generally occurred in the northern and central parts of the state and include slumps, debris flows, rock falls, and rockslides. They are not as common in New Jersey as in other parts of the country. As of March 2017, there were 287 landslides in New Jersey as reported by the New Jersey Department of Environmental Protection (NJDEP).[98] Of the 278 landslides recorded in New Jersey from 1887 to 2015, nearly 14% (39) occurred during the heavy rains of Hurricane Irene in August 2011. No landslides have occurred in Verona Township.

Earthquakes

The NJDEP maintains a database of recorded earthquakes in New Jersey, with more than 200 as of July 2018. They occur more frequently along the fault lines in north-central New Jersey than in other parts of the state. These earthquakes are typically minor in nature, often registering in the category of micro-quakes. The strongest earthquake epicentered in New Jersey, with a magnitude of 5.3, occurred in 1783, just north of present-day Picatinny Arsenal in Rockaway Township. The strongest earthquakes *felt* in New Jersey had a magnitude of 8.0-8.8 and were epicentered in New Madrid, Missouri in 1811-1812. An earthquake epicentered in Virginia was felt in New Jersey in August 2011.[99] NOAA's website indicates the closest area that tests for earthquakes is New York, in which there was most recently an earthquake in 2002. In it, there was minimal damage, costing under one million dollars. It was a surface magnitude 4.2 earthquake with no deaths.[100] There has not been an earthquake in Verona since 1937.

In New Jersey, damage from earthquakes is rare or minor. The baseline for the hazard ranking is the level of horizontal shaking that have a 2-in-100 chance of being exceeded in a 50-year period. Shaking is expressed as a percentage of the acceleration of a falling object due to gravity. Maps

available from the USGS can "form the basis for seismic design provisions of building codes, insurance rate structures, earthquake loss studies, retrofit priorities, and land-use planning."[101]

Earthquakes are measured by magnitude, intensity (level of shaking), and depth to hypocenter. Magnitude measures the relative size and energy released (when one block or rock, along a fault line, slips over another, causing the ground to vibrate).[102] The magnitude scale begins at 0 and the highest magnitude ever recorded was 9.5. Of the 200 earthquakes recorded in the database, 61% had a magnitude of 2 or less and are considered "micro earthquakes." *Table 27. Magnitude Summary for Earthquakes in New Jersey* shows the magnitude summary.

Table 27. Magnitude Summary for Earthquakes in New Jersey

Range	*Count*	*% of Total*
<2.0	126	63%
2.1-3.0	61	30.5%
3.1-4.0	11	5.5%
4.1-5.0	1	0.5%
>5.1	1	0.5%
Total:	200	100%

Source: NJDEP

Generally, the intensity of an earthquake relates to its magnitude, with a higher level of intensity occurring at or near the epicenter of a higher magnitude earthquake. The intensity scale ranges from I to VIII or higher. Intensities of VI (felt by all, frightening but damage is slight) or VII (damage negligible in buildings of good design and construction) are generally associated with a magnitude in the 5 range. Intensities of IV (felt by nearly everyone; some shaking, cracking of walls, standing cars rocked) or V (felt by everyone) are generally associated with magnitudes in the 4 range.

Another earthquake measurement is the depth below the surface at which the hypocenter occurs. The hypocenter is the point in the earth where the rupture starts, and the epicenter is the point at the earth's surface directly above the hypocenter. Depth levels are grouped as shallow, 0-70 km deep; intermediate, 70-300 km deep; and deep, 300-700 km deep. All earthquakes in New Jersey have a shallow depth to hypocenter with the deepest recorded hypocenter at 25 km below the surface for an earthquake occurrence near Sussex in northwestern New Jersey in 1969. *Figure 22. Earthquakes in New Jersey* shows the frequency of earthquakes in New Jersey from 1983-2015. The highest annual count was 13 in 1984, and no earthquakes were reported in either 1985 or 2000.

Earthquakes epicentered around Verona Township are listed in *Appendix F. Earthquakes Epicentered Around Verona 1783-2017 (20 mile radius).* The strongest earthquake recorded within 20 miles of Verona was along the Longwood Valley Fault in Morris County in 1793, which is also the strongest earthquake in the history of New Jersey.

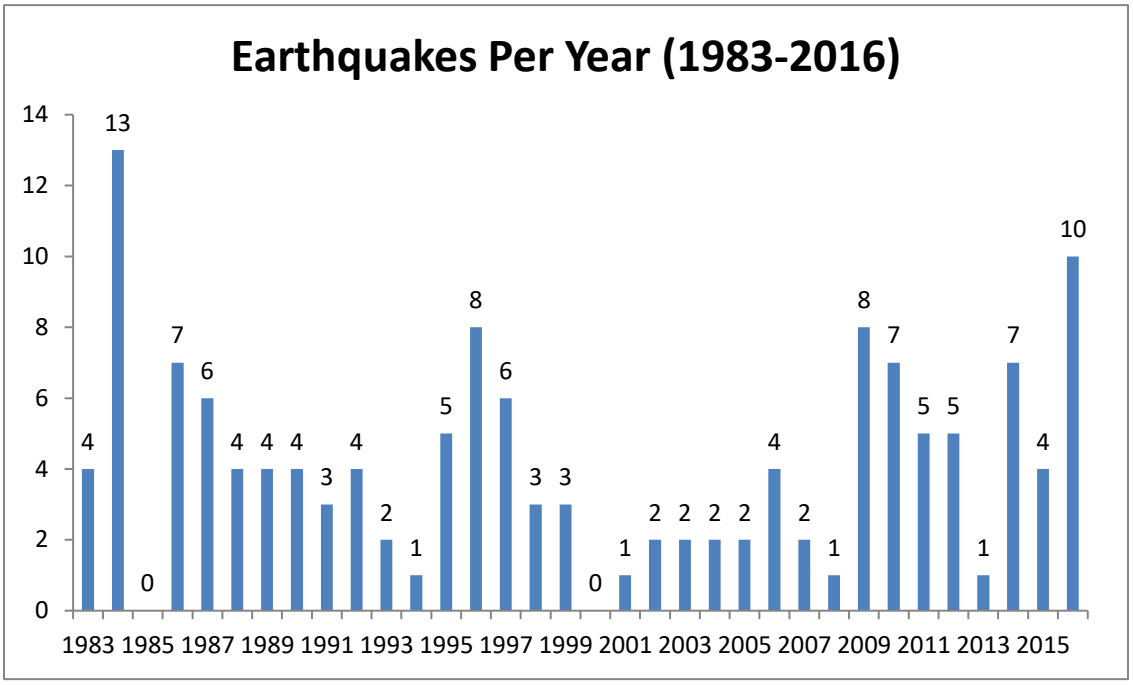


Figure 23. Earthquakes in New Jersey

Climate Change

In 2007, the Intergovernmental Panel on Climate Change (IPCC) reported that increasing carbon dioxide (CO_2) emissions into the atmosphere, as a result of human activity, has warmed the Earth's surface by more than 1.3°F during the last century. The Union of Concerned Scientists has indicated that temperatures in the northeast are likely to rise in winter and summer over the next several decades. Without a reduction in CO_2 and other Greenhouse Gas (GHG) Emissions, average temperatures may rise by up to 14°F in the summer by 2100. Studies have predicted that by the end of the century the New York City region and cities such as Trenton could experience more than 20 days per summer with temperatures above 100°F.[103]

The National Centers for Environmental Information noted that 2017 was the second warmest year on record behind 2016. Additionally, the global land and ocean temperatures for March of that year were 1.9°F above the 20th century average. This was the first time a monthly temperature was above 1.8°F in difference, in the absence of El Niño. Of importance is the trend in temperatures, as 2017 itself is the 41st consecutive year with both land and ocean temperatures above the average for its century. Since the 21st century began, these temperatures for land and ocean have broken records five times, three of which happening consecutively, from 2014-2016.

This warming trend can have impacts on the health of humans and the environment. The predicted effects on humans include heat stress, increased particulates in the air, and increased occurrences of insect-spread diseases such as West Nile Virus in the winter season of northern climates. Ecosystem repercussions include changes to the water cycle, with the following potential consequences: loss of critical habitat, further stressing some already threatened and endangered

species; impacts on water supply and agriculture; more intense rain events; more frequent periods of extended dryness; and increases in fires, pests, disease pathogens, and invasive weed species.[104] A Greenhouse Gas (GHG) is defined by the NJDEP as:

> "an atmospheric gas that slows the rate at which heat radiates into space, thus having a warming effect on the atmosphere. GHGs include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide, chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), and some other halogenated gases."[105]

To address the effects of GHGs, New Jersey enacted the Global Warming Response Act in 2007. This law requires:

- Stabilization of statewide GHGs to 1990 levels by 2020, and
- A further reduction to 80% below 2006 levels by 2050

According to the NJDEP, New Jersey must meet these limits in order to avoid the most damaging impacts of climate change. In 2012, the latest year for which major sector estimates are available, total estimated emissions were 104.6 million metric tons of CO_2 equivalent (MMTCOe), below the 1990 baseline and 2020 target of 125.6 MMTCOe. The 2050 goal is much more ambitious: to be 80% below the 2006 level, or approximately 25.5 MMTCOe.

In December 2011, the state revised its *Energy Master Plan* and released an updated draft in December 2015. The state *Energy Master Plan* is the strategic vision for the use, management, and development of energy in New Jersey over the next decade. Because fossil fuels such as coal, oil, and natural gas are the largest source of GHGs in the state, the *Energy Master Plan* serves as the platform for discussions about how New Jersey can meet the Global Warming Response Act's 2050 greenhouse gas limit.[106] On May 23, 2018, Governor Phil Murphy signed an Executive Order for the Energy Master Plan Committee to undertake an update to the 2015 Plan.[107]

The transportation sector continues to be the major contributor to GHGs (44% in 2012) and vehicle miles traveled continue to increase while fuel efficiencies have leveled off. In 2012, electricity generation was the second largest contributor at approximately 20% followed by residential at 11%, commercial at approximately 10%, and industrial at approximately 10%, combining for 31% of gross statewide emission. Highly warming gases, waste management, and land clearing contributed approximately 12%, while terrestrial carbon sequestration (forests absorbing carbon) provided an offset of -7.9%.[108]

Clean Energy Initiatives

The Sustainable Jersey program is a certification program that acknowledges communities that complete qualifying actions toward sustainability. Verona Township is a participating community. Among the qualifying actions are a number of Greenhouse Gas initiatives that can be undertaken by the municipality. Verona Township sells composters and rain barrels through the Sustainable Verona Green Team.[109] Verona also offers the Field Goods subscription for local produce delivered weekly, to help reduce gas emissions that the meat and food production industries release.

Essex County has recently celebrated the installation and opening of a charging station for electric-vehicles at the DPW building.[110] This station is the third in the county to offer vehicle charging for the public, the other two are located in the parking garage of the Turtle Back Zoo and the Juror's Parking Lot near the Veteran's courthouse. The Verona Environmental Commission supported the Essex County Board of Freeholders in their Resolution to take action against climate change.[111]

More recently, the Environmental Commission worked with the Council to approve an anti-idling program. Verona Township adopted an Anti-Idling Resolution in 2015. Since 2009, the Commission has run an anti-idling campaign with annual poster contests and exhibits at all Verona public schools, and encourages people to walk and bike to school, instead of driving. "No Idling" signage was installed at all elementary schools and the Community Center. In addition, in 2017 the Commission recommended Verona Township's governing body to adopt a resolution stating its commitment to implement measures in order to reduce greenhouse gas (GHG) emissions at a rate of at least 3.6% a year.[112]

Verona Township has also taken the pledge to use solar power. The Verona Solar Challenge is sponsored by the municipality in partnership with EnergySage, which gives community members access to information about solar energy.

On an individual level, rebates on energy efficient alternatives for household appliances, heating, cooling, and alternative energy systems are available through New Jersey's Clean Energy Program (NJCEP), which are administered by the New Jersey Board of Public Utilities. Commercial, industrial, and local government programs are also available.[113]

FLOOD HAZARD/FLOOD PRONE AREAS

Flood Zones

Federal, state, and municipal governments oversee areas prone to flooding through various acts, laws, and ordinances. The intent is to minimize property damage and negative ecological effects by limiting development and protecting positive environmental influences in areas subject to frequent flooding.

At the federal level, the United States Geological Survey (USGS) maps flood prone areas and the federal Emergency Management Agency (FEMA) evaluates and maps Special Flood Hazard Areas (SFHAs) that can be used in participating communities to determine flood insurance rates. On the state level, the NJDEP delineates Flood Hazard Areas along streams and regulated activities within these areas. In recent years, FEMA and the state have coordinated to integrate NJDEP flood hazard area parameters into FEMA updates. Municipal code may set standards that are stricter than either the state or FEMA.

FEMA Mapping and Flood Insurance Program

Special Flood Hazard areas, evaluated and mapped by FEMA, and other flood zones are used to create official Flood Insurance Rate Mapping (FIRM) that can be used in participating communities, such as Verona Township, to determine flood insurance rates. Communities can choose to participate in the National Flood Insurance Program (NFIP), which requires mandatory flood insurance in areas mapped as Special Flood Hazard Areas. A Special Flood Hazard Area is defined as "an area that would be inundated by the flood having one percent of chance being equaled or exceeded in any given year," also known as the base flood or 100-year flood zone. NFIP mapping also includes information of 500-year flood zones and various sublevels within the 100-year zone.[114] *Map 15* illustrates the 100-year and 500-year threshold for Verona Township, located primarily along Peckman River and its tributary in the Township (comprising under 4% of the community). *Table 28* details the flood zones in Verona Township.

Table 28. FEMA Flood Zones

Flood Hazard	Acres	% of Total Municipal Area
100-year Flood (1% annual chance)	64.54	3.59%
500-year Flood (0.2% annual chance)	14.30	0.80%
Not in Flood Zone	1,717.29	95.61%
Total:	1,796.13	100%

Source: FEMA DFIRM (2014)

NJDEP Regulated Water Ways

At the state level, New Jersey regulates flood prone areas through the New Jersey Flood Hazard Area Control Act, *N.J.S.S. 58:16A-50 et seq.*, and its rule, adopted November 5, 2017. The act recognizes the importance not only avoiding building in unsafe places, but also preserving the vegetation that "is essential for maintaining bank stability and water quality." The rules set

standards for development in flood hazard areas and areas adjacent to surface waters "in order to mitigate the adverse impacts to flooding and the environment that can be cause by such development." As defined by the rules, a flood hazard area exists along every regulated waterway that has a drainage area of 50 acres or more.

A Flood Hazard Area is defined as the area inundated by the flood hazard area design flood, which is equal to the 100-year food plus a "factor of safety". It includes both a floodway and a flood fringe. There are six measures for determining the flood hazard area under the FHCA rules. They include a NJDEP delineation method (flood studies are undertaken; FEMA tidal, fluvial, and hydraulic methods; and approximation and calculation methods).

NJDEP regulated activities in a flood hazard area or riparian include:

1. The alteration of topography through excavation, grading, and/or placement of fill;
2. The clearing, cutting, and/or removal of vegetation in a riparian zone;
3. The creation of impervious surface;
4. The storage of unsecured material;
5. The construction, reconstruction and/or enlargement of a structure; and
6. The conversion of building into a private residence on a public building. (N.J.A.C. 7:13-2.4)

The appropriate permit must be obtained in order to engage in any of these activities in a regulated area. There are several different categories of permits: permits by rule, general permits and individual permits. There are also area specific standards, depending on whether or not the area includes a channel, riparian zone, floodway, flood fringe, fishery resource, threatened and endangered species, or acid producing soils. Construction is not necessarily prohibited in a regulated area.

Flooding in Verona Township

The Peckman River traverses through Verona Township from north to south, with a tributary entering from the east near Sunset Avenue. The Peckman River flows into the Passaic River. In Verona Township, the 100-year flood zone is found along the Peckman River and its tributary.

The Verona Township Municipal Code addresses flood hazard areas in Chapter 77, Flood Control Code, which specifies strict standards for flood hazard reduction in those areas designated as Special Flood Hazard Areas (SFHA), as defined by FEMA. Article 5 of Chapter 77, *Provisions for Flood Hazard Reduction*, provides the general standards for building in flood areas.[115]

Impervious Cover Assessment

According to the *2016 Impervious Cover Assessment* prepared for Verona Township by the Rutgers Cooperative Extension Water Resources Program, the primary cause of the pollution, flooding, and erosion problems is the quantity of impervious surfaces draining directly to local waterways. The study recommends to implement green infrastructure and reduce impervious area in the Township of Verona at least 10%, to repair local waterways, reduce flooding, and minimize erosion.

A total of 82.5% of Verona Township's land is classified as urban. Based upon the 2012 NJDEP land use/land cover data, approximately 31.5% of Verona Township has impervious cover. This level of impervious cover suggests that the streams in Verona Township are likely non-supporting. Non-supporting streams have a watershed impervious cover of greater than 25%; at this high level of impervious cover, streams are conduits for stormwater flow and no longer support a diverse stream community.

Water resources are typically managed on a watershed/subwatershed basis. On a subwatershed basis, impervious cover ranges from 6% in the Upper Passaic River subwatershed to 36% in the Second River subwatershed. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in the subwatersheds where frequent flooding occurs.

The cumulative effect of these impervious surfaces and thousands of connected downspouts reduces the amount of water that can infiltrate into soils and greatly increases the volume and rate of runoff that flows to waterways. Stormwater runoff volumes (specific to Verona Township) associated with impervious surfaces were calculated for the following storms:

- New Jersey water quality design storm of 1.25 inches of rain, an annual rainfall of 44 inches
- 2-year design storm (3.4 inches of rain)
- 10-year design storm (5.2 inches of rain)
- 100-year design storm (8.7 inches of rain)

A substantial amount of rainwater drains from impervious surfaces in Verona Township. If the stormwater runoff from one water quality storm (1.25 inches of rain) in the Second River subwatershed was harvested and purified, it could supply water to 171 homes for one year.

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure projects capture, filter, absorb, and reuse stormwater to maintain or mimic natural systems and to treat runoff as a resource. As a general principal, green infrastructure practices use soil and vegetation to recycle stormwater runoff through infiltration and evapotranspiration. When used as components of a stormwater management system, green infrastructure practices, including bioretention, greenroofs, porous pavement, rain gardens, and vegetated swales, can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits.

Based upon the Rutgers Cooperative Extension (RCE) Water Resources Program's experience, a 10% reduction would be a reasonably achievable reduction for these subwatersheds in Verona Township. Once impervious surfaces have been identified, the next steps for managing impervious surfaces are to:

1. Eliminate surfaces that are not necessary. For example, a paved courtyard at a public school could be converted to a grassed area.

2. Reduce or convert impervious surfaces. There may be surfaces that are required to be hardened, such as roadways or parking lots, but could be made smaller and still be functional. A parking lot that has two-way car ways could be converted to one-way car ways. There also are permeable paving materials such as porous asphalt, pervious concrete, or permeable paving stones that could replace impermeable paving materials.

3. Disconnect impervious surfaces from flowing directly to local waterways. The RCE Water Resources Program recommends that all green infrastructure practices that are installed to disconnect impervious surfaces should be designed for the 2-year design storm (3.4 inches of rain over 24-hours). Although this results in management practices that are slightly over-designed by NJDEP standards, which require systems to be designed for the New Jersey water quality storm (1.25 inches of rain over 2-hours), these systems will be able to handle the increase in storm intensities that are expected to occur due to climate change. By designing these management practices for the 2-year design storm, these practices will be able to manage 95% of the annual rainfall volume. [116]

KNOWN CONTAMINATED SITES

Soil and groundwater contamination is tracked by the state and federal government. This includes the following type of sites and locations:

- ✓ Brownfields – Extensive, long-term remediation sites
- ✓ Community Right to Know program locations – Point Source facilities that require ongoing, continuous monitoring
- ✓ Known Contaminated Sites – Point source occurrences that are specific and limited

The NJDEP Site Remediation Program currently maintains a list of more than 12,000 New Jersey sites that have been confirmed contaminated and are undergoing remedial investigation, cleanup, or awaiting assignment of a Licensed Site Remediation Professional (LSRP). These sites include private residences, active/abandoned manufacturing/commercial properties, and gas stations. The list does not include sites that have been successfully remediated. There are 16 active Known Contaminated Sites in Verona Township, and 14 are non-homeowner sites.

Brownfields

A brownfield is "any former or current commercial or industrial site, currently vacant or underutilized and on which there has been, or there is suspected to have been, a discharge of a contaminant."[117] The State of New Jersey encourages municipalities and counties to redevelop their brownfields as part of Smart Growth initiatives. According to the State of New Jersey Brownfield SiteMart, there are no brownfield site locations in Verona Township.[118]

Community Right to Know

The Community Right to Know (CRTK) program is responsible for collecting and disseminating data on hazardous substances produced, stored, or used at companies in New Jersey. Companies or organizations storing certain hazardous substances in levels above specific threshold amounts are required by state and federal law to file annual reports. The Release and Pollution Prevention Report (RPPR) is used to collect information for the NJDEP Community Right to Know and Pollution Prevention programs. The RPPR gathers data on toxic chemical throughput, multi-media environmental releases, on-site waste management, and off-site transfers, collectively known as material accounting. The Emergency Planning and Community Right-to-Know Act (EPCRA) is a federal regulation that "established requirements … regarding emergency planning and "Community Right-to-Know" reporting on the hazardous toxic chemicals" to increase public knowledge and information about chemical uses."[119]

In 2017, there were two active sites in Verona Township that met the threshold for the State CRTK.[120] The first site is a property owned by Comcast of New Jersey, located at 799 Bloomfield Avenue. The second site is an "out of business" gasoline station owned by Lukoil, located at 655 Bloomfield Avenue.

Known Contaminated Sites

The Known Contaminated Sites (KCS) List includes those sites and properties where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards. Known Contaminated Sites may include:

- *Active sites* with known contamination, having one or more active cases with any number of pending and closed cases;
- *Pending sites* with confirmed contamination having one or more pending cases, no active cases, and any number of closed cases;
- *Closed sites* with remediated contamination, which are those sites having only closed cases, and no active or pending cases.

The KCS list was produced in response to the Brownfields and Contaminated Sites Remediation Act (*N.J.S.A. 58:10-23.16-17*) which required the preparation of a list of sites affected by hazardous substances. It also satisfied obligations under the New Jersey New Residential Construction Off-Site Conditions Disclosure Act (*N.J.S.A. 46:3C1 et seq.*). Sites included can undergo a wide variety of remedial activities, ranging from relatively simply "cut and scrape" cleanups to highly complex cleanups. The sites with complex contamination issues can have several sources of contamination, which can affect both soil and groundwater at the same time.

The Site Remediation Reform Act, *N.J.S.A. 58:10C-1 et seq.* (SRRA), enacted in 2009, has helped to speed up the remediation process, "thus helping to decrease the threat of contamination to public health and safety to the environment, and to quickly return underutilized properties to productive use." Active sites are rated with B, C1, C2, C3, or D depending on the type of severity of the contamination defined as follows:

> B – Remedial level associated with emergency response, simply removal of activities of contaminants, usually no impact to soil or ground water
>
> C1 – Remedial levels are associated with simple sites one or two contaminates localized to soil and the immediate spill or discharge area
>
> C2 – Remedial levels are associated within more complicated contaminant discharge such as multiple site spills and discharges, or more than one contaminant, with both soil and ground water impacted or threatened
>
> C3 – Remedial levels are associated with highly complex threatening sites. These sites can have multiple contaminants, some at high concentrations with unknown sources continuing to impact soils, groundwater, and possibly surface waters and potable water resources. These sites are dangerous for direct contact with contaminated soils
>
> D – Same conditions as C3 except that D levels are also usually designated Federal "Superfund Sites"

The Classification Exception Area (CEA) Status explains an area where one or more standards and designated uses are suspended. (N.J.A.C. 7:9C-1.4)[121] In Verona Township there are 16 active sites: 14 are non-homeowner and 2 are homeowner. (*Table 29* and *Map 16*) There is one pending contaminated site (non-homeowner) located at 49 Gould Street (Site ID 64393). There are 265 closed sites, of these, 62 are non-homeowner sites.

Table 29. Active (Non-Homeowner) Contaminated Sites					
Site ID	**PI Number**	**PI Name**	**Address**	**CEA Status**	**Category**
8164	017140	B&D Fire and Auto Center	202 Pompton Ave	Ongoing 4-25-2012	C2
8167	026859	Verona High School	151 Fairview Ave	Ongoing 6-25-2013	B
8171	014839	Sunoco 0007-0417	195 Pompton Ave	Ongoing 1-20-2015	B
8180	032682	Annin Flag Corporation	163 Bloomfield Ave	Ongoing 8-5-2016	C2
8189	007787	Site #30115*	101 Bloomfield Ave	Ongoing 8-13-2011	C2
24610	006746	Miscia's Service Center, Inc.	277 Bloomfield Ave	Ongoing 7-16-2011	C2
27149	024873	Alberona Auto Clinic	246 Bloomfield Ave	Ongoing 11-19-2015	B
27952	006358	Carnevale's Service Center 121376	710 Bloomfield Ave	Ongoing 10-23-2010	C2
50298	007787	Site #30115*	115 Bloomfield Ave	Ongoing 8-13-2011	C2
50331	012535	Charles Bahr & Son, Inc./ Oil Company	52 56 Durrell St	Ongoing 7-27-2011	C2
51801	017804	Radiac Abrasives, Inc.	271 Grove Ave	Ongoing 8-29-2013	B, C2
149999	004684	Lee Myles Transmission	667 Bloomfield Ave	Ongoing 5-5-2012	C2
445234	615709	Block 129, Lot 2	10 White Rock Rd	Ongoing 8-19-2013	C1, GW Contamination
571489	715831	PSE&G Transformer near 799 Bloomfield Ave	799 Bloomfield Ave	Ongoing 1-14-2016	B

**Block and Lot Numbers are the same, with different site IDs*
Source: NJDEP Site Remediation Program (March 22, 2018), NJDEP, NJDEP Data Miner

HISTORIC AND CULTURAL RESOURCES

Overview of Verona Township[c]

The first known inhabitants of the region were the Lenni Lenape Native Americans. Colonist settlement began in 1702 when a group from Newark purchased 14,000 acres from the Lenni Lenape. These settlers dominated the land with small farmsteads which were supported by a multitude of industries including mills, blacksmiths, shops, and general stores. The original colonists from Newark were soon joined by Dutch settlers from Bergen County. The title of the land was disputed over several decades between the Newark and Dutch settlers. These disputes lead to "The Horse Neck Riots" in the 1740s.

In 1770, the first Verona schoolhouse was believed to have been built. It was a log structure, but the exact location remains unknown. During the Revolutionary War, the Montclair/Verona border was used as a vantage point for Washington's troops to survey British movement in New York. The hilltop location is where the Hotel Montclair used to stand.[122] In 1798, "The Horseneck" seceded from Newark becoming the Township of Caldwell. Later, this area would once again be divided to become Verona, Cedar Grove, Fairfield, and the Caldwells.

At the end of the 18th century, the Enos Martin House, the Priest Farm Homestead, and the Hathaway House were constructed. These three properties are considered historic sites by the Verona Historic Preservation Commission (VHPC).

Beginning in 1806, the Newark and Pompton Turnpike was constructed. Today it is known as Bloomfield and Pompton Avenues. By the mid-19th century, Caldwell's control began to slip in the area known at that time as Vernon Valley. When an application for a post office in this location area was submitted, residents learned that another Vernon Valley existed in Sussex County, leading them to change the name to Verona.

During the mid-1800s, Captain Hiram Cook purchased land between the area of present-day Wayland Drive and the east shore of Verona Lake. He built several homes and allowed people to picnic on his property. A boathouse, bathhouse, and small pavilion were also built where people could enjoy refreshments. He nicknamed his property "Eden Wild." In 1900, he sold his portion of the lakefront property to the Verona Lake and Park Association. Verona Park is now owned and operated by Essex County.[123]

As the population grew, the need for essential services increased and talks of separation from Caldwell began. In 1892, the citizens of Verona and Cedar Grove elected to secede from Caldwell Township. The combined communities became Verona Township. During the late 1800s, the Newark City Home, which was established in 1874 to house Newark children and orphans, created an in-house print shop which later became *The Caldwell News*. For many years, *The Caldwell News* was the only printed newspaper west of the First Watchung Mountain in Essex County.

[c] This section of the *Environmental Resource Inventory Update* is adapted from the *Township of Verona 2009 Master Plan, Old Verona History: An Overview of Verona's History* and the *2017 Historic Resources Survey Update.*

The 1890s was a prosperous time for Verona. A railroad was constructed and trolley service was readily available. The area, home to more than 800 residents, transformed from an agricultural community to a suburban community. Verona Lake was used for recreation, and the Montclair Golf Club relocated to Verona during this time. With Verona exceeding the growth of Cedar Grove, the town split once more, creating two towns in 1902. The Borough of Verona was officially recognized by the state on May 13, 1907.

Kip's Castle, originally known as "Kypsburg," was completed in 1905. The estate is on eleven acres on the ridge of First Mountain in Montclair and Verona Townships, and provides spectacular views of New York City. It was constructed over a three-year period by Frederic Ellsworth Kip and his wife, Charlotte Bishop Williams Kip. After Charlotte's passing in 1926, the estate was sold and went through several owners. In 2007 it was purchased and preserved by Essex County.

In 1981, the Borough of Verona was changed to Verona Township to increase federal revenue-sharing money.[124] According to 2010 Census data, the population of Verona was 13,332.[125] The estimated population was 13,519 in 2016.[126]

In 2017 the Verona Township Landmark Preservation Commission was changed to the Historic Preservation Commission.[127] Ordinance #6-13 established the commission and their responsibility is to, "assist in the identification and preservation of [Verona's] landmarks and historic sites."[128] Barton Ross & Associates completed a Historic Resources Survey and Inventory Update in 2017.

Historic and Cultural Sites

The historic sites of Verona Township identified by the NJDEP Historic Preservation Office (State Historic Preservation Office or SHPO) are identified in *Table 30*.

Table 30. Verona Township SHPO Sites [129]

Site Name	Address	Designation	Designation
Annin and Company Building	163 Bloomfield Avenue	SHPO Opinion: 6/9/2014 (ID#5344)	State
Forest Hill Historic District*	Newark, NJ	NR: 8/3/1990 SR: 1/9/1990 (ID#1256)	Federal & State
Kip's Castle & Park	22 Crestmont Road, also located in Montclair Township	COE: 2/6/2009 (ID#4868)	State
Verona Lake Park	Lakeside Avenue	SHPO Opinion: 8/2/2001 (ID#3822)	State

**Bounded by Verona Township*
Source: NJDEP State Historic Preservation Office

Several other sites in the Township are of special historic interest and may be eligible for inclusion on the National or State Register but have yet to receive an opinion from either or both. A list of locally designated historic sites and landmarks is included in *Table 31*.

Table 31. Locally Designated Historic Sites and Landmarks of Verona Township			
Name	**Address**	**Block/Lot**	**Designation**
Enos Martin House	42 Martin Road	910/17	Locally Significant
Freight Shed	62 Depot Street	2301/1	Locally Significant
Hathaway House	190 Grove Avenue	1403/86	Locally Significant
Johnson House	16 Grove Avenue	1605/31	Locally Significant
Kip's Castle	22 Crestmont Road	104/12	Locally, Regionally & State Significant
Methodist Church	24 Montrose Avenue	1807/13	Locally Significant
Pease House	66 Lakeside Avenue	1806/26	Locally Significant
Priest Farm Homestead	110 Claremont Avenue	806/7	Locally Significant
The White Rock (Hilltop)	Second Watchung Mountain		Locally Significant
Verona Civic Center	Gould Street and Bloomfield Ave	1603/2	Locally Significant
Verona Public Library	Verona Civic Center (800 Bloomfield Avenue)	1603/2	Locally Significant
Source: Verona Township Historic Sites Survey, 2017			

Site Descriptions (Locally Significant)

Enos Martin House

The Enos Martin house, located on 42 Martin Road, was constructed in the late 18th century. The house was originally built by Enos Martin, who served during the Revolutionary War. It contains a large hearth along with the remains of a beehive oven. There are exposed overhead ceiling beams on the first floor. The house remained in the Enos family for over a century and is currently being restored. It is eligible for Register listing due to its early architecture styles and sympathetic alterations.

Freight Shed

The Freight Shed is located at 62 Depot Street. This landmark was built during the turn of the 19th century. It is a small wooden structure that served as a freight shed. This structure is the sole-survivor of a once-busy rail line. It linked Verona to the Caldwell Branch of the Erie Railroad.

Hathaway House

The Hathaway House is located at 190 Grove Avenue. It was likely constructed around 1790. The exterior walls are brick lined, which was an early form of insulation. The house's characteristics are known as the "East Jersey Cottage." The house was built on a farm belonging to one of the earliest European families to settle in the area, the Baldwin family.[130]

Johnson House

The Johnson House, located at 16 Grove Avenue, was built around 1870. It is an Italianate-style house. Past residents of the house include Hiram Cook, William P. Rich, and William Johnson. Cook moved to Verona after the Civil War and was the person responsible for turning Verona Lake into a recreation center.

Kip's Castle

Kip's Castle, or "Kypsburg" as it was originally named, is located at 22 Crestmont Road. The property consists of a castle and a two-story carriage house. The castle itself is 9,000 square feet and is modeled after a medieval Norman castle. Now a public park, it is owned and managed by Essex County. It houses the County's Division of Cultural Historic Affairs and is known as Kip's Castle Park.

Methodist Church

The Methodist Church, located at 24 Montrose Avenue, was built in 1909. It models other 19th century wooden tabernacle buildings, located in Mount Tabor, Ocean City, and Ocean Grove, with its yellow brick exterior and hexagonal lantern on top. The church was eventually retrofitted to accommodate the fire and police departments and the library. A fire destroyed the original church and only the rear annex remained. The annex was moved to South Prospect Street.

Pease House

Gilbert Pease built the house in 1893 and it is located at 66 Lakeside Avenue. Much of the property is covered by overgrowth and is barely visible from Verona Lake.

Priest Farm Homestead

Constructed in the 18th century, the Priest Farm Homestead is located at 110 Claremont Avenue. The Homestead was purchased by Reverend Priest. He was a Presbyterian pastor who served in Montclair from 1858 to 1861. Upon purchase, the farm underwent significant changes and expanded into the mid-Victorian style. The house is surrounded by maple trees that are more than 150 years old, as well as a white picket fence lining the front lawn. Alfred F. Harris was the most recent owner.

The White Rock

The boulder is atop the Second Watchung Mountain, which divides Verona from other towns. There is no written history of the boulder, but according to handed down stories, The White Rock was a religious meeting place in the early 1800s.

Verona Civic Center

The Verona Civic Center was constructed in 1923. This Georgian Revival style of buildings is connected with the City Beautiful movement in the early 20th century. The scenic, park-like center is in the shape of a square, with Gould Street and Bloomfield Ave acting as borders. It includes the H.B. Whitehorne School, the Verona Public Library, and the Verona Town Hall. In addition

to these structures, there is a large bronze statue commemorating town residents who served in World War I.

Verona Public Library

Prior to the construction of the Verona Public Library in 1923, Anna M. DeGolier, among others, established the Isabella Literary Club. The club dedicated funds to establishing a library which was housed in Anna DeGolier sister's home. Over the years, the library moved to several locations. Construction of the permanent library began in 1922.

Potential Historic Sites, Landmarks, and Districts

The *2017 Verona Township Historic Resources Survey and Inventory Update* offers documentation regarding potential historic sites, landmarks and districts within the municipality. The six potential districts include:

- Claremont Avenue
- Forest Avenue, between Bloomfield and Pease Avenues
- Sunnyside Heights
- Kip's Castle Historic District
- Afterglow Historic District
- Fairview Avenue Historic District

Appendix G includes the full list of historic sites and landmarks in Verona Township which appear in the *2017 Historic Resources Survey*. *Table 32* highlights several of these. Of the six proposed districts, two include 38 of the 87 surveyed properties in the report. These are the Afterglow Historic District which has "a significant concentration of elaborate large scale, historical revival residences, many in the Tudor Revival and Romantic styles of the early twentieth century," and the Claremont Avenue Historic District. This district encompasses many wood framed, moderate-sized homes spanning three centuries of varying architecture design and construction techniques.

Table 32. Potential Designated Historic Sites and Landmarks of Verona Township

Name	Address	Block/Lot	Recommendation
Verona Lake Park			2009 Master Plan
Brower House	190 Grove Avenue	1403/86	2009 Master Plan 2017 Historic Survey
Farm House	77-79 Sunset Avenue	501/38	2009 Master Plan
Idle Woods	14 Manor Road	612/1	2017 Historic Survey
Dr. Personett House	30 Grove Avenue	1605/28	2017 Historic Survey

Source: 2009 Master Plan and 2017 Historic Survey

TRANSPORTATION

Roadways

There are approximately 38 miles of roadway in Verona. The Township has two major east/west roads and five north/south roads. The major east/west roads are Bloomfield and Linden Avenues. The major north/south roads are Mount Prospect Avenue, Fairview Avenue, Grove Avenue, Lakeside Avenue, and Pompton Avenue (Route 23). The remainder of the roads in Verona primarily serve to access the residential neighborhoods. Verona has not been classified utilizing the Residential Site Improvement Standards (RSIS) because that applies to proposed new roads and Verona's road system is an older, established infrastructure. The hierarchy of roads, based on functional classification system, is detailed below:

Arterial - Carry large volumes of traffic at relative high speeds and may connect to interstate highway network:

- Bloomfield Avenue, Pompton Avenue (Route 23), Lakeside Avenue, and Mount Prospect Avenue:
  Bloomfield Avenue runs from the west to the southeast portion of Verona and is the road where most Arterial and Collector roads meet.
  Mount Prospect Avenue (Route 577) runs from the east portion of Verona to Bloomfield Avenue.
  Lakeside Avenue runs south from the middle of Bloomfield Avenue.
  Mount Prospect is also known as Essex County Route 577; it runs from where Pompton Avenue runs into Bloomfield Avenue.
- 3.65 miles are classified as arterial roads.

Collectors - Provide access and traffic circulation within residential neighborhoods, commercial, and industrial areas and connect local roads with arterials:

- Fairview, Grove, and Linden Avenues:
  Fairview Avenue and Grove Avenue enter from the north and northeast respectively, and join Bloomfield Avenue.
  Linden Avenue runs from the end of Fairview Avenue to the end of Pompton Avenue.
- 3.56 miles are classified as collector roads.

The remaining 31 miles of roads in Verona are classified as *Local Roads,* serving the residential neighborhoods.

According to the Essex County Master Plan, Verona's "circulation efforts should be made to ensure an efficient transportation system. Specifically, the intersection at Claremont and Pompton Avenues extending southerly from Bloomfield Avenue and including the intersection of Sunset Avenue should be studied."[131]

Mass Transit

Verona has access to train stations and bus stops. There are several regularly scheduled mass transit service destinations in Verona.

Train - Passenger rail service is available to Verona residents. New Jersey Transit provides mass transit into New York City. The routes are 11, 28, 29, and 75. These routes also provide stops to neighboring communities and nearby shopping malls.

Bus - New Jersey Transit provides service. There are three bus stops located along Bloomfield Avenue at the intersection of Pompton Avenue (Route 23), Lakeside Avenue, and Sunset Avenue. NJ Transit has three routes to Newark and three routes to New York City. Additionally, DeCamp Busing provides service into New York City, Wall Street, and the Meadowlands Racetrack. The DeCamp bus routes use the intersection of Bloomfield and Lakeside Avenues as a bus stop.

Bicycle and Pedestrian

The West Essex Trail is a 2.8-mile bicycling and hiking trail running from Passaic County into Verona. The West Essex Trail follows the former rail bed of the Caldwell Branch on the Erie-Lackawanna Railroad. The trail runs between the Essex–Passaic County line in Little Falls and Arnold Way in Verona. The trail crosses a trestle over the Peckman River.[132] The *Essex County Comprehensive Transportation Plan* found pedestrian sign and signal deficiencies exists with compliance with the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD shows many typical standard signs approved for use on streets, bikeways, and pedestrian crossings that could be added to the West Essex Trail.[133] The *Essex County Master Plan* also recommended the installation of bus shelters at Bloomfield Avenue with Linn Drive and Sunset Avenue; pedestrian access improvements to Verona Park; pedestrian safety improvements at the intersection of Fairview Avenue and Personette Avenue; the installation of bike racks at the Bloomfield Avenue intersection with Oakridge Road, Fells Road, Fairview Avenue, and Linn Drive.[134]

The Township of Verona has Class 3 bicycle routes, which provide for shared use with the pedestrian or motor vehicle traffic. These bicycle routes are currently not signed in the Township.

REGIONAL PLANNING REVIEW

Regional Planning

New Jersey State Development and Redevelopment Plan (SDRP)

The *2001 SDRP*, in effect as of the date of this *ERI Update*, designates planning areas designed to reflect appropriate levels of development. It identifies areas for growth, areas for limited growth, and areas for conservation. The State Plan Policy Map dated October 9, 2012 designates the majority of Verona Township as Metropolitan Planning Area – Planning Area 1 (PA1), with the exclusions of the northwest corner of Verona, including the Hilltop Reservation, which is identified as Environmentally Sensitive Planning Area – Planning Area 5 (PA5), and the southeast corner, which includes Eagle Rock Reservation and is identified as PA8, Parks and Natural Areas.

Metropolitan Planning Areas (PA1) comprise the most densely developed regions in the state. The goals in these areas revolve around revitalizing existing cities and towns by encouraging compact growth and redevelopment. The Metropolitan Planning Area is identified as the most appropriate location for future development in New Jersey. Verona will want to monitor future development and redevelopment to ensure that environmental resources are not negatively impacted.

Environmentally Sensitive Planning Areas (PA5) comprise of large contiguous tracks of land with valuable ecosystems, geological features, and wildlife habitats. The goals in these areas revolve around guiding development into Existing Centers, "to preserve open space, farmland and natural resources and to preserve or improve community character, increase opportunities for reasonably priced housing and strengthen beneficial economic and development opportunities."[135] In the 2009 *Verona Master Plan*, it describes the need for Verona, "to promote the establishment of appropriate population densities and concentrations that will contribute to the well-being of people, neighborhoods, communities and regions and preservation of the environment."[136] It goes into further detail stating that its objectives are to:

- Preserve the environmental resources of the Township by locating conservation parklands and easements where necessary; by limiting development in environmentally sensitive areas; by encouraging the preservation of specimen trees and general landscaping; and by preservation of the township's natural character.
- Preserve environmentally sensitive lands by identifying wetlands and preserving them according to the rules and regulations promulgated by the New Jersey Department of Environmental Protection.
- Preserve environmentally sensitive lands by identifying steep slopes and deterring development on said lands.

In addition to the *Master Plan,* the 2005 *Hilltop Redevelopment Plan and Master Plan Update* details conservation of the Hilltop Reservation. The Plan states, "the conservation area, a.k.a., Hilltop Reservation, shall be considered public lands with the intent of preserving that includes low-impact recreation and public educational uses."[137] In addition, the goal is, "to prohibit residential, commercial and industrial uses of the land, commercial recreational use of the land; and any use of the land that would diminish its value in serving the recreational needs of Verona, Cedar Grove, north Caldwell and Caldwell."

Within *Parks and Natural Areas (PA8)*, the intention of the State Plan is to provide for the protection of critical natural resources, provide public recreational and education opportunities, ensure the maintenance of associated facilities, and ensure the connection of these areas into systems of open lands. The Eagle Rock Reservation is maintained and protected by the Eagle Rock Conservancy.

The State Planning Commission has been working on a replacement to the current State Plan, which is titled the State Strategic Plan. Originally proposed for adoption in 2012, this has not occurred. According to the Association of New Jersey Environmental Commissions (ANJEC), the emphasis of this proposed plan is on economic growth, and "although it discusses open space preservation, it does not offer measures for environmental protection. Instead, it calls for focusing State policies and investments in 'vibrant regions,' fostering critical job growth, supporting effective regional planning and preserving the State's critical resources."[138] If this Plan is adopted, the official state policy map will be phased out. In this version of the State Plan "the responsibility of protecting the environment through zoning and other ordinances lies specifically with local governments."

Garden State Greenways (GSG)

Garden State Greenways (GSG) is a vision for a statewide system of interconnected natural lands, or greenways, in New Jersey.[139] GSG identifies natural resources – wetlands, forests, fertile soils, and diverse plant and animal habitat – that help provide clean water, clean air, a healthy food supply, scenic areas, and recreation. Connectors link resource hubs. The connectors identified in Verona include the area along the Peckman River and Verona Lake as well as area on the eastern side of Verona which would connect Kips Castle and Eagle Rock Reservation.[140] Both these areas include wetlands, riparian zones, and "of importance" rare species strong holds.[141]

Water Quality Management Plan

The Statewide Water Quality Management (WQM) Plan was adopted by the NJDEP in November 1985 as part of a comprehensive effort to protect water quality in the State. The Plan serves as the foundation of the State's Water Quality Management Planning Program, and unified three federal Clean Water Act programs – wastewater facilities, planning (201), basin planning (303e), and area-wide planning (208) – into one comprehensive Statewide program. In addition to addressing federal requirements, these three programs serve to satisfy State requirements for water quality planning specified in the NJ Water Quality Planning Act. The existing DEP Water Quality Management Planning Program and Water Quality Management Planning rules (N.J.A.C. 7:15) represent the State's current implementation of the area-wide planning program (208). The area-wide WQM plans (formerly known as 208 plans), as part of the Statewide WQM Plan, are umbrella plans, each with various adopted components that address different aspects of water resource planning.

Twelve WQM areas were created in New Jersey and WQMPs for each area received Governor and EPA approval. Essex County is part of the Northeast Water Quality Management Planning Area. WQMPs may be amended by following a specific set of procedures.

Wastewater Management Plans

Wastewater management plans (WMPs), including designated sewer service areas are a major component of the WQMP. The State requires WMPs to be updated every six years. For Verona, this responsibility lies with the County Board of Chosen Freeholders and the Essex County Utilities Authority.[142] A WQM amendment in 1996 adopted a Wastewater Management Plan (WMP) for Verona Township.[143] The Verona Township WMP proposed the expansion of the sewer service area to address wastewater discharge from the Essex County Hospital and Essex County Correctional Facility.[144]

Essex County

Essex County Park, Recreation and Open Space Master Plan

Essex County adopted a Park, Recreation, and Open Space Master Plan in 2003. Among the goals and objectives of this Plan, the following align with the protection of environmental resources:

- Provide for the care and maintenance of the Essex County Park System in a manner consistent with the Olmsted vision
- Rehabilitate each County park for the full use and enjoyment of all County residents.
- Maintain each County Park to a superior level
- Protect the significant natural resources of Essex County
- Support local and community based efforts that preserve open space and that expand the recreational opportunities available to County residents
- Establish partnerships with community groups and user groups that support the County Park System
- Pursue Federal, State, and non-profit funding to improve County parks, preserve open space, and conserve natural and cultural resources
- Capitalize on the unique features of the Essex County Park System and provide new recreational programs and facilities to meet the needs of all County residents
- Establish a safe environment in each County Park so that every visitor feels secure.
- Organize all park functions under one management structure that is responsible for parks and recreation and empower it with an integrated management approach to ensure staff accountability, achieve standards, and promote an increased level of commitment to the care and improvement of each and every park in the Essex County Park System
- Expand the County Park System giving particular attention to including sites or lands contiguous to existing County parks or to acquiring new sites of substantial size that can be developed or redeveloped for active recreation facilities and special outdoor events
- Promote the preservation and restoration of cultural, archaeological and historic sites

Essex County Utilities Authority

The Essex County Utilities Authority (ECUA), created in 1992 by the Essex County Executive and the Essex County Board of Chosen Freeholders, provides collection, recycling, and disposal of solid waste to more than 790,000 residents. The mission of the ECUA, "is to plan, develop and implement cost effective solid waste methods emphasizing the recovery of materials and energy, with a minimal impact on the environment." It is governed by a 7-member Board of Commissioners.

APPENDIX

Appendix A. Soils of Verona Township

Appendix B. Soil Erodibility

Appendix C. Soil Limitations

Appendix D. Soil Limitations for Building Site Development

Appendix E. Values and Limitations of Soils in Verona for Recreational Use

Appendix F. Earthquakes Epicentered Around Verona 1783-2017 (20 mile radius)

Appendix G. Map of Surveyed Properties, *Verona Township Historic Resources Survey & Inventory (June 2017)*

Appendix A. Soils of Verona Township

Abbrv.	MU (Map Unit) Name/Description	MU Type	Acres	% of Verona
BouB	Boonton-Urban land, Boonton substratum complex, 0 to 8 % slopes	Complex (Cx)	635.36	35%
BouC	Boonton-Urban land, Boonton substratum complex, 8 to 15 % slopes	Complex	146.4	8%
BouD	Boonton-Urban land, Boonton substratum complex, 15 to 25 % slopes	Complex	18.92	1%
BogBc	Boonton loam, 0 to 8 % slopes, extremely stony	Consociation (Cn)	113.97	6%
BogCc	Boonton loam, 8 to 15 % slopes, extremely stony	Consociation	32.9	2%
BogDc	Boonton loam, 15 to 35 % slopes, extremely stony	Consociation	37.3	2%
HasB	Haledon-Urban land, Haledon substratum complex, 0 to 8 % slopes	Complex	40.79	2%
HanBc	Haledon silt loam, 0 to 8 % slopes, extremely stony	Consociation	20.5	1.5%
HanB	Haledon silt loam, 3 to 8 % slopes	Consociation	8.58	0.5%
HanCc	Haledon silt loam, 8 to 15 % slopes, extremely stony	Consociation	9.8	0.5%
PecuuB	Peckmantown-Urban land, Peckmantown substratum complex, 0 to 8 % slopes	Complex	329.96	18%
PecuuC	Peckmantown-Urban land, Peckmantown substratum complex, 8 to 15 % slopes	Complex	33.8	2%
PecmBc	Peckmantown silt loam, 0 to 8 % slopes, extremely stony	Consociation	11.67	0.5%
PecmB	Peckmantown silt loam, 3 to 8 % slopes	Consociation	2.15	0.5%
PecmCc	Peckmantown silt loam, 8 to 15 % slopes, extremely stony	Consociation	5.53	0.5%
UdbonB	Udorthents, Boonton substratum, 0 to 8 % slopes	Consociation	92.59	5%
UdhalB	Udorthents, Haledon substratum, 0 to 8 % slopes	Consociation	13.1	1%
UdhorB	Udorthents, Horseneck substratum, 0 to 8 % slopes	Consociation	19.43	1%
UdpecB	Udorthents, Peckmantown substratum, 0 to 8 % slopes	Consociation	23.32	1%

Appendix A. Soils of Verona Township

Abbrv.	MU (Map Unit) Name/Description	MU Type	Acres	% of Verona
URBONB	Urban land, Boonton substratum, 0 to 8 % slopes	Consociation	26.6	1.5%
URPECB	Urban land, Peckmantown substratum, 0 to 8 % slopes	Consociation	4.87	1%
USYRRB	Urban land, Yalesville substratum-Yalesville-Rock outcrop complex, 0 to 8 % slopes	Complex	16.99	1%
YaobBc	Yalesville-Boonton-Holyoke complex, 0 to 8 % slopes, extremely stony	Complex	15.61	1%
YaohEh	Yalesville-Holyoke complex, 35 to 60 % slopes, very rocky	Complex	24.75	1.5%
YaorCc	Yalesville-Rock outcrop complex, 8 to 15 % slopes, extremely stony	Complex	18.21	1%
YaotuB	Yalesville-Urban land, Yalesville substratum complex, 0 to 8 % slopes	Complex	24.59	1.5%
YaotuC	Yalesville-Urban land, Yalesville substratum complex, 8 to 15 % slopes	Complex	12.02	0.5%
UR	Urban Land	Consociation/ Complex	48.46	2.5%
Water	Water	Consociation	12.98	0.5%
		Total:	1,801.15	100%
Source: Essex County Soil Survey 2007				

Appendix B. Soil Erodibility

Soil Type	Depth (inches)	Sand (%)	Silt (%)	Clay (%)	Erosion[d]			Wind	
					Kw	Kf	T	Wind Erodibility Group[e]	Wind Erodibility Index
BouB	0-12	---	---	---	---	---	---	8	0
	12-47	30-50	41-54	9-16	0.37	0.43			
	47-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			
BouC	0-12	---	---	---	---	---	---	8	0
	12-47	30-50	41-54	9-16	0.37	0.43			
	47-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			
BouD	0-12	---	---	---	---	---	---	8	0
	12-47	30-50	41-54	9-16	0.37	0.43			
	47-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			
BogBc	0-1	0-50	0-57	0-13	0.05	0.05	3	5	56
	1-3	0-50	0-57	0-13	0.05	0.05			
	3-5	30-50	43-57	7-13	0.43	0.43			
	5-8	30-50	43-57	7-13	0.43	0.43			
	8-17	30-50	43-57	7-13	0.37	0.43			
	17-30	30-50	41-54	9-16	0.37	0.43			
	30-40	40-60	25-45	8-15	0.28	0.32			
	40-47	40-70	22-45	8-15	0.28	0.32			
	47-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			
BogCc	0-1	0-50	0-57	0-13	0.05	0.05	3	5	56
	1-3	0-50	0-57	0-13	0.05	0.05			
	3-5	30-50	43-57	7-13	0.43	0.43			
	5-8	30-50	43-57	7-13	0.43	0.43			
	8-17	30-50	43-57	7-13	0.37	0.43			
	17-30	30-50	41-54	9-16	0.37	0.43			
	30-40	40-60	25-45	8-15	0.28	0.32			
	40-47	40-70	22-45	8-15	0.28	0.32			
	47-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			

[d] *The higher the K value, the more susceptible the soil is to sheet and rill erosion by water.*

[e] *Soils in group 1 are most susceptible to wind erosion, while soils in group 8 are less susceptible to wind erosion.*

Appendix B. Soil Erodibility

Soil Type	Depth (inches)	Sand (%)	Silt (%)	Clay (%)	Erosion[d]			Wind	
					Kw	Kf	T	Wind Erodibility Group[e]	Wind Erodibility Index
BogDc	0-1 1-3 3-5 5-8 8-17 17-30 30-40 40-47 47-58 58-72	0-50 0-50 30-50 30-50 30-50 30-50 40-60 40-70 75-90 75-90	0-57 0-57 43-57 43-57 43-57 41-54 25-45 22-45 7-17 7-17	0-13 0-13 7-13 7-13 7-13 9-16 8-15 8-15 3-8 3-8	0.05 0.05 0.43 0.43 0.37 0.37 0.28 0.28 0.28 0.28	0.05 0.05 0.43 0.43 0.43 0.43 0.32 0.32 0.32 0.32	3	5	56
HasB	0-2 2-8 8-15 15-22 22-27 27-30 30-60	0-50 20-50 20-50 20-50 23-52 23-52 45-85	0-80 50-80 50-80 50-80 28-50 28-50 5-45	0-18 12-18 12-18 12-18 7-18 7-18 5-10	0.05 0.32 0.37 0.37 0.24 0.24 0.32	0.05 0.32 0.43 0.43 0.28 0.28 0.37	3	5	56
HanBc	0-2 2-8 8-15 15-22 22-27 27-30 30-60	0-50 20-50 20-50 20-50 23-52 23-52 45-85	0-80 50-80 50-80 50-80 28-50 28-50 5-45	0-18 12-18 12-18 12-18 7-18 7-18 5-10	0.05 0.32 0.37 0.37 0.24 0.24 0.32	0.05 0.32 0.43 0.43 0.28 0.28 0.37	3	5	56
HanB	0-2 2-8 8-15 15-22 22-27 27-30 30-60	0-50 20-50 20-50 20-50 23-52 23-52 45-85	0-80 50-80 50-80 50-80 28-50 28-50 5-45	0-18 12-18 12-18 12-18 7-18 7-18 5-10	0.05 0.32 0.37 0.37 0.24 0.24 0.32	0.05 0.32 0.43 0.43 0.28 0.28 0.37	3	5	56

Appendix B. Soil Erodibility

Soil Type	Depth (inches)	Sand (%)	Silt (%)	Clay (%)	Erosion[d]			Wind	
					Kw	Kf	T	Wind Erodibility Group[e]	Wind Erodibility Index
HanCc	0-2 2-8 8-15 15-22 22-27 27-30 30-60	0-50 20-50 20-50 20-50 23-52 23-52 45-85	0-80 50-80 50-80 50-80 28-50 28-50 5-45	0-18 12-18 12-18 12-18 7-18 7-18 5-10	0.05 0.32 0.37 0.37 0.24 0.24 0.32	0.05 0.32 0.43 0.43 0.28 0.28 0.37	3	8	0
PecuuB	0-12 12-59 59-63 63-74 74-88	--- 20-50 70-90 86-100 86-100	--- 50-80 10-20 1-10 1-10	--- 2-18 2-12 0-9 0-9	--- 0.37 0.20 0.20 0.20	--- 0.37 0.28 0.24 0.28	---	8	0
PecuuC	0-12 12-59 59-63 63-74 74-88	--- 20-50 70-90 86-100 86-100	--- 50-80 10-20 1-10 1-10	--- 2-18 2-12 0-9 0-9	--- 0.37 0.20 0.20 0.20	--- 0.37 0.28 0.24 0.28	---	8	0
PecmBc	0-2 2-8 8-14 14-27 27-37 37-40 40-59 59-63 63-74 74-88	20-50 23-52 23-52 20-50 20-50 20-50 20-50 70-90 86-100 86-100	50-80 28-50 28-50 50-80 45-80 50-80 50-80 10-20 1-10 1-10	2-18 7-18 7-18 2-18 2-18 2-18 2-18 2-12 0-9 0-9	0.28 0.28 0.28 0.37 0.64 0.64 0.64 0.20 0.20 0.20	0.28 0.28 0.28 0.37 0.64 0.64 0.64 0.28 0.24 0.28	3	5	56

Appendix B. Soil Erodibility

Soil Type	Depth (inches)	Sand (%)	Silt (%)	Clay (%)	Erosion[d]			Wind	
					Kw	Kf	T	Wind Erodibility Group[e]	Wind Erodibility Index
PecmB	0-2	20-50	50-80	2-18	0.28	0.28	3	5	56
	2-8	23-52	28-50	7-18	0.28	0.28			
	8-14	23-52	28-50	7-18	0.28	0.28			
	14-27	20-50	50-80	2-18	0.37	0.37			
	27-37	20-50	45-80	2-18	0.64	0.64			
	37-40	20-50	50-80	2-18	0.64	0.64			
	40-59	20-50	50-80	2-18	0.64	0.64			
	59-63	70-90	10-20	2-12	0.20	0.28			
	63-74	86-100	1-10	0-9	0.20	0.24			
	74-88	86-100	1-10	0-9	0.20	0.28			
PecmCc	0-2	20-50	50-80	2-18	0.28	0.28	3	5	56
	2-8	23-52	28-50	7-18	0.28	0.28			
	8-14	23-52	28-50	7-18	0.28	0.28			
	14-27	20-50	50-80	2-18	0.37	0.37			
	27-37	20-50	45-80	2-18	0.64	0.64			
	37-40	20-50	50-80	2-18	0.64	0.64			
	40-59	20-50	50-80	2-18	0.64	0.64			
	59-63	70-90	10-20	2-12	0.20	0.28			
	63-74	86-100	1-10	0-9	0.20	0.24			
	74-88	86-100	1-10	0-9	0.20	0.28			
UdbonB	0-12	23-52	28-50	7-27	0.43	0.43	5	5	56
	12-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			
UdhalB	0-12	23-52	28-50	7-27	0.43	0.43	5	3	86
	12-60	45-85	5-45	5-10	0.32	0.37			
UdhorB	0-12	23-52	28-50	7-27	0.43	0.43	5	3	86
	12-60	70-90	9-25	1-8	0.17	0.20			
UdpecB	0-12	23-52	28-50	7-27	0.43	0.43	5	3	86
	12-63	70-90	10-20	2-12	0.20	0.28			
	63-74	86-100	1-10	0-9	0.20	0.24			
	74-88	86-100	1-10	0-9	0.20	0.28			
URBONB	0-12	---	---	---	---	---	---	8	0
	12-47	30-50	41-54	9-16	0.37	0.43			
	47-58	75-90	7-17	3-8	0.28	0.32			
	58-72	75-90	7-17	3-8	0.28	0.32			

Appendix B. Soil Erodibility

Soil Type	Depth (inches)	Sand (%)	Silt (%)	Clay (%)	Erosion[d]			Wind	
					Kw	Kf	T	Wind Erodibility Group[e]	Wind Erodibility Index
URPECB	0-12	---	---	---	---	---	---	8	0
	12-59	20-50	50-80	2-18	0.37	0.37			
	59-63	70-90	10-20	2-12	0.20	0.28			
	63-74	86-100	1-10	0-9	0.20	0.24			
	74-88	86-100	1-10	0-9	0.20	0.28			
USYRRB	0-12	---	---	---	---	---	---	8	0
	12-31	40-65	20-35	6-18	0.28	0.43			
	31-32	40-65	10-45	6-18	0.24	0.37			
	>32	---	---	---	---	---			
YaobBc	0-1	0-40	0-50	0-18	0.05	0.05	2	5	56
	1-5	20-40	38-50	8-18	0.28	0.32			
	5-19	40-65	20-35	6-18	0.28	0.43			
	19-31	40-65	20-35	6-18	0.28	0.43			
	31-32	40-85	10-35	6-18	0.24	0.37			
	>32	---	---	---	---	---			
YaohEh	0-1	0-40	0-50	0-18	0.05	0.05	2	5	56
	1-5	20-40	38-50	8-18	0.28	0.32			
	5-19	40-65	20-35	6-18	0.28	0.43			
	19-31	40-65	20-35	6-18	0.28	0.43			
	31-32	40-85	10-35	6-18	0.24	0.37			
	>32	---	-----	---	---	---			
YaorCc	0-1	0-40	0-50	0-18	0.05	0.05	2	5	56
	1-5	20-40	38-50	8-18	0.28	0.32			
	5-19	40-65	20-35	6-18	0.28	0.43			
	19-31	40-65	20-35	6-18	0.28	0.43			
	31-32	40-85	10-35	6-18	0.24	0.37			
	>32	---	---	---	---	---			
YaotuB	0-1	0-40	0-50	0-18	0.05	0.05	2	5	56
	1-5	20-40	38-50	8-18	0.28	0.32			
	5-19	40-65	20-35	6-18	0.28	0.43			
	19-31	40-65	20-35	6-18	0.28	0.43			
	31-32	40-85	10-35	6-18	0.24	0.37			
	>32	---	---	---	---	---			
YaotuC	0-1	0-40	0-50	0-18	0.05	0.05	2	5	56
	1-5	20-40	38-50	8-18	0.28	0.32			
	5-19	40-65	20-35	6-18	0.28	0.43			
	19-31	40-65	20-35	6-18	0.28	0.43			
	31-32	40-85	10-35	6-18	0.24	0.37			
	>32	---	---	---	---	---			

Source: Essex County Soil Survey 2007

Appendix C. Soil Limitations

Soil	Depth to Restrictive Feature (inches to fragipan)	Drainage	Depth to High Water Table	Available Water Capacity	Flooding	Ponding	Frost Action Potential	Rick of Corrosion Steel	Risk of Corrosion Concrete	Septic Limitations
BouB	20 to 36 inches	Well	Greater than 6 feet	Moderate	None	None	Moderate	Moderate	High	Very Limited
BouC	20 to 36 inches	Well	Greater than 6 feet	Moderate	None	None	Moderate	Moderate	High	Very Limited
BouD	20 to 36 inches	Well	Greater than 6 feet	Moderate	None	None	Moderate	Moderate	High	Very Limited
BogBc	20 to 36 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
BogCc	20 to 36 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
BogDc	20 to 36 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
HasB	24 to 36 inches	Poor	7 to 18 inches	Moderate	None	None	High	Moderate	Moderate	Very Limited
HanBc	24 to 36 inches	Poor	7 to 18 inches	Moderate	None	None	High	Moderate	Moderate	Very Limited
HanB	24 to 36 inches	Poor	7 to 18 inches	Moderate	None	None	High	Moderate	Moderate	Very Limited

Appendix C. Soil Limitations

Soil	Depth to Restrictive Feature (inches to fragipan)	Drainage	Depth to High Water Table	Available Water Capacity	Flooding	Ponding	Frost Action Potential	Rick of Corrosion Steel	Risk of Corrosion Concrete	Septic Limitations
HanCc	24 to 36 inches	Poor	7 to 18 inches	Moderate	None	None	High	Moderate	Moderate	Very Limited
PecuuB	20 to 40 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
PecuuC	20 to 40 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
PecmBc	20 to 40 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
PecmB	20 to 40 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
PecmCc	20 to 40 inches	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
UdbonB	N/A	Well	Greater than 6 feet	High	None	None	Moderate	Moderate	High	Very Limited
UdhalB	N/A	Poor	7 to 18 inches	Low	None	None	High	Moderate	Moderate	Very Limited
UdhorB	N/A	Moderate	18 to 40 inches	Low	None	None	Moderate	Moderate	Moderate	Very Limited

Appendix C. Soil Limitations

Soil	Depth to Restrictive Feature (inches to fragipan)	Drainage	Depth to High Water Table	Available Water Capacity	Flooding	Ponding	Frost Action Potential	Rick of Corrosion Steel	Risk of Corrosion Concrete	Septic Limitations
UdpecB	N/A	Well	Greater than 6 feet	Low	None	None	Moderate	Moderate	High	Very Limited
URBONB	N/A	N/A	Greater than 6 feet	Moderate	None	None	Moderate	Moderate	High	Very Limited
URPECB	N/A	N/A	Greater than 6 feet	Moderate	None	None	Moderate	Moderate	High	Very Limited
USYRRB	20 to 40 inches to bedrock (lithic)	N/A	Greater than 6 feet		None	None	Low	Low	Moderate	Very Limited
YaobBc	20 to 40 inches to bedrock (lithic)	Well	Greater than 6 feet	Low	None	None	Moderate	Moderate	High	Very Limited
YaohEh	20 to 40 inches to bedrock (lithic)	Well	Greater than 6 feet	Low	None	None	Moderate	Low	Moderate	Very Limited
YaorCc	20 to 40 inches to bedrock (lithic)	Well	Greater than 6 feet	Low	None	None	Moderate	Low	Moderate	Very Limited

Appendix C. Soil Limitations										
Soil	**Depth to Restrictive Feature (inches to fragipan)**	**Drainage**	**Depth to High Water Table**	**Available Water Capacity**	**Flooding**	**Ponding**	**Frost Action Potential**	**Rick of Corrosion Steel**	**Risk of Corrosion Concrete**	**Septic Limitations**
YaotuB	20 to 40 inches to bedrock (lithic)	Well	Greater than 6 feet	Low	None	None	Low	Low	Moderate	Very Limited
YaotuC	20 to 40 inches to bedrock (lithic)	Well	Greater than 6 feet	Low	None	None	Low	Low	Moderate	Very Limited

Appendix D. Soil Limitations for Building Site Development			
Rating	**Dwelling without Basements**	**Dwellings with Basements**	**Small Commercial Buildings**
Not Rated	PHG (0.12) Water (12.98) YaorCc (18.21) **Total Acreage: 31.31** **% of Township: 2%**	PHG (0.12) Water (12.98) YaorCc (18.21) **Total Acreage: 31.31** **% of Township: 2%**	PHG (0.12) Water (12.98) YaorCc (18.21) **Total Acreage: 31.31** **% of Township: 2%**
Not Limited	BouB (635.36) BouC (146.4) BouD (18.92) BogBc (113.97) KneB (8.21) PecmB (2.15) PecmBc (11.67) PecuuB (329.96) PecuuC (33.8) UdbonB (92.59) UdpecB (23.32) URBONB (26.6) URPECB (4.87) **Total Acreage: 1,447.82** **% of Township: 80%**	BouB (635.36) BouC (146.4) BouD (18.92) BogBc (113.97) PecmB (2.15) PecmBc (11.67) PecuuB (329.96) PecuuC (33.8) UdbonB (92.59) UdpecB (23.32) URBONB (26.6) URPECB (4.87) **Total Acreage: 1,439.61** **% of Township: 80%**	BouB (635.36) BouC (146.4) BouD (18.92) PecuuB (329.96) PecuuC (33.8) UdbonB (92.59) UdpecB (23.32) URBONB (26.6) URPECB (4.87) **Total Acreage: 1,311.82** **% of Township: 73%**
Somewhat Limited	BogCc (32.9) HotA (1.89) PecmCc (5.53) UdhorB (19.43) USYRRB (16.99) YaotuB (24.59) YaotuC (12.02) YamnBc (11.28) **Total Acreage: 124.63** **% of Township: 7%**	BogCc (32.9) KneB (8.21) PecmCc (5.53) **Total Acreage: 46.64** **% of Township: 2%**	BogBc (113.97) KneB (8.21) PecmB (2.15) PecmBc (11.67) UdhorB (19.43) USYRRB (16.99) YaotuB (24.59) YaotuC (12.02) YamnBc (11.28) **Total Acreage: 220.31** **% of Township: 12%**

Appendix D. Soil Limitations for Building Site Development			
Rating	**Dwelling without Basements**	**Dwellings with Basements**	**Small Commercial Buildings**
Very Limited	BogDc (37.3) HasB (40.79) HanB (8.58) HanBc (20.5) HanCc (9.8) HctBc (12.83) HokCh (11.13) NazA (2.55) UcdAt (2.36) UdhalB (13.1) YaobBc (15.61) YaohEh (24.75) **Total Acreage: 199.3** **% of Township: 11%**	BogDc (37.3) HasB (40.79) HanB (8.58) HanBc (20.5) HanCc (9.8) HctBc (12.83) HokCh (11.13) HotA (1.89) NazA (2.55) UcdAt (2.36) UdhalB (13.1) UdhorB (19.43) USYRRB (16.99) YaobBc (15.61) YaohEh (24.75) YaotuB (24.59) YaotuC (12.02) YamnBc (11.28) **Total Acreage: 285.5** **% of Township: 16%**	BogCc (32.9) BogDc (37.3) HasB (40.79) HanB (8.58) HanBc (20.5) HanCc (9.8) HctBc (12.83) HokCh (11.13) HotA (1.89) NazA (2.55) PecmCc (5.53) UcdAt (2.36) UdhalB (13.1) YaobBc (15.61) YaohEh (24.75) **Total Acreage: 239.62** **% of Township: 13%**

Appendix E. Values[f] and Limitations of Soils in Verona for Recreational Use

Map Symbol Soil Name	Camp Rating Limitations	Camp Area Value	Picnic Rating Limitations	Picnic Area Value	Playground Rating Limitations	Playground Area Value
BouB- Boonton	(S) slow water*	 0.96	(S) slow water	 0.96	(V) slope slow water	 1 0.96
BouC- Boonton	(S) slow water slope	 0.96 0.63	(S) slow water slope	 0.96 0.63	(V) slope slow water	 1 0.96
BouD- Boonton	(V) slope slow water	 1 0.96	(V) slope slow water	 1 0.96	(V) slope slow water	 1 0.96
BogBc- Boonton, extremely stony	(V) large stones slow water	 1 0.96	(V) large stones slow water	 1 0.96	(V) large stones slope slow water	 1 1 0.96
BogCc- Boonton, extremely stony	(V) large stones slow water slope	 1 0.96 0.63	(V) large stones slow water slope	 1 0.96 0.63	(V) large stones slope, slow water	 1 1 0.96
BogDc- Boonton, extremely stony	(V) slope large stones slow water	 1 1 0.96	(V) slope large stones slow water	 1 1 0.96	(V) large stones slope slow water	 1 1 0.96
HasB- Haledon	(V) saturated zone** slow water	 1 0.96	(V) saturated zone slow water	 1 0.96	(V) saturated zone slow water slope	 1 0.96 0.5
HanBc- Haledon, extremely stony	(V) saturated zone large stones slow water	 1 1 0.96	(V) large stones saturated zone slow water	 1 1 0.96	(V) large stones saturated zone slow water slope	 1 1 0.96 0.5
HanB- Haledon	(V) saturated zone slow water	 1 0.96	(V) saturated zone slow water	 1 0.96	(V) saturated zone slow water slope	 1 0.96 0.5

[f] *The value columns indicate a value from 0.01 to 1, with a larger value indicating more limitations.*

Appendix E. Values[f] and Limitations of Soils in Verona for Recreational Use

Map Symbol Soil Name	Camp Rating Limitations	Camp Area Value	Picnic Rating Limitations	Picnic Area Value	Playground Rating Limitations	Playground Area Value
HanCc-Haledon, extremely stony	(V) saturated zone large stones slow water slope	 1 1 0.96 0.63	(V) large stones saturated zone slow water slope	 1 1 0.96 0.63	(V) large stones saturated zone slope slow water	 1 1 1 0.96
PecuuB-Peckmantown	(S) slow water	 0.96	(S) slow water	 0.96	(S) slope slow water	 1 0.96
PecuuC-Peckmantown	(S) slow water slope	 0.96 0.16	(S) slow water slope	 0.96 0.16	(S) slope slow water	 1 0.96
PecmBc-Peckmantown, extremely stony	(V) large stones slow water	 1 0.96	(V) large stones slow water	 1 0.96	(V) large stones slope slow water	 1 1 0.96
PecmB-Peckmantown	(S) slow water	 0.96	(S) slow water	 0.96	(S) slope slow water	 1 0.96
PecmCc-Peckmantown, extremely stony	(V) large stones slow water slope	 1 0.96 0.16	(V) large stones slow water slope	 1 0.96 0.16	(V) large stones slope slow water	 1 1 0.96
UdbonB-Udorthents, Boonton substratum	(N)		(N)		(S) slope	 0.12
UdhalB-Udorthents, Haledon substratum	(V) saturated zone slow water	 1 0.96	(V) saturated zone slow water	 1 0.96	(V) saturated zone slow water slope	 1 0.96 0.12
UdhorB-Udorthents, Horseneck substratum	(S) saturated zone	 0.67	(S) saturated zone	 0.35	(S) saturated zone slope	 0.67 0.12
UdpecB-Udorthents, Peckmantown substratum	(N)		(N)		(S) slope	 0.12

Appendix E. Values[f] and Limitations of Soils in Verona for Recreational Use

Map Symbol Soil Name	Camp Rating Limitations	Camp Area Value	Picnic Rating Limitations	Picnic Area Value	Playground Rating Limitations	Playground Area Value
URBONB-Urban land, Boonton substratum	Not rated		Not rated		Not rated	
URPECB-Urban land, Peckmantown substratum	Not rated		Not rated		Not rated	
USYRRB-Urban land, Yalesville substratum	Not rated		Not rated		Not rated	
YaobBc-Yalesville, extremely stony	(V) large stones	1	(V) large stones	1	(V) large stones slope bedrock*	1 1 0.29
YaohEh-Yalesville, very rocky	(V) slope large stones	1 1	(V) large stones slope	1 1	(V) large stones slope bedrock	1 1 0.29
YaorCc-Yalesville, extremely stony	(V) large stones slope	1 0.16	(V) large stones slope	1 0.16	(V) large stones slope bedrock	1 1 0.29
YaotuB-Yalesville	(N)		(N)		(S) slope bedrock	0.5 0.29
YaotuC-Yalesville	(S) slope	0.16	(S) slope	0.16	(V) slope bedrock	1 0.29

**slow water: slow water movement through soil*
***saturated zone: depth to saturated zone*
****bedrock: depth to bedrock*
S: Somewhat Limited, V: Very Limited, N: Not Limited

Source: Essex County Soil Survey 2007[145]

Appendix F. Earthquakes Epicentered Around Verona 1783-2017 (20 mile radius)

ID	Date	Time	Lat_N	Long_W	Depth (km)	Magnitude	Location
1	11/30/1783	3:50	41.000	74.500	0.00	5.3	West of New York City
2	1/25/1841	5:30	40.790	74.250	0.00	2.9	West Orange, NJ
3	3/5/1861	17:00	40.700	74.200	0.00	2.4	Newark, NJ
5	8/10/1880	17:15	40.800	74.500	0.00	0.0	Near Morristown, NJ
7	5/27/1902	0:00	40.800	74.200	0.00	0.0	Bayonne-Wayne, NJ
8	8/11/1902	0:00	40.800	74.200	0.00	0.0	Bayonne-Wayne, NJ
14	9/30/1937	22:08	40.830	74.250	0.00	0.0	Verona, NJ
15	5/16/1938	19:25	40.800	74.300	0.00	2.3	Verona, NJ
18	12/6/1938	19:38	40.800	74.300	0.00	2.6	Verona, NJ
19	9/13/1939	1:22	40.800	74.000	0.00	2.2	Union City, NJ
21	4/1/1947	13:25	41.020	74.300	0.00	2.7	Pompton Lakes NJ
27	10/13/1962	0:00	41.000	74.300	0.00	2.2	Pompton Lakes, NJ
34	4/13/1976	15:39	40.800	74.000	0.00	3.1	Near Ridgefield, NJ
41	11/27/1977	13:57	41.000	74.200	5.00	1.8	Oakland, NJ
43	2/15/1978	5:28	40.900	74.400	6.00	1.6	Boonton, NJ
45	5/18/1978	1:29	41.000	74.300	6.00	1.5	Bloomingdale, NJ
51	3/10/1979	4:49	40.700	74.500	3.00	3.1	Bernardsville, NJ
56	3/19/1981	8:51	40.940	74.360	9.60	2.0	Boonton, NJ
63	6/1/1983	9:50	40.870	74.530	5.10	1.5	Dover, NJ
64	9/6/1983	10:44	40.830	73.970	7.10	1.5	Fort Lee, NJ
67	5/13/1984	3:18	40.920	74.540	5.60	2.1	Mount Hope, NJ
68	6/3/1984	7:04	41.010	74.410	0.20	1.3	Kinnelon, NJ
69	6/6/1984	17:44	40.780	74.480	7.00	1.7	Near Morristown, NJ
87	5/16/1987	10:01	40.860	74.180	3.06	1.4	Near Paterson, NJ
92	4/13/1988	9:48	40.840	74.530	4.82	1.4	Dover, NJ
96	1/22/1989	8:27	40.880	73.940	5.90	2.0	Englewood, NJ
100	1/26/1990	4:27	40.990	74.510	11.90	1.0	Franklin, NJ
101	5/10/1990	3:41	40.815	74.541	7.60	1.8	Mt. Freedom, NJ
104	5/12/1991	9:36	41.029	74.304	5.70	1.3	Wanaque, NJ
105	7/5/1991	16:26	40.931	74.353	8.80	1.3	Pompton Plains, NJ
114	1/27/1995	2:37	40.958	74.501	3.00	2.3	Rockaway, NJ
115	4/1/1995	5:50	40.950	74.510	5.00	1.5	Rockaway, NJ
128	5/25/1997	6:23	40.856	73.967	12.00	0.5	1 km NE Fort Lee, NJ
129	6/27/1997	20:58	40.942	74.510	2.00	1.6	4.6 km N of Rockaway, NJ
132	10/24/1997	3:32	40.765	74.069	7.00	0.5	3 km SW Secaucus, NJ
136	1/12/1999	5:45	40.872	74.176	7.00	1.4	1 km NW of Clifton, NJ
141	8/24/2003	9:21	40.775	74.511	1.00	1.5	6 km SW of Morris Plains,

Appendix F. Earthquakes Epicentered Around Verona 1783-2017 (20 mile radius)

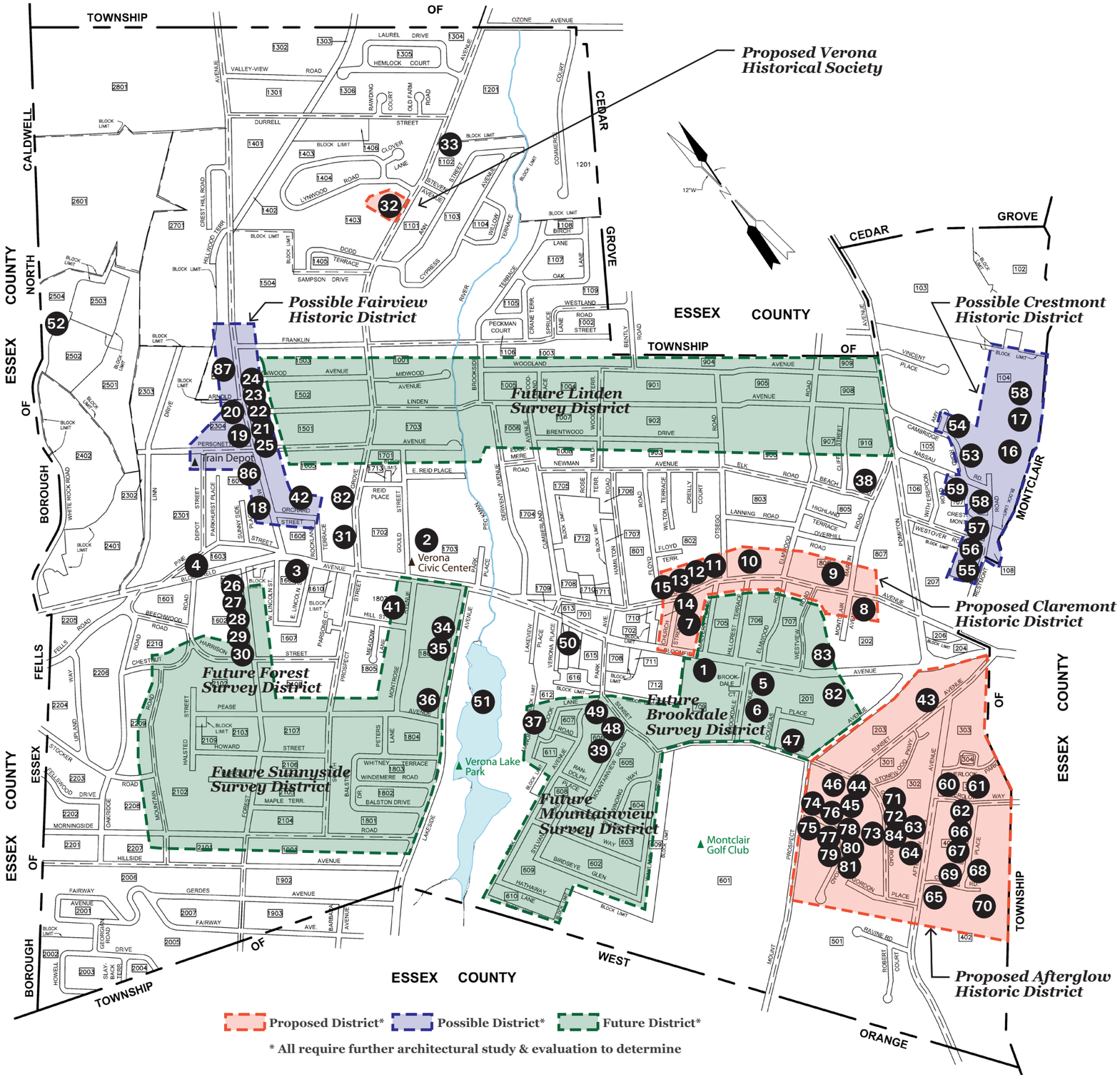
ID	Date	Time	Lat_N	Long_W	Depth (km)	Magnitude	Location
145	04/23/2005	14:24	40.885	74.069	6.60	1.9	1.3 Km East of Lodi, NJ
146	12/09/2005	3:35	40.790	74.379	4.70	2.1	16 km W of Franklin Lakes, NJ
150	05/15/2006	8:25:26	40.862	74.152	8.00	2.0	9 km S of Fair Lawn, NJ
151	06/28/2007	6:18:09	40.876	74.194	2.00	2.1	7 km E of Fairfield, NJ
152	10/05/2007	12:48:54	40.895	74.033	8.00	1.3	5 km NNE of Teterboro, NJ
154	2/3/2009	03:34:19	40.870	74.522	5.00	3.0	3.5km SSW of Rockaway, NJ
155	02/14/2009	22:22:22	40.948	74.392	2.00	2.4	5 km NNE of Boonton, NJ
156	2/18/2009	18:17:55	40.963	74.389	2.00	1.1	3 km SSW of Kinnelon, NJ
158	2/16/2009	06:42:35	40.868	74.551	4.00	2.3	2 km SSE of Dover, NJ
161	12/26/2009	23:53:14	40.878	74.550	6.00	2.0	8 km NW of Morris Plains, NJ
168	12/25/2010	18:32:31	40.859	74.179	2.00	2.1	1 km W of Clifton, NJ
169	05/08/2011	12:32:00	40.854	74.170	5.60	1.2	1 km SW of Clifton, NJ
171	05/29/2011	8:33:07	40.823	73.973	8.00	1.3	3 km S of Fort Lee, NJ
174	07/17/2012	2:25:45	40.892	74.570	2.00	1.1	16 km NW of Morristown, NJ
175	07/18/2012	8:04:10	40.899	74.588	2.00	1.1	18 km NW of Morristown, NJ
179	06/23/2013	15:54:40	40.904	74.510	2.00	2.1	1 km E of Rockaway, NJ
180	05/31/2014	9:28:36	40.952	74.397	8.00	1.9	6 km N of Boonton, NJ
182	07/08/2014	9:08:26	40.723	74.114	11.10	1.6	3 km W of Jersey City, NJ
183	07/18/2014	15:43:50	41.088	74.282	5.00	1.2	4 km SW of Ringwood, NJ
184	09/03/2014	10:47:13	41.018	74.032	14.00	1.3	2 km S of Park Ridge, NJ
186	12/28/2014	14:19:18	40.842	74.174	4.20	1.5	2 km SW of Clifton, NJ
187	03/27/2015	20:19:44	40.844	74.177	4.60	1.2	2 km SW of Clifton, NJ
188	07/12/2015	4:05:55	41.054	74.295	6.20	1.2	2 km N of Wanaque, NJ
189	08/14/2015	7:41:24	40.751	74.552	3.50	2.7	3.5 km N of Bernardsville, NJ
190	08/22/2015	19:16:58	40.894	74.338	7.90	1.4	5 km WNW of Fairfield, NJ
191	01/02/2016	5:58:01	41.130	74.265	8.38	2.1	2.4 km NW of Ringwood, NJ
192	02/19/2016	1:17:00	41.013	74.347	4.11	1.1	1.1 km NW of Butler, NJ
193	05/27/2016	16:48:43	41.042	74.353	2.93	0.8	4.4 km N of Butler, NJ
194	07/04/2016	4:06:49	41.011	74.352	2.00	1.1	1 km NW of Butler, NJ
195	07/31/2016	0:34:45	40.841	74.177	4.71	0.8	2.2 km SW of Clifton, NJ
196	08/09/2016	2:01:45	41.056	74.291	5.61	1.0	2 km N of Wanaque, NJ
197	08/09/2016	2:33:00	41.010	74.344	1.62	0.5	1 km N of Butler, NJ
198	09/20/2016	3:04:04	41.070	74.254	7.90	0.6	5 km NE of Wanaque, NJ
201	03/25/2017	17:44:50	40.8338	74.4828	6.03	1.31	1.4 km S of Morris Plains, NJ
202	09/25/2017	22:35:07	40.7987	74.5138	5.00	1.71	3.7 km SW of Morris Plains, NJ
203	09/30/2017	12:05:54	40.8093	74.5095	11.50	0.98	2.7 km SW of Morris Plains, NJ

Source: NJDEP-NJGS Digital Geodata Series, Earthquakes Epicentered in New Jersey

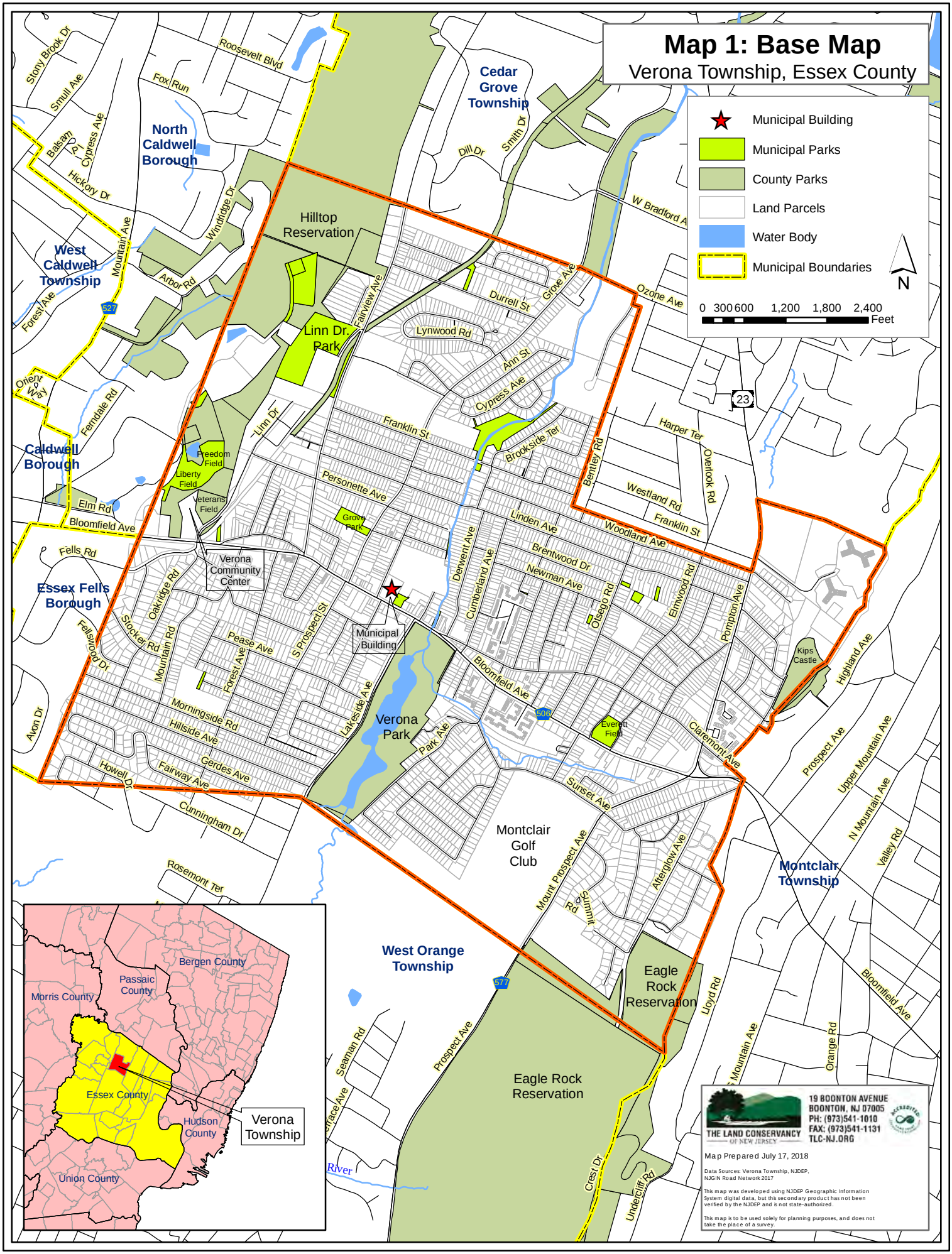
Appendix G. Map of Surveyed Properties

MAP OF SURVEYED PROPERTIES

1	297-299 Bloomfield Ave.	46	89 Sunset Ave.
2	600 Bloomfield Ave.	47	108 Sunset Ave.
3	707 Bloomfield Ave.	48	181 Sunset Ave.
4	820 Bloomfield Ave.	49	191 Sunset Ave.
5	15 Brookdale Ave.	50	15 Verona Place
6	33 Brookdale Ave.	51	Lakeside Ave.
7	19 Church St.	52	Second Mountain
8	93 Claremont Ave.	53	10 Cambridge Rd.
9	110 Claremont Ave.	54	16 Cambridge Rd.
10	176 Claremont Ave.	55	9 Crestmont Rd.
11	200 Claremont Ave.	56	11 Crestmont Rd.
12	216 Claremont Ave.	57	17 Crestmont Rd.
13	224 Claremont Ave.	58	24 Crestmont Rd.
14	223 Claremont Ave.	59	21 Nassau Rd.
15	228 Claremont Ave.	60	37 Afterglow Ave.
16	22 Crestmont Ave.	61	44 Afterglow Way
17	23 Crestmont Ave.	62	45 Afterglow Way
18	40-42 Fairview Ave.	63	50 Afterglow Ave.
19	70 Fairview Ave.	64	64 Afterglow Ave.
20	80 Fairview Ave.	65	79 Afterglow Ave.
21	79 Fairview Ave.	66	4 Belleclaire Pl.
22	83 Fairview Ave.	67	10 Belleclaire Pl.
23	87-89 Fairview Ave.	68	35 Belleclaire Pl.
24	91 Fairview Ave.	69	36 Belleclaire Pl.
25	73 Fairview Ave.	70	11 Cole Rd.
26	20 Forest Ave.	71	11 Glen Rd.
27	26 Forest Ave.	72	15 Glen Rd.
28	30 Forest Ave.	73	23 Glen Rd.
29	34 Forest Ave.	74	69 Mt. Prospect Ave.
30	38 Forest Ave.	75	73 Mt. Prospect Ave.
31	16 Grove Ave.	76	7 Summit Rd.
32	190 Grove Ave.	77	10 Summit Rd.
33	229 Grove Ave.	78	13 Summit Rd.
34	32 Lakeside Ave.	79	14 Summit Rd.
35	36 Lakeside Ave.	80	25 Summit Rd.
36	66 Lakeside Ave.	81	27 Summit Rd.
37	14 Manor Road	82	30 Grove Ave.
38	42 Martin Road	83	163 Bloomfield Ave.
39	20 Mountainview Ave.	84	26 Glen Rd.
40	20 Mountain Ave.	85	200 Bloomfield Ave.
41	24 Montrose Ave.	86	60 Fairview Ave.
42	12 Orchard St.	87	100 Fairview Ave.
43	42 Sunset Ave.		
44	79 Sunset Ave.		
45	83 Sunset Ave.		



MAPS


Map 1: Base Map
Verona Township, Essex County
Municipal Building
Municipal Parks
County Parks
Land Parcels
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400
Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Montclair Township
West Orange Township
Hilltop Reservation
Linn Dr. Park
Verona Park
Eagle Rock Reservation
Montclair Golf Club
Verona Community Center
Municipal Building
Kips Castle
Everett Field
Freedom Field
Liberty Field
Veterans Field
Grove Park
Roosevelt Blvd
Fox Run
Stony Brook Dr
Smull Ave
Cypress Ave
Balsam Pl
Hickory Dr
Windridge Dr
Mountain Ave
Arbor Rd
Forest Ave
Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Oakridge Rd
Stocker Rd
Fellswood Dr
Mountain Rd
Pease Ave
Forest Ave
S Prospect St
Morningside Rd
Hillside Ave
Gerdes Ave
Howell Dr
Fairway Ave
Cunningham Dr
Avon Dr
Rosemont Ter
Lakeside Ave
Park Ave
Fairview Ave
Durrell St
Grove Ave
Lynwood Rd
Ann St
Cypress Ave
Linn Dr
Franklin St
Brookside Ter
Personette Ave
Linden Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Olsego Rd
Elmwood Rd
Pompton Ave
Woodland Ave
Bentley Rd
Overlook Rd
Harper Ter
Westland Rd
Franklin St
Ozone Ave
W Bradford Ave
Dill Dr
Smith Dr
Highland Ave
Claremont Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Bloomfield Ave
Sunset Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
Lloyd Rd
Orange Rd
Seaman Rd
Prospect Ave
Crest Dr
Undercliff Rd
Bergen County
Passaic County
Morris County
Essex County
Hudson County
Union County
Verona Township
River
THE LAND CONSERVANCY OF NEW JERSEY
19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG
Map Prepared July 17, 2018
Data Sources: Verona Township, NJDEP, NJGIN Road Network 2017
This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
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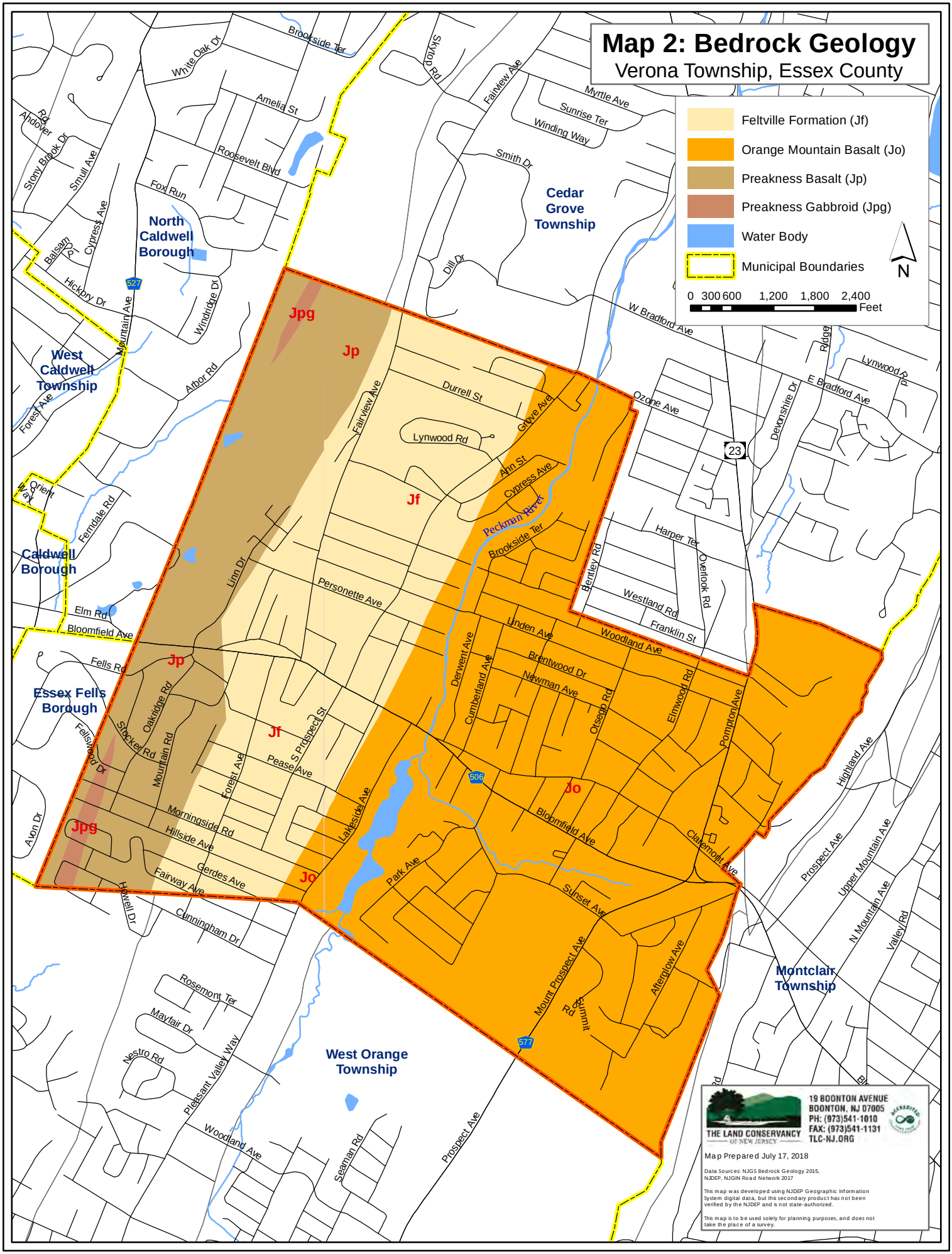

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TLC-NJ.ORG

Map Prepared July 17, 2018

Data Sources: NJGS Bedrock Geology 2015, NJDEP, NJGIN Road Network 2017

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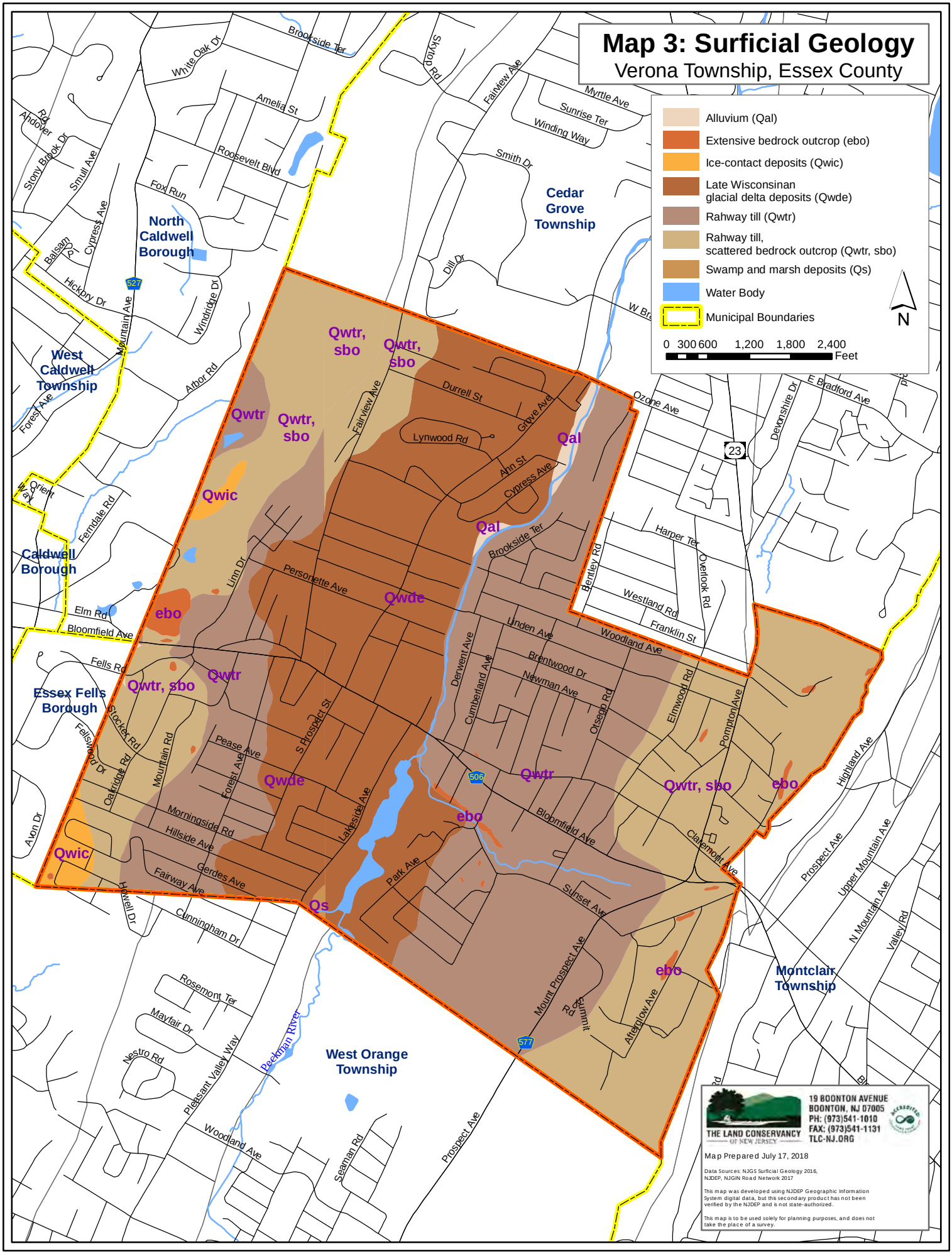
Map 3: Surficial Geology
Verona Township, Essex County
Alluvium (Qal)
Extensive bedrock outcrop (ebo)
Ice-contact deposits (Qwic)
Late Wisconsinan glacial delta deposits (Qwde)
Rahway till (Qwtr)
Rahway till, scattered bedrock outcrop (Qwtr, sbo)
Swamp and marsh deposits (Qs)
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400 Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
West Orange Township
Montclair Township
Qwtr, sbo
Qwtr
Qwic
Qwde
Qal
ebo
Qs
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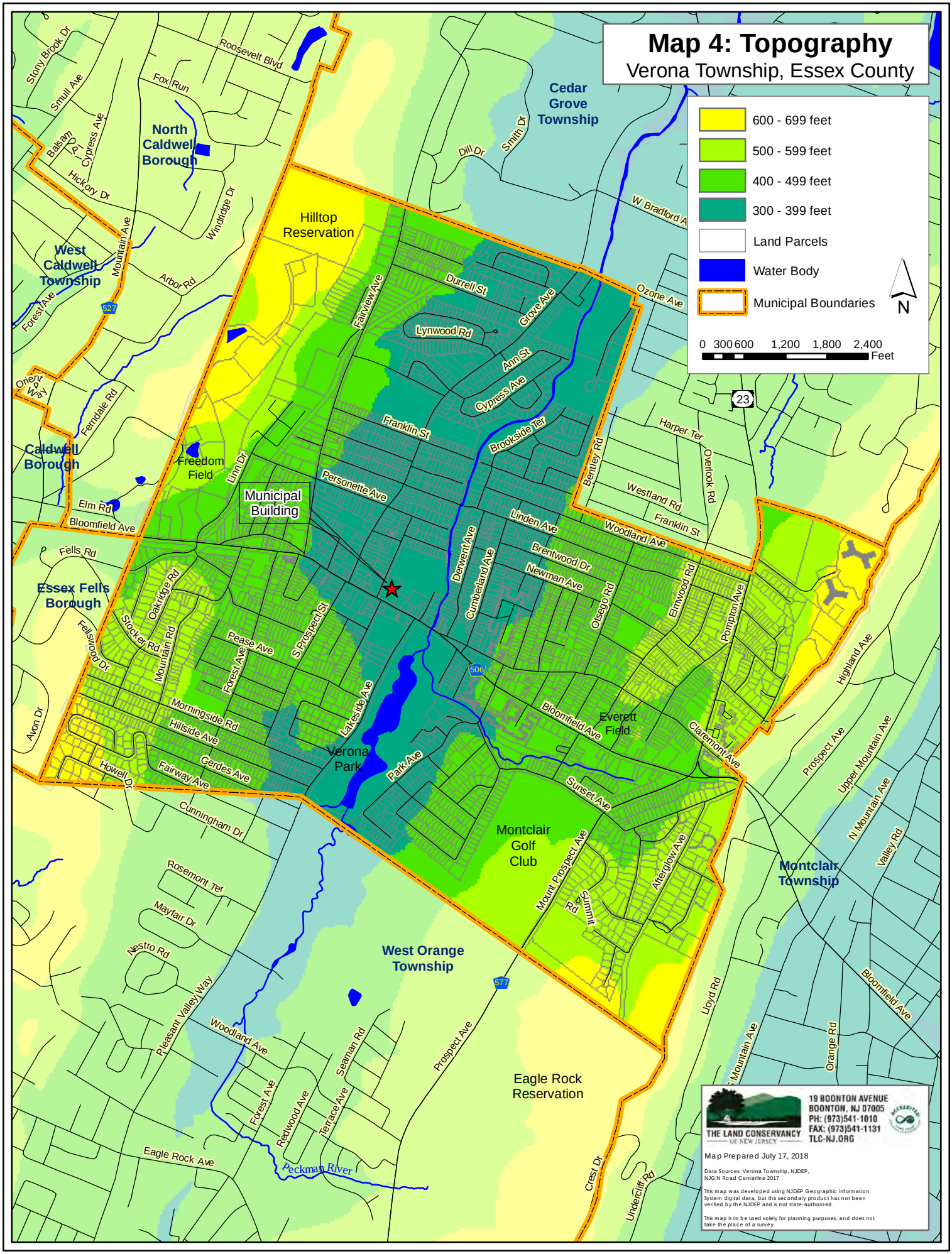
Map 4: Topography
Verona Township, Essex County
600 - 699 feet
500 - 599 feet
400 - 499 feet
300 - 399 feet
Land Parcels
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400
Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Montclair Township
West Orange Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Everett Field
Montclair Golf Club
Eagle Rock Reservation
Peckman River
Roosevelt Blvd
Fox Run
Stony Brook Dr
Smull Ave
Balsam Pl
Cypress Ave
Hickory Dr
Windridge Dr
Mountain Ave
Arbor Rd
Forest Ave
Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Oakridge Rd
Stocker Rd
Fellswood Dr
Mountain Rd
Avon Dr
Howell Dr
Cunningham Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Woodland Ave
Eagle Rock Ave
Forest Ave
Redwood Ave
Terrace Ave
Seaman Rd
Prospect Ave
Crest Dr
Undercliff Rd
Lloyd Rd
Mountain Ave
Orange Rd
Bloomfield Ave
Valley Rd
N Mountain Ave
Upper Mountain Ave
Prospect Ave
Highland Ave
Claremont Ave
Sunset Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
Park Ave
Lakeside Ave
Hillside Ave
Morningside Rd
Gerdes Ave
Fairway Ave
Pease Ave
S Prospect St
Forest Ave
Linn Dr
Personette Ave
Fairview Ave
Durrell St
Lynwood Rd
Grove Ave
Ann St
Cypress Ave
Franklin St
Brookside Ter
Linden Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Otsego Rd
Elmwood Rd
Pompton Ave
Woodland Ave
Franklin St
Westland Rd
Overlook Rd
Harper Ter
Bentley Rd
Ozone Ave
W Bradford Ave
Dill Dr
Smith Dr
506
577
527
23
19 BOONTON AVENUE
BOONTON, NJ 07005
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THE LAND CONSERVANCY OF NEW JERSEY
Map Prepared July 17, 2018
Data Sources: Verona Township, NJDEP, NJGIN Road Centerline 2017
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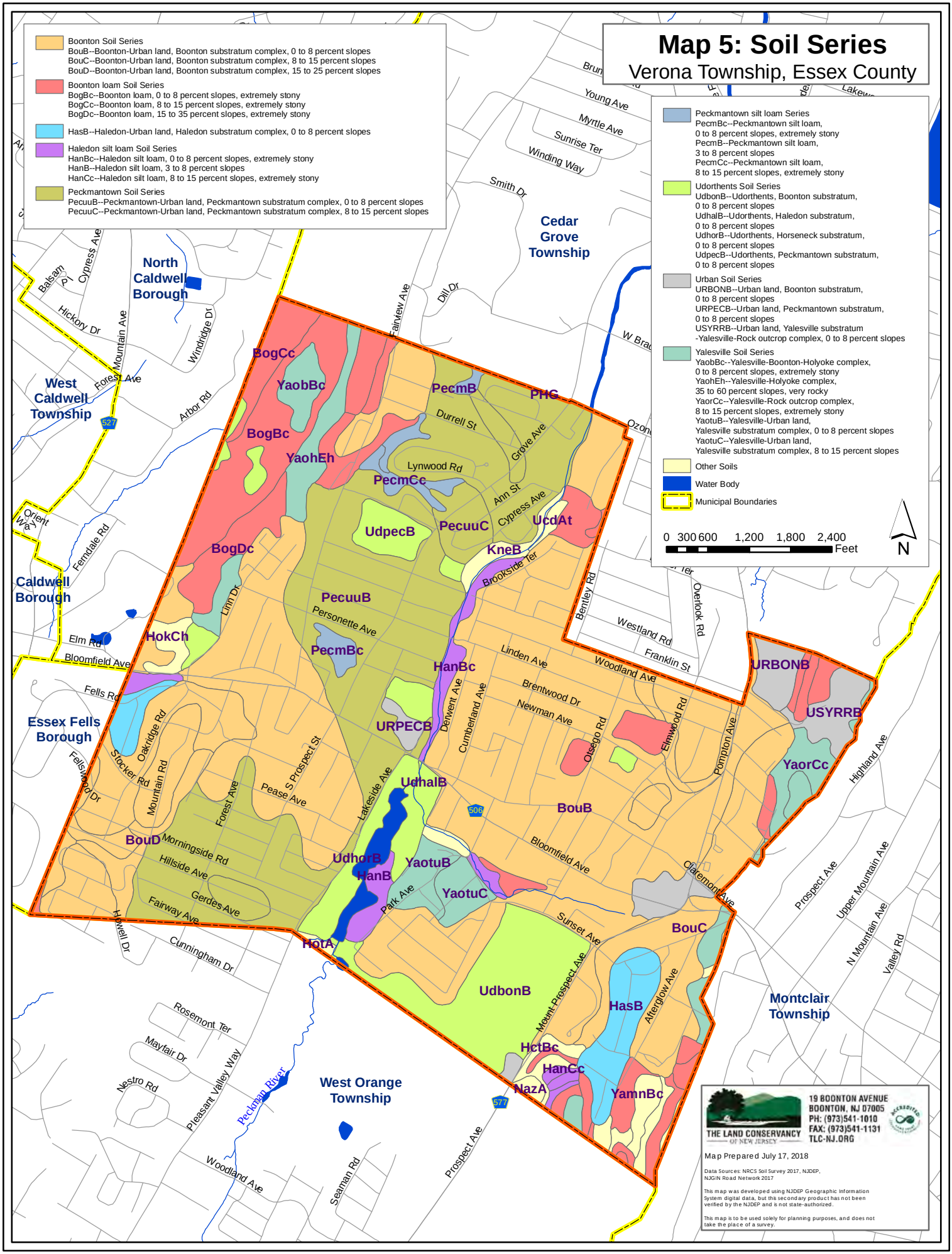
Map 5: Soil Series
Verona Township, Essex County
Boonton Soil Series
BouB--Boonton-Urban land, Boonton substratum complex, 0 to 8 percent slopes
BouC--Boonton-Urban land, Boonton substratum complex, 8 to 15 percent slopes
BouD--Boonton-Urban land, Boonton substratum complex, 15 to 25 percent slopes
Boonton loam Soil Series
BogBc--Boonton loam, 0 to 8 percent slopes, extremely stony
BogCc--Boonton loam, 8 to 15 percent slopes, extremely stony
BogDc--Boonton loam, 15 to 35 percent slopes, extremely stony
HasB--Haledon-Urban land, Haledon substratum complex, 0 to 8 percent slopes
Haledon silt loam Soil Series
HanBc--Haledon silt loam, 0 to 8 percent slopes, extremely stony
HanB--Haledon silt loam, 3 to 8 percent slopes
HanCc--Haledon silt loam, 8 to 15 percent slopes, extremely stony
Peckmantown Soil Series
PecuuB--Peckmantown-Urban land, Peckmantown substratum complex, 0 to 8 percent slopes
PecuuC--Peckmantown-Urban land, Peckmantown substratum complex, 8 to 15 percent slopes
Peckmantown silt loam Series
PecmBc--Peckmantown silt loam, 0 to 8 percent slopes, extremely stony
PecmB--Peckmantown silt loam, 3 to 8 percent slopes
PecmCc--Peckmantown silt loam, 8 to 15 percent slopes, extremely stony
Udorthents Soil Series
UdbonB--Udorthents, Boonton substratum, 0 to 8 percent slopes
UdhalB--Udorthents, Haledon substratum, 0 to 8 percent slopes
UdhorB--Udorthents, Horseneck substratum, 0 to 8 percent slopes
UdpecB--Udorthents, Peckmantown substratum, 0 to 8 percent slopes
Urban Soil Series
URBONB--Urban land, Boonton substratum, 0 to 8 percent slopes
URPECB--Urban land, Peckmantown substratum, 0 to 8 percent slopes
USYRRB--Urban land, Yalesville substratum -Yalesville-Rock outcrop complex, 0 to 8 percent slopes
Yalesville Soil Series
YaobBc--Yalesville-Boonton-Holyoke complex, 0 to 8 percent slopes, extremely stony
YaohEh--Yalesville-Holyoke complex, 35 to 60 percent slopes, very rocky
YaorCc--Yalesville-Rock outcrop complex, 8 to 15 percent slopes, extremely stony
YaotuB--Yalesville-Urban land, Yalesville substratum complex, 0 to 8 percent slopes
YaotuC--Yalesville-Urban land, Yalesville substratum complex, 8 to 15 percent slopes
Other Soils
Water Body
Municipal Boundaries
0 300 600 1,200 1,800 2,400
Feet
N
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Cedar Grove Township
West Orange Township
Montclair Township
BogCc
YaobBc
BogBc
YaohEh
BogDc
HokCh
PecmB
PHC
PecmCc
UdpecB
PecuuC
UcdAt
KneB
PecuuB
PecmBc
HanBc
URPECB
UdhalB
BouB
BouD
UdhorB
HanB
YaotuB
YaotuC
HotA
UdbonB
HctBc
HanCc
NazA
HasB
YamnBc
BouC
YaorCc
URBONB
USYRRB
Durrell St
Grove Ave
Lynwood Rd
Ann St
Cypress Ave
Brookside Ter
Linden Ave
Woodland Ave
Brentwood Dr
Newman Ave
Franklin St
Westland Rd
Bentley Rd
Overlook Rd
Dewent Ave
Cumberland Ave
Otsego Rd
Elmwood Rd
Pompton Ave
Highland Ave
Claremont Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Sunset Ave
Mount Prospect Ave
Afterglow Ave
Bloomfield Ave
Park Ave
Lakeside Ave
S Prospect St
Pease Ave
Forest Ave
Morningside Rd
Hillside Ave
Gerdes Ave
Fairway Ave
Howell Dr
Cunningham Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Peckman River
Woodland Ave
Seaman Rd
Prospect Ave
Oakridge Rd
Stocker Rd
Mountain Rd
Fellswood Dr
Fells Rd
Bloomfield Ave
Elm Rd
Orient Way
Ferndale Rd
Linn Dr
Personette Ave
Fairview Ave
Dill Dr
Smith Dr
Sunrise Ter
Winding Way
Myrtle Ave
Young Ave
Hickory Dr
Balsam Pl
Cypress Ave
Forest Mountain Ave
Windridge Dr
Arbor Rd
527
506
577
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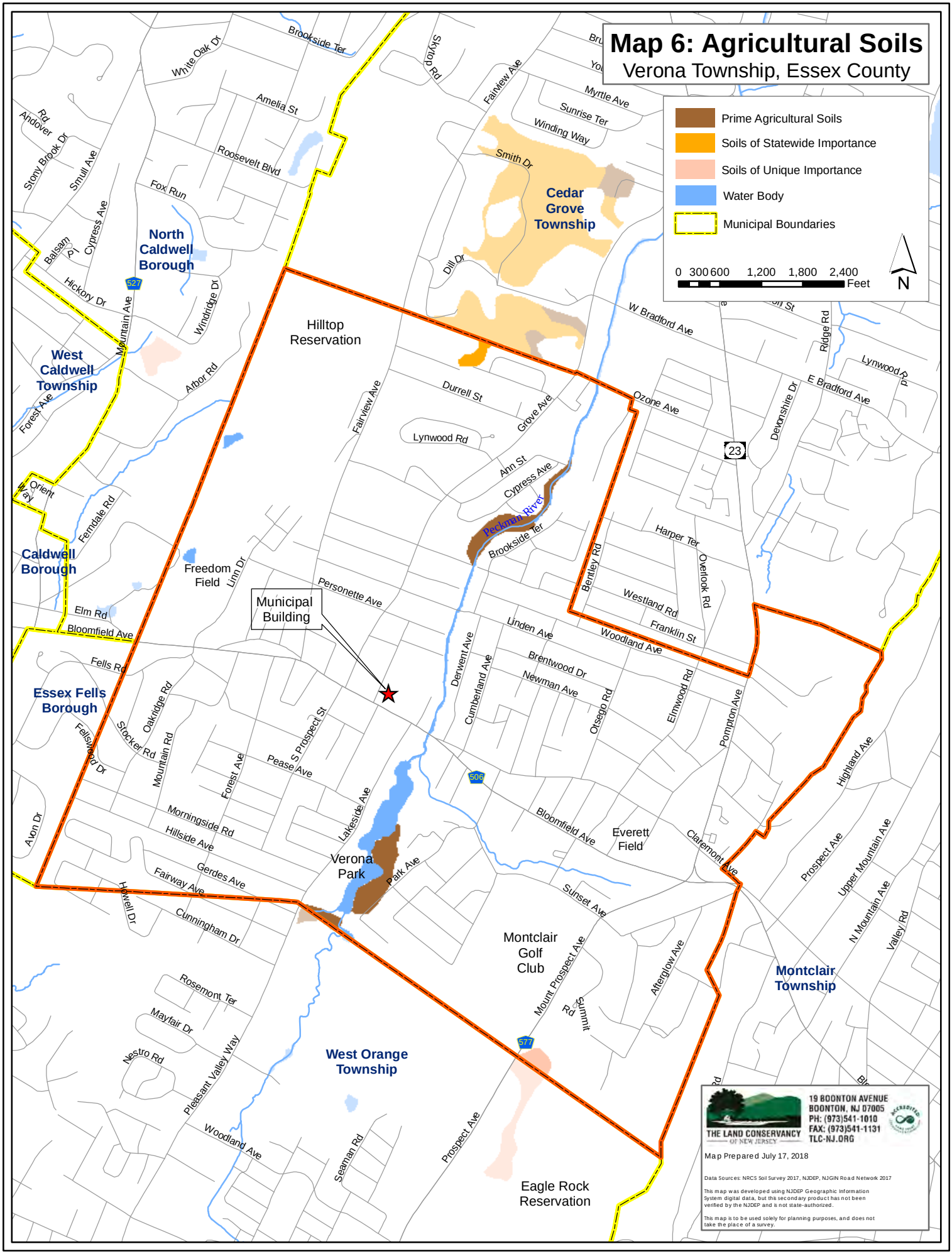
Map 6: Agricultural Soils
Verona Township, Essex County
Prime Agricultural Soils
Soils of Statewide Importance
Soils of Unique Importance
Water Body
Municipal Boundaries
0 300 600 1,200 1,800 2,400
Feet
N
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
West Orange Township
Montclair Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Montclair Golf Club
Everett Field
Eagle Rock Reservation
Peckman River
Brookside Ter
White Oak Dr
Amelia St
Roosevelt Blvd
Fox Run
Smull Ave
Stony Brook Dr
Andover Rd
Cypress Ave
Balsam Pl
Hickory Dr
Mountain Ave
Windridge Dr
Arbor Rd
Forest Ave
W Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Fellswood Dr
Oakridge Rd
Stocker Rd
Mountain Rd
Avon Dr
Howell Dr
Morningside Rd
Hillside Ave
Gerdes Ave
Fairway Ave
Cunningham Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Woodland Ave
Seaman Rd
Prospect Ave
Park Ave
Lakeside Ave
Pease Ave
S Prospect St
Forest Ave
Linn Dr
Personette Ave
Skyline Rd
Fairview Ave
Durrell St
Grove Ave
Lynwood Rd
Ann St
Cypress Ave
Brookside Ter
Dill Dr
Smith Dr
Sunrise Ter
Winding Way
Myrtle Ave
Fairview Ave
W Bradford Ave
Ozone Ave
E Bradford Ave
Ridge Rd
Lynwood Rd
Devonshire Dr
Harper Ter
Overlook Rd
Bentley Rd
Westland Rd
Franklin St
Woodland Ave
Linden Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Otsego Rd
Elmwood Rd
Pompton Ave
Highland Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Claremont Ave
Bloomfield Ave
Sunset Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
527
506
577
23
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BOONTON, NJ 07005
PH: (973)541-1010
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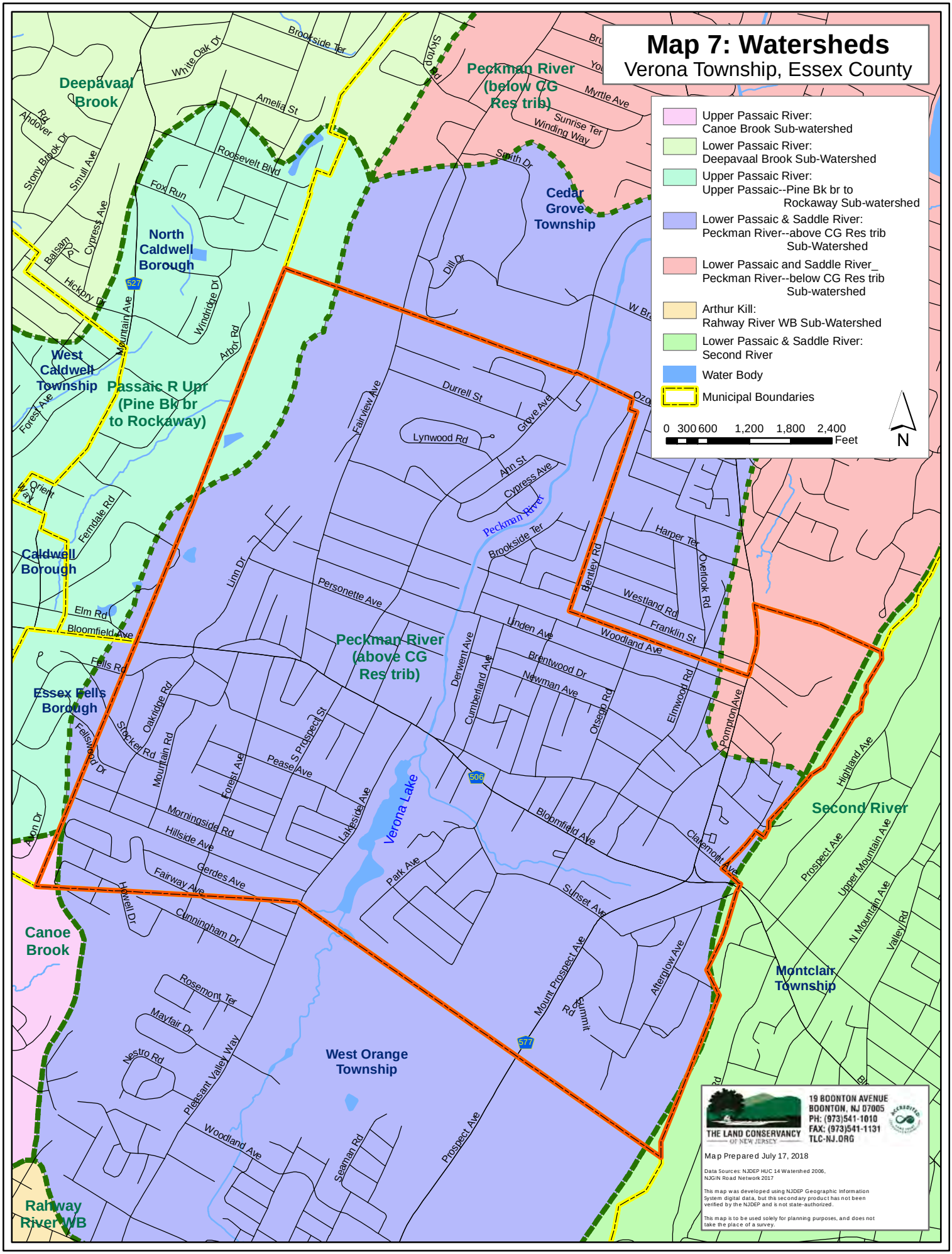
Map 7: Watersheds
Verona Township, Essex County
Upper Passaic River: Canoe Brook Sub-watershed
Lower Passaic River: Deepavaal Brook Sub-Watershed
Upper Passaic River: Upper Passaic--Pine Bk br to Rockaway Sub-watershed
Lower Passaic & Saddle River: Peckman River--above CG Res trib Sub-Watershed
Lower Passaic and Saddle River_ Peckman River--below CG Res trib Sub-watershed
Arthur Kill: Rahway River WB Sub-Watershed
Lower Passaic & Saddle River: Second River
Water Body
Municipal Boundaries
0 300 600 1,200 1,800 2,400 Feet
N
Deepavaal Brook
Peckman River (below CG Res trib)
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Passaic R Upr (Pine Bk br to Rockaway)
Caldwell Borough
Peckman River (above CG Res trib)
Essex Fells Borough
Verona Lake
Second River
Montclair Township
Canoe Brook
West Orange Township
Rahway River WB
Peckman River
THE LAND CONSERVANCY OF NEW JERSEY
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BOONTON, NJ 07005
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Map Prepared July 17, 2018
Data Sources: NJDEP HUC 14 Watershed 2006, NJGIN Road Network 2017
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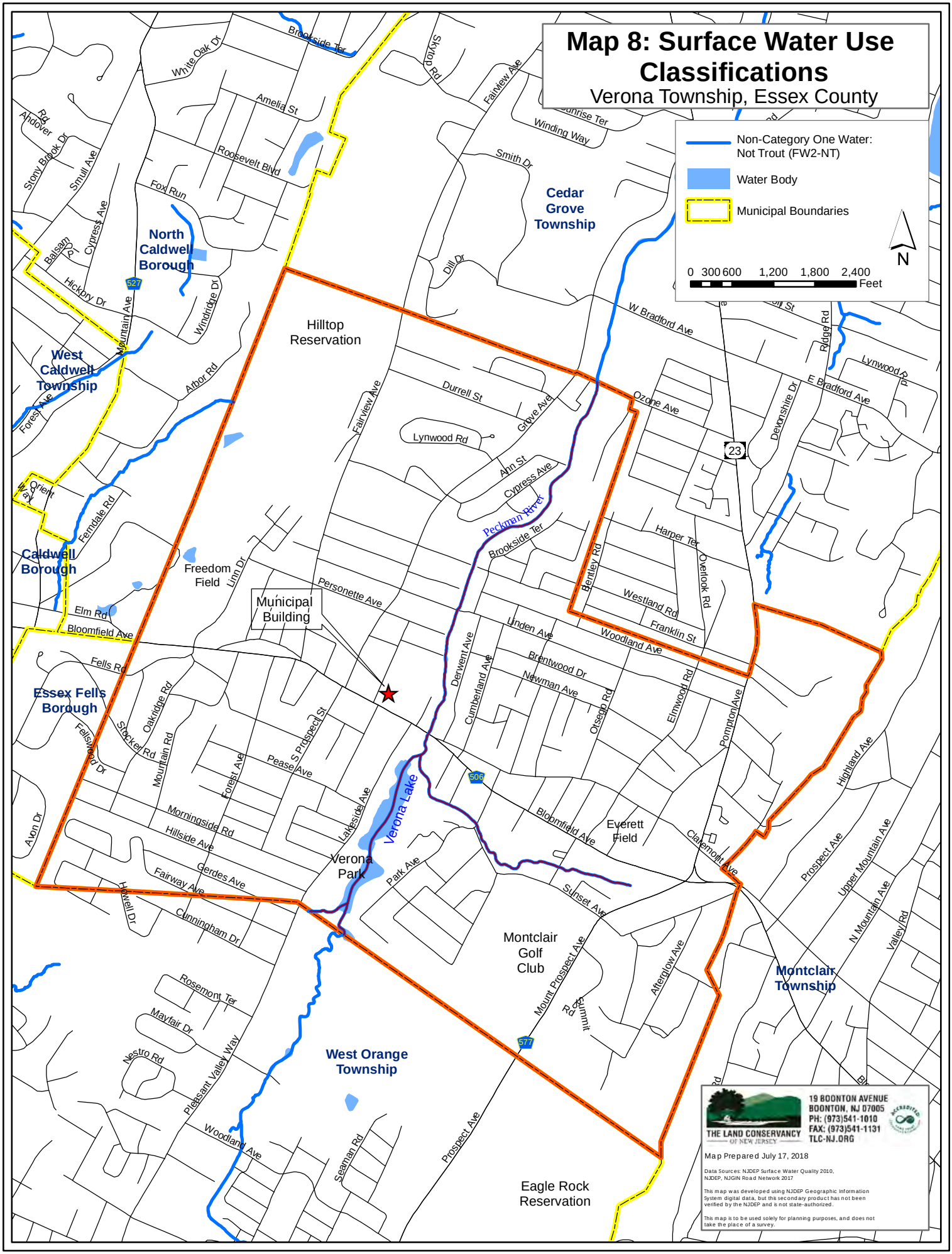

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Map Prepared July 17, 2018

Data Sources: NJDEP Surface Water Quality 2010, NJDEP, NJGIN Road Network 2017

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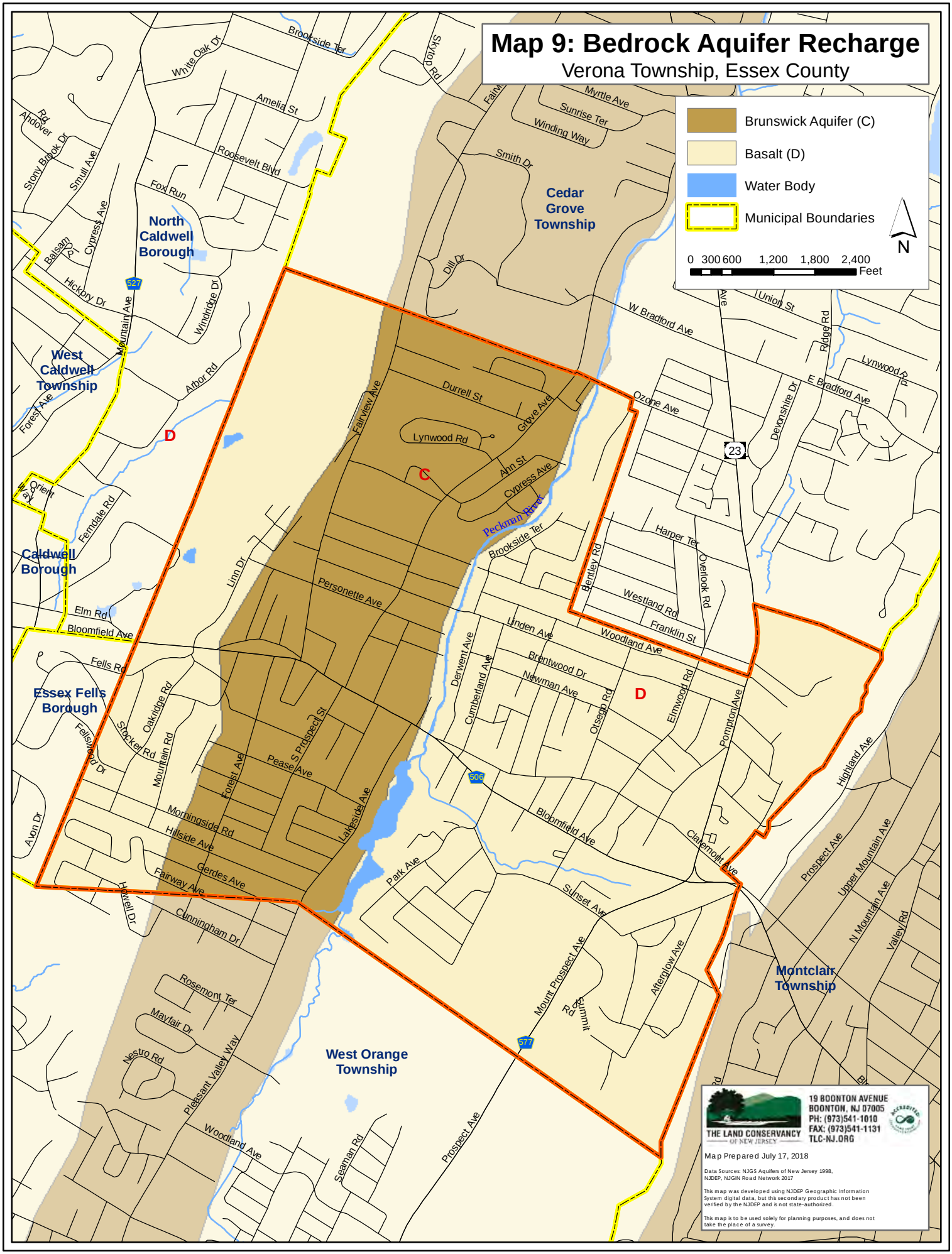

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Map Prepared July 17, 2018

Data Sources: NJGS Aquifers of New Jersey 1998, NJDEP, NJGIN Road Network 2017

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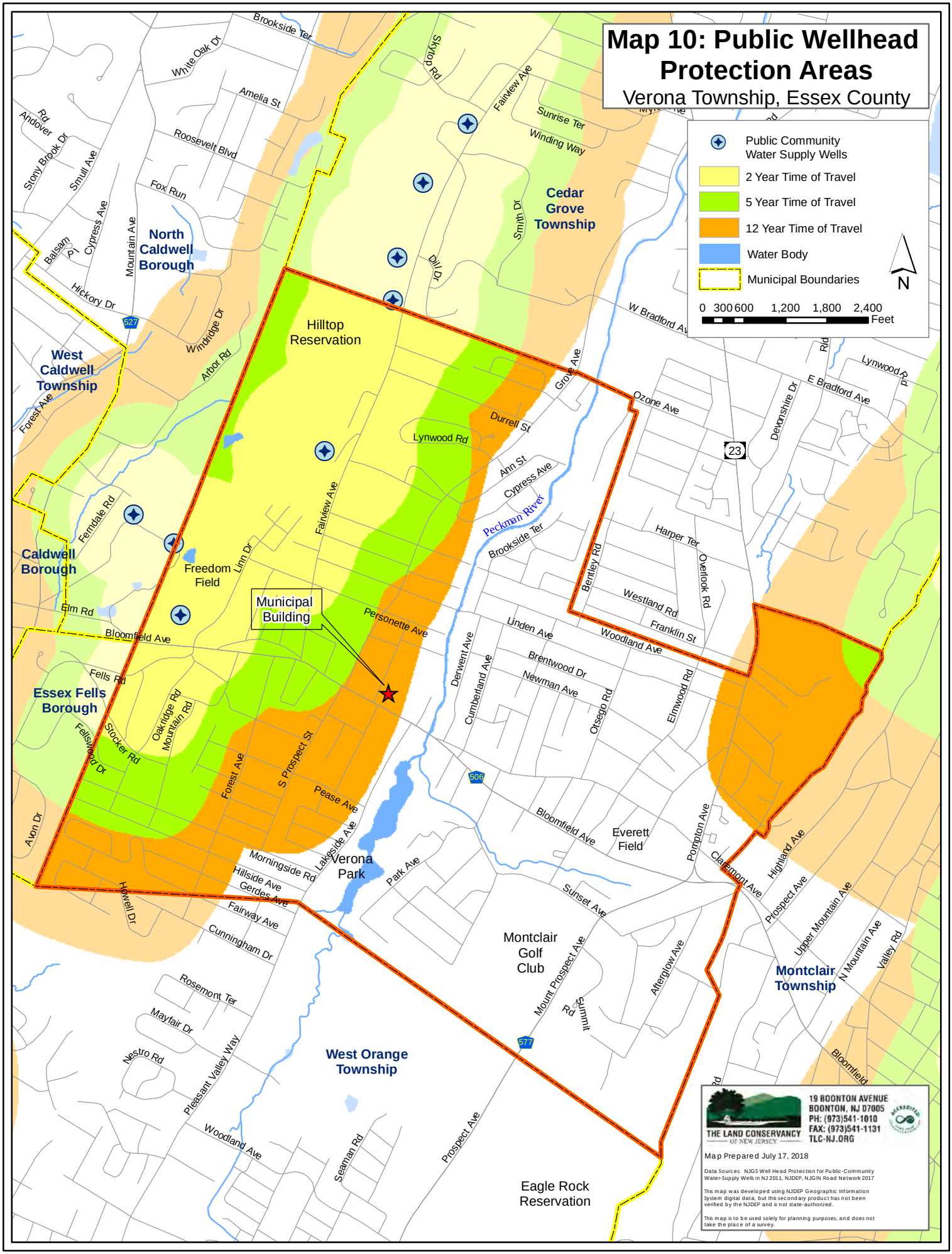
Map 10: Public Wellhead Protection Areas
Verona Township, Essex County
Public Community Water Supply Wells
2 Year Time of Travel
5 Year Time of Travel
12 Year Time of Travel
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400 Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Verona Park
Montclair Township
West Orange Township
Hilltop Reservation
Freedom Field
Municipal Building
Everett Field
Montclair Golf Club
Eagle Rock Reservation
Peckman River
Brookside Ter
White Oak Dr
Amelia St
Roosevelt Blvd
Fox Run
Stony Brook Dr
Smull Ave
Cypress Ave
Mountain Ave
Hickory Dr
Windridge Dr
Arbor Rd
Forest Ave
Ferndale Rd
Linn Dr
Elm Rd
Bloomfield Ave
Fells Rd
Fellsmere Dr
Stocker Rd
Oakridge Rd
Mountain Rd
Avon Dr
Howell Dr
Morningside Rd
Hillside Ave
Gerdes Ave
Fairway Ave
Cunningham Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Woodland Ave
Seaman Rd
Prospect Ave
Pease Ave
Lakeside Ave
Park Ave
Sunset Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
Skyline Rd
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Sunrise Ter
Winding Way
Smith Dr
Dill Dr
Grove Ave
Durrell St
Lynwood Rd
Ann St
Cypress Ave
Personette Ave
Linden Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Otsego Rd
Elmwood Rd
Woodland Ave
Franklin St
Westland Rd
Bentley Rd
Overlook Rd
Harper Ter
Ozone Ave
W Bradford Ave
E Bradford Ave
Devonshire Dr
Lynwood Rd
Pompton Ave
Claremont Ave
Highland Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Bloomfield
23
506
577
527
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Data Sources: NJGS Well Head Protection for Public-Community Water-Supply Wells in NJ 2011, NJDEP, NJGIN Road Network 2017
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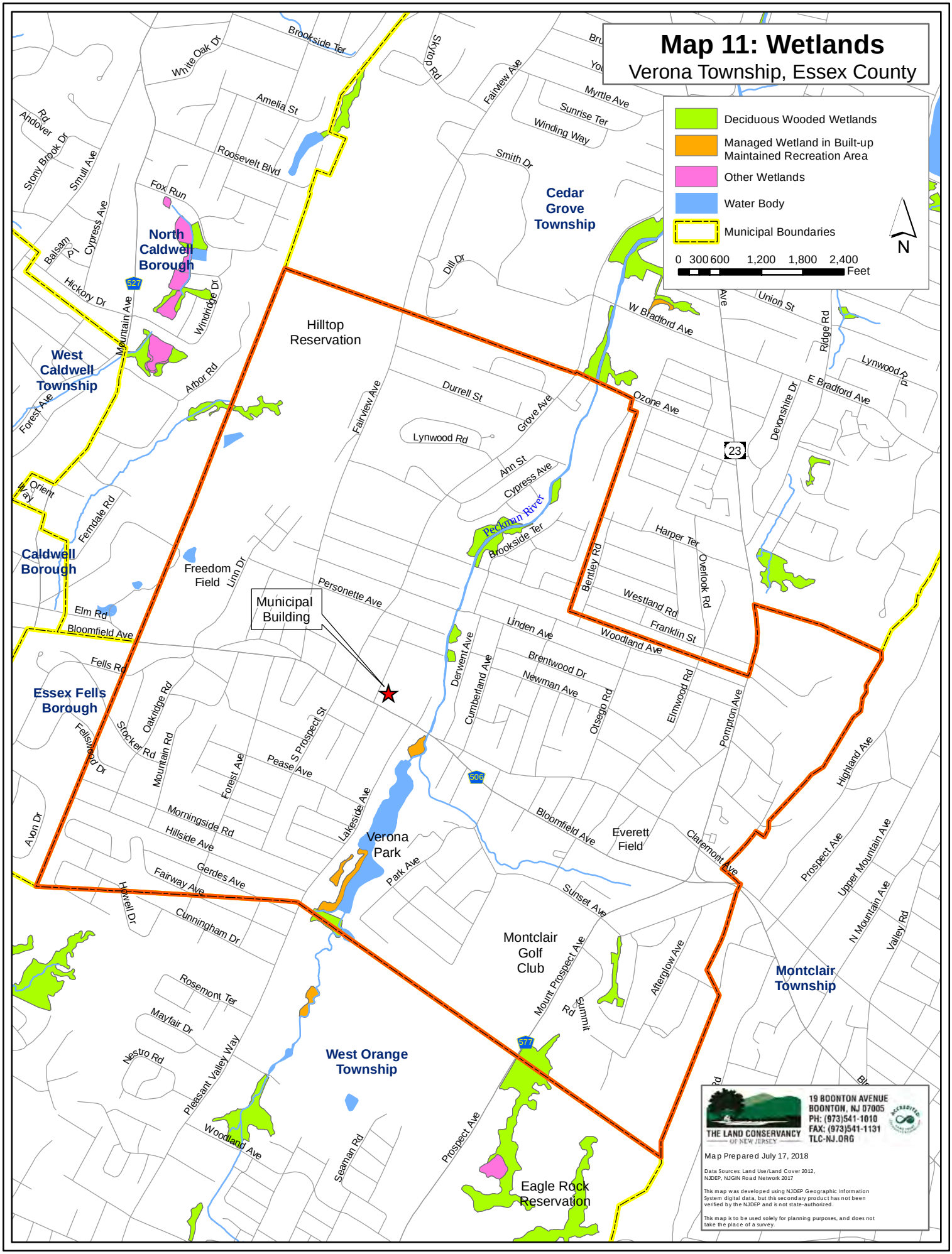
Map 11: Wetlands
Verona Township, Essex County
Deciduous Wooded Wetlands
Managed Wetland in Built-up Maintained Recreation Area
Other Wetlands
Water Body
Municipal Boundaries
0 300 600 1,200 1,800 2,400 Feet
N
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
West Orange Township
Montclair Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Everett Field
Montclair Golf Club
Eagle Rock Reservation
Peckman River
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Fox Run
Stony Brook Dr
Smull Ave
Cypress Ave
Balsam Pl
Hickory Dr
Mountain Ave
Windridge Dr
Arbor Rd
Forest Ave
W Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Linn Dr
Personette Ave
Fairview Ave
Durrell St
Grove Ave
Lynwood Rd
Ann St
Cypress Ave
Skyline Rd
Fairview Ave
Myrtle Ave
Sunrise Ter
Winding Way
Smith Dr
Dill Dr
W Bradford Ave
Union St
Ridge Rd
Lynwood Rd
E Bradford Ave
Ozone Ave
Devonshire Dr
Harper Ter
Overlook Rd
Bentley Rd
Westland Rd
Franklin St
Woodland Ave
Linden Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Otsego Rd
Elmwood Rd
Pompton Ave
Highland Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Claremont Ave
Afterglow Ave
Mount Prospect Ave
Summit Rd
Sunset Ave
Park Ave
Lakeside Ave
Bloomfield Ave
Pease Ave
S Prospect St
Forest Ave
Oakridge Rd
Stocker Rd
Mountain Rd
Fellswood Dr
Howell Dr
Avon Dr
Morningside Rd
Hillside Ave
Gerdes Ave
Fairway Ave
Cunningham Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Woodland Ave
Seaman Rd
Prospect Ave
23
506
527
577
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BOONTON, NJ 07005
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Map Prepared July 17, 2018
Data Sources: Land Use/Land Cover 2012, NJDEP, NJGIN Road Network 2017
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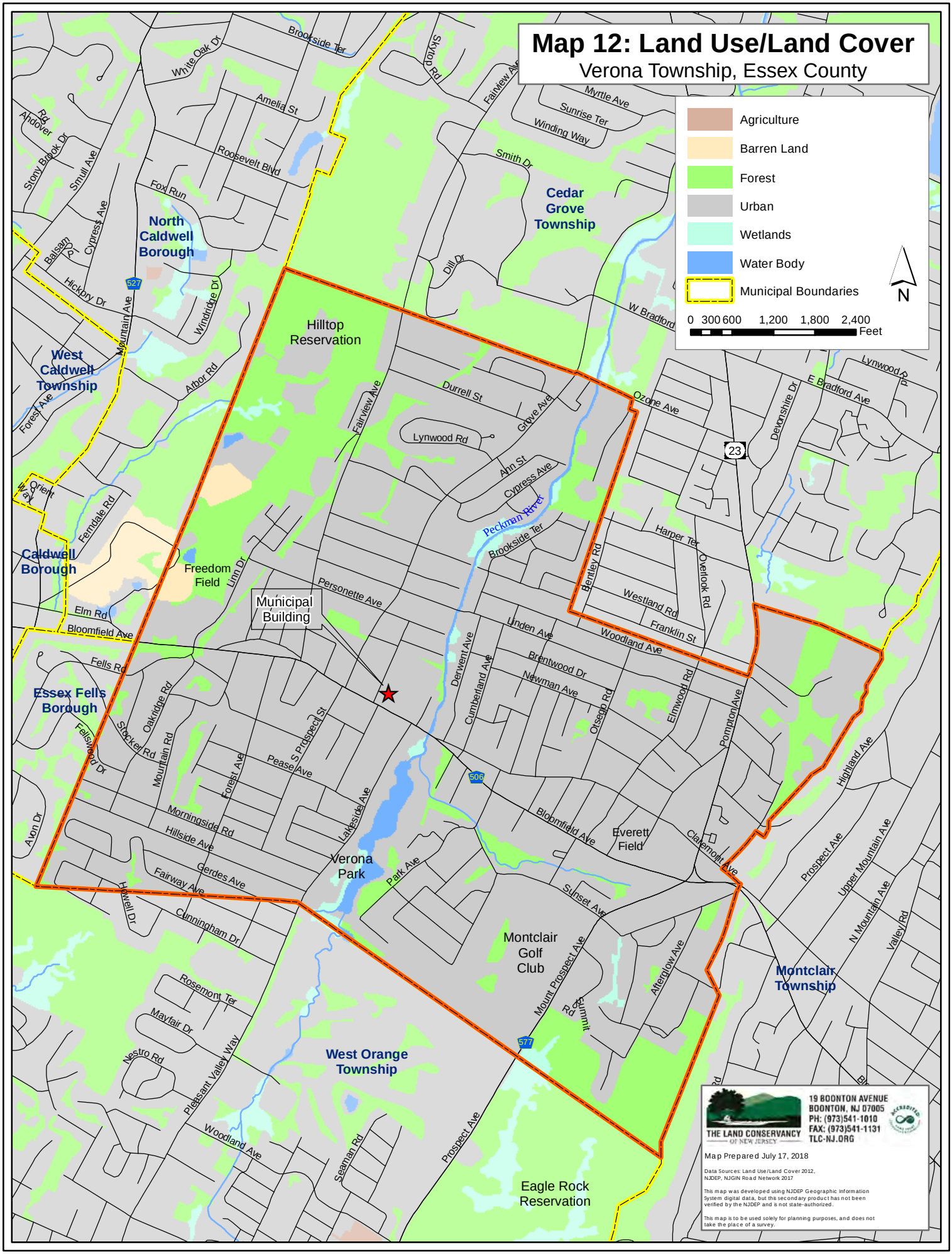
Map 12: Land Use/Land Cover
Verona Township, Essex County
Agriculture
Barren Land
Forest
Urban
Wetlands
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400
Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
West Orange Township
Montclair Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Montclair Golf Club
Everett Field
Eagle Rock Reservation
Peckman River
Brookside Ter
White Oak Dr
Amelia St
Roosevelt Blvd
Fox Run
Stony Brook Dr
Smull Ave
Cypress Ave
Balsam Pl
Hickory Dr
Mountain Ave
Windridge Dr
Arbor Rd
Forest Ave
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Fellswood Dr
Oakridge Rd
Stocker Rd
Mountain Rd
Linn Dr
Personette Ave
Durrell St
Grove Ave
Fairview Ave
Lynwood Rd
Ahn St
Cypress Ave
Brookside Ter
Dill Dr
Smith Dr
Skyline Rd
Fairview Ave
Myrtle Ave
Sunrise Ter
Winding Way
W Bradford
E Bradford Ave
Ozone Ave
Lynwood Rd
Devonshire Dr
Harper Ter
Overlook Rd
Bentley Rd
Westland Rd
Franklin St
Woodland Ave
Linden Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Otseeb Rd
Elmwood Rd
Pompton Ave
Highland Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
S Prospect St
Pease Ave
Forest Ave
Lakeside Ave
Morningside Rd
Hillside Ave
Gerdes Ave
Fairway Ave
Cunningham Dr
Howell Dr
Avon Dr
Park Ave
Blomfield Ave
Sunset Ave
Clairemont Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Woodland Ave
Seaman Rd
Prospect Ave
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THE LAND CONSERVANCY OF NEW JERSEY
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TLC-NJ.ORG
Map Prepared July 17, 2018
Data Sources: Land Use/Land Cover 2012, NJDEP, NJGIN Road Network 2017
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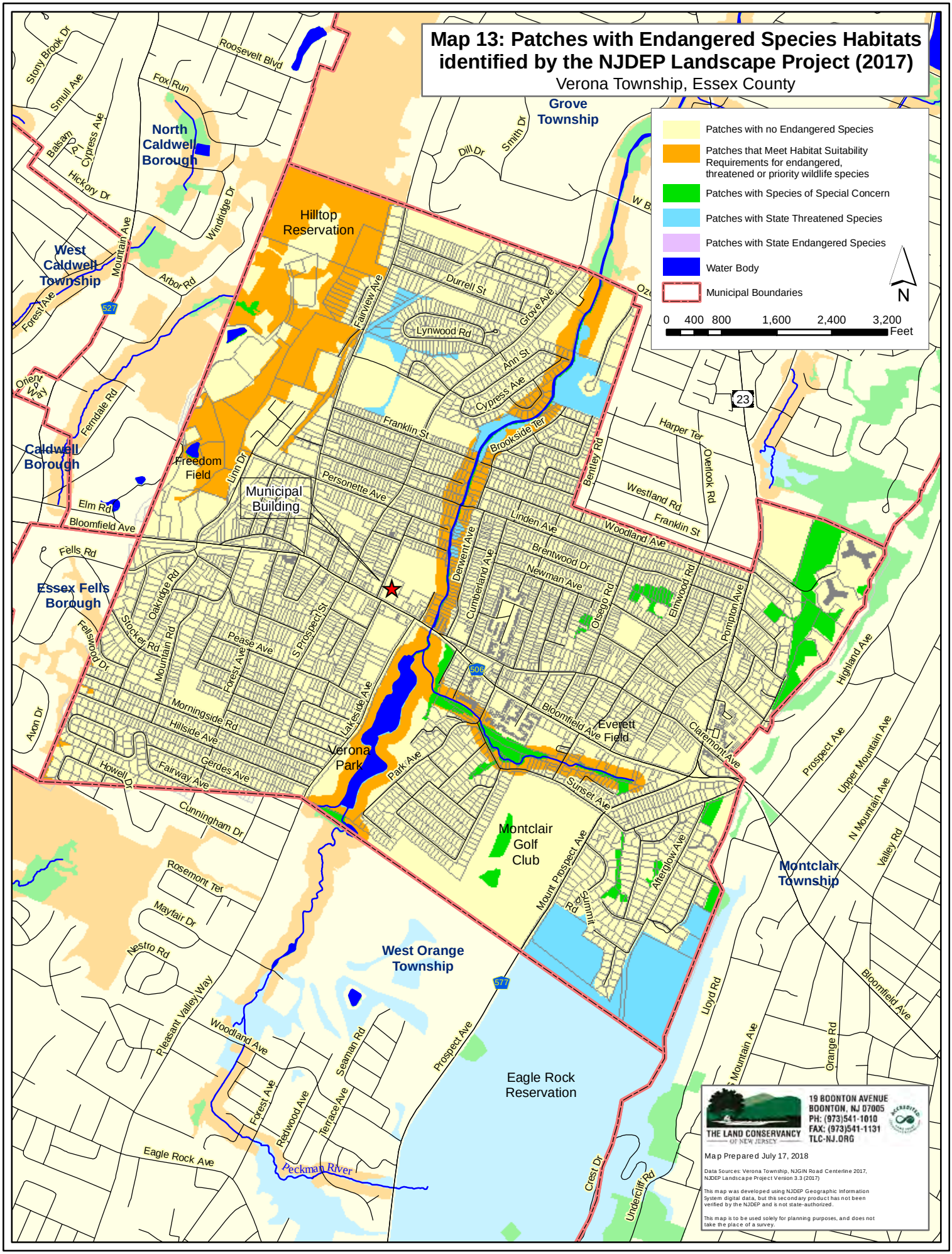
Map 13: Patches with Endangered Species Habitats identified by the NJDEP Landscape Project (2017)
Verona Township, Essex County
Patches with no Endangered Species
Patches that Meet Habitat Suitability Requirements for endangered, threatened or priority wildlife species
Patches with Species of Special Concern
Patches with State Threatened Species
Patches with State Endangered Species
Water Body
Municipal Boundaries
N
0 400 800 1,600 2,400 3,200
Feet
Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Montclair Township
West Orange Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Everett Field
Montclair Golf Club
Eagle Rock Reservation
Peckman River
Roosevelt Blvd
Fox Run
Stony Brook Dr
Smull Ave
Balsam Pl
Cypress Ave
Hickory Dr
Windridge Dr
Mountain Ave
Arbor Rd
Forest Ave
Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Fellswood Dr
Stocker Rd
Oakridge Rd
Mountain Rd
Pease Ave
Forest Ave
S Prospect St
Morningside Rd
Hillside Ave
Howell Dr
Fairway Ave
Gerdes Ave
Cunningham Dr
Avon Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Woodland Ave
Eagle Rock Ave
Seaman Rd
Forest Ave
Redwood Ave
Terrace Ave
Prospect Ave
Park Ave
Lakeside Ave
Fairview Ave
Durrell St
Lynwood Rd
Grove Ave
Ann St
Cypress Ave
Franklin St
Linn Dr
Personette Ave
Linden Ave
Brookside Ter
Bentley Rd
Harper Ter
Overlook Rd
Westland Rd
Franklin St
Woodland Ave
Derwent Ave
Cumberland Ave
Brentwood Dr
Newman Ave
Osseo Rd
Elmwood Rd
Pompton Ave
Highland Ave
Bloomfield Ave
Claremont Ave
Sunset Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Lloyd Rd
Orange Rd
Crest Dr
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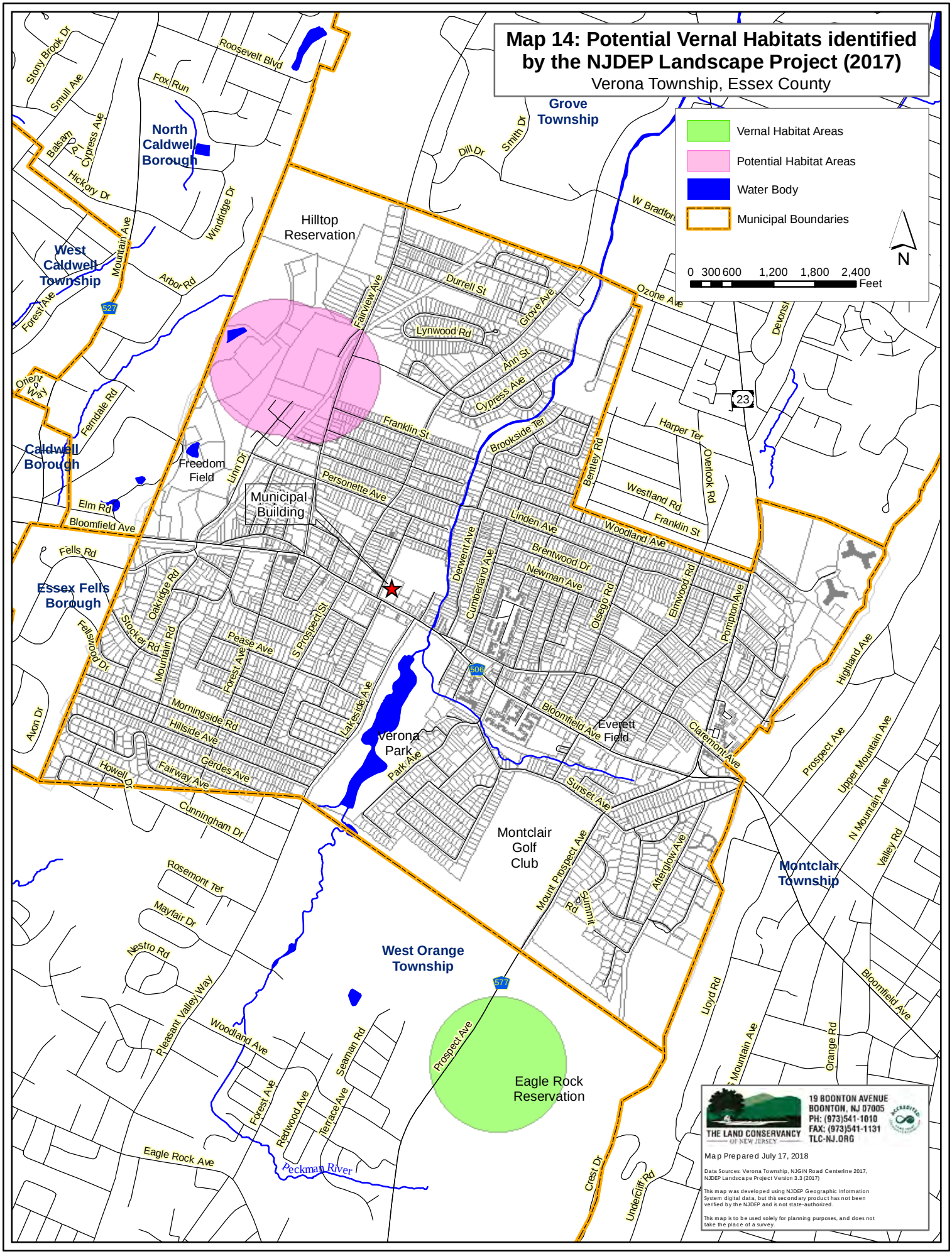
Map 14: Potential Vernal Habitats identified by the NJDEP Landscape Project (2017)
Verona Township, Essex County
Vernal Habitat Areas
Potential Habitat Areas
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400
Feet
Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
West Orange Township
Montclair Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Everett Field
Montclair Golf Club
Eagle Rock Reservation
Peckman River
Roosevelt Blvd
Fox Run
Stony Brook Dr
Smull Ave
Balsam Pl
Cypress Ave
Hickory Dr
Windridge Dr
Mountain Ave
Arbor Rd
Forest Ave
Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Fellswood Dr
Stocker Rd
Oakridge Rd
Mountain Rd
Avon Dr
Howell Dr
Fairway Ave
Gerdes Ave
Hillside Ave
Morningside Rd
Cunningham Dr
Rosemont Ter
Mayfair Dr
Nestro Rd
Pleasant Valley Way
Eagle Rock Ave
Woodland Ave
Seaman Rd
Forest Ave
Redwood Ave
Terrace Ave
Prospect Ave
Park Ave
Lakeside Ave
S Prospect St
Pease Ave
Linn Dr
Fairview Ave
Durrell St
Lynwood Rd
Grove Ave
Ann St
Cypress Ave
Franklin St
Personette Ave
Brookside Ter
Dill Dr
Smith Dr
W Bradford
Ozone Ave
Bentley Rd
Harper Ter
Overlook Rd
Westland Rd
Franklin St
Linden Ave
Woodland Ave
Brentwood Dr
Newman Ave
Derwent Ave
Cumberland Ave
Otsego Rd
Elmwood Rd
Pompton Ave
Highland Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Bloomfield Ave
Claremont Ave
Sunset Ave
Mount Prospect Ave
Summit Rd
Afterglow Ave
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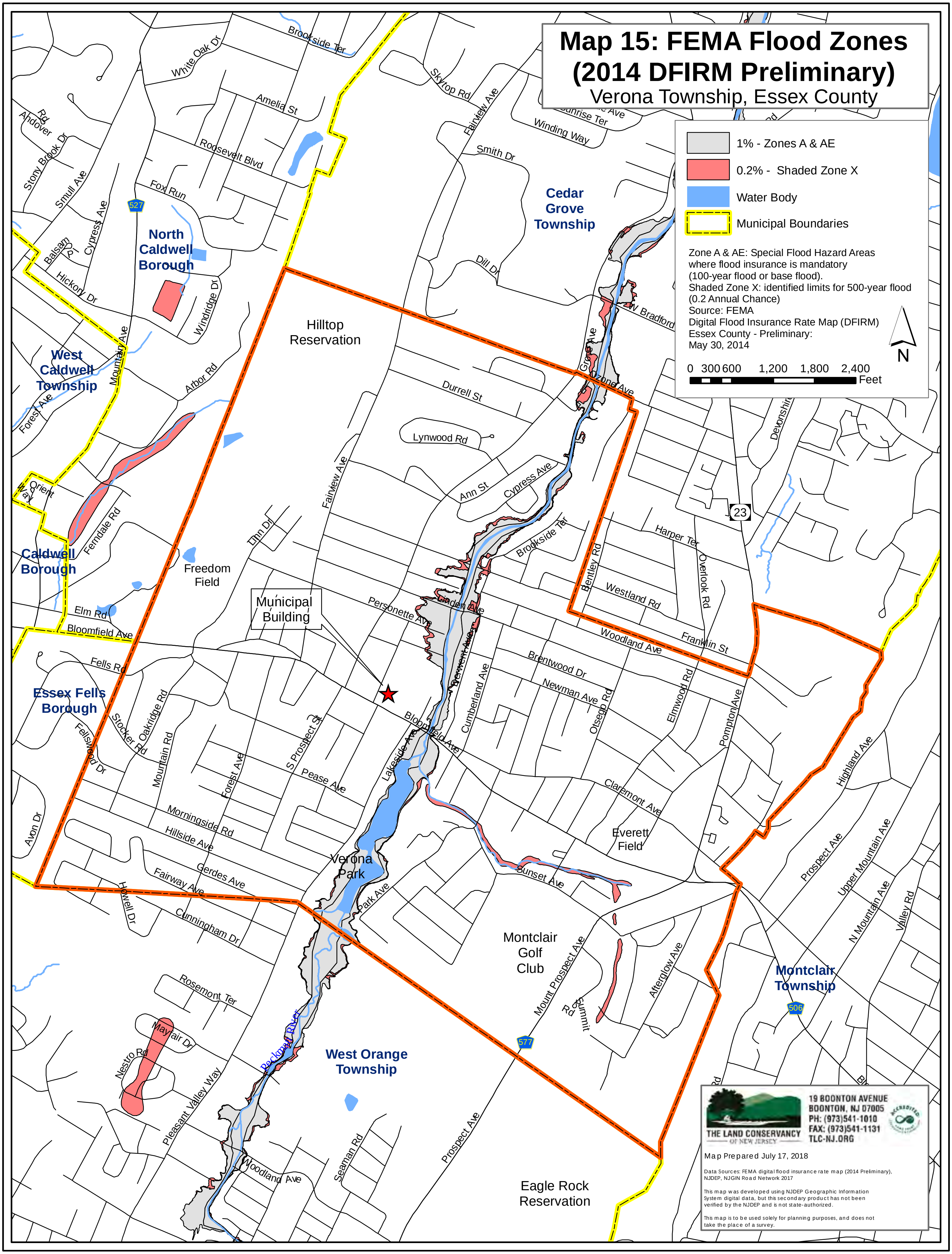
Map 15: FEMA Flood Zones
(2014 DFIRM Preliminary)
Verona Township, Essex County
1% - Zones A & AE
0.2% - Shaded Zone X
Water Body
Municipal Boundaries
Zone A & AE: Special Flood Hazard Areas where flood insurance is mandatory (100-year flood or base flood).
Shaded Zone X: identified limits for 500-year flood (0.2 Annual Chance)
Source: FEMA
Digital Flood Insurance Rate Map (DFIRM)
Essex County - Preliminary:
May 30, 2014
N
0 300 600 1,200 1,800 2,400
Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Montclair Township
West Orange Township
Hilltop Reservation
Freedom Field
Municipal Building
Verona Park
Everett Field
Montclair Golf Club
Eagle Rock Reservation
Peckman River
Brookside Ter
White Oak Dr
Amelia St
Roosevelt Blvd
Fox Run
Skytop Rd
Fairview Ave
Sunrise Ter
Winding Way
Smith Dr
Dill Dr
W Bradford
Andover Rd
Stony Brook Dr
Small Ave
Cypress Ave
Balsam Dr
Hickory Dr
Windridge Dr
Mountain Ave
Arbor Rd
Forest Ave
Orient Way
Ferndale Rd
Elm Rd
Bloomfield Ave
Fells Rd
Durrell St
Lynwood Rd
Ann St
Cypress Ave
Brookside Ter
Grove Ave
Ozone Ave
Devonshire
Harper Ter
Overlook Rd
Bentley Rd
Westland Rd
Franklin St
Woodland Ave
Brentwood Dr
Newman Ave
Otsego Rd
Elmwood Rd
Pompton Ave
Personette Ave
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Derwent Ave
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Elm Dr
Fairview Ave
S Prospect St
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Stocker Rd
Oakridge Rd
Fellswood Dr
Mountain Rd
Forest Ave
Morningside Rd
Hillside Ave
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Fairway Ave
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Howell Dr
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Data Sources: FEMA digital flood insurance rate map (2014 Preliminary), NJDEP, NJGIN Road Network 2017
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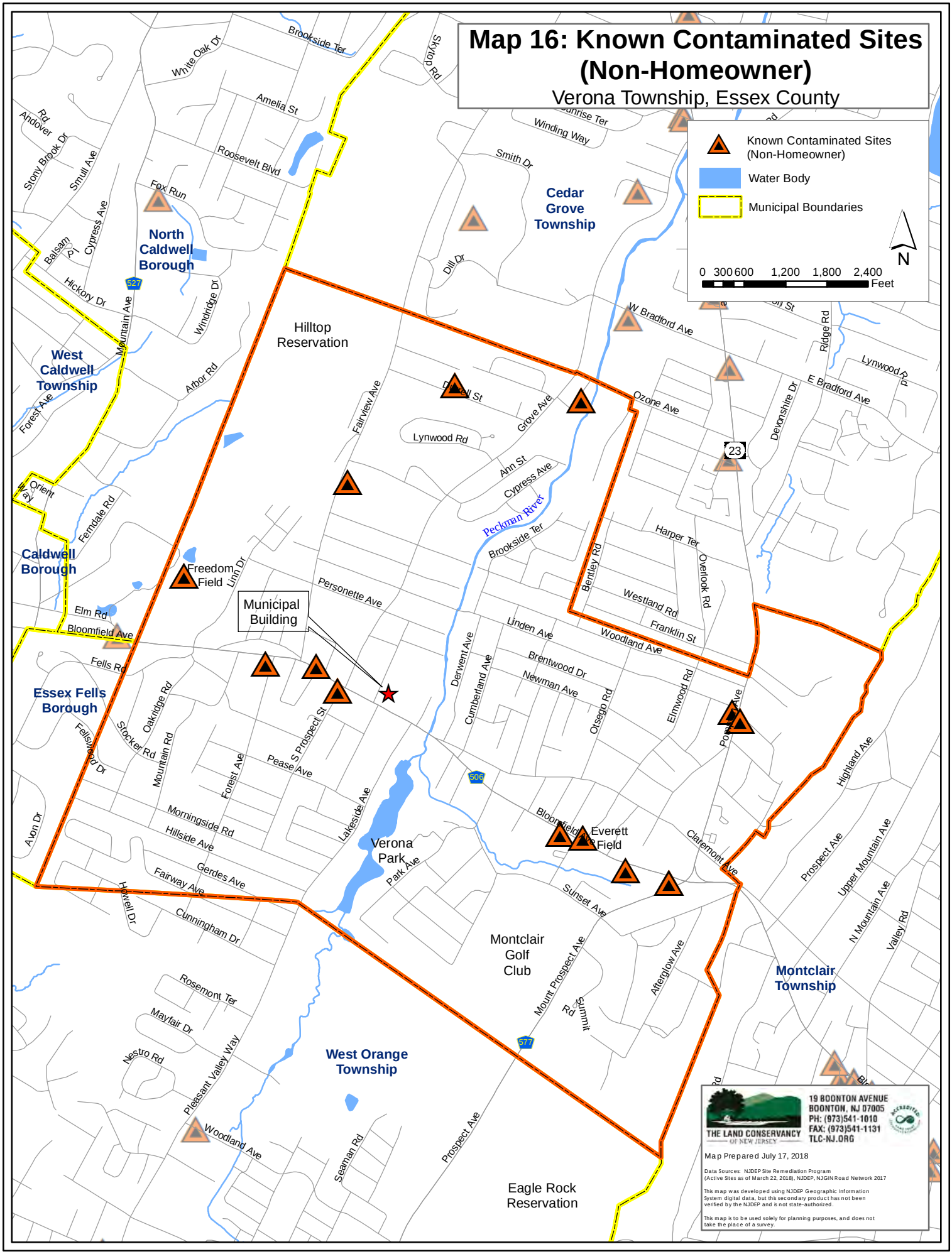
Map 16: Known Contaminated Sites (Non-Homeowner)
Verona Township, Essex County
Known Contaminated Sites (Non-Homeowner)
Water Body
Municipal Boundaries
N
0 300 600 1,200 1,800 2,400 Feet
Cedar Grove Township
North Caldwell Borough
West Caldwell Township
Caldwell Borough
Essex Fells Borough
Hilltop Reservation
Municipal Building
Freedom Field
Everett Field
Verona Park
Montclair Golf Club
West Orange Township
Montclair Township
Eagle Rock Reservation
Peckman River
Brookside Ter
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Roosevelt Blvd
Fox Run
Smith Dr
Winding Way
Dill Dr
Hickory Dr
Mountain Ave
Windridge Dr
Arbor Rd
Forest Ave
W Orient Way
Ferndale Rd
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Bloomfield Ave
Fells Rd
Fellswood Dr
Oakridge Rd
Stocker Rd
Mountain Rd
Forest Ave
S Prospect St
Pease Ave
Lakeside Ave
Morningside Rd
Hillside Ave
Gerdes Ave
Fairway Ave
Cunningham Dr
Howell Dr
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Rosemont Ter
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Seaman Rd
Prospect Ave
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Mount Prospect Ave
Summit Rd
Afterglow Ave
Clairemont Ave
Bloomfield Ave
Personette Ave
Linden Ave
Woodland Ave
Brentwood Dr
Newman Ave
Franklin St
Westland Rd
Harper Ter
Overlook Rd
Bentley Rd
Elmwood Rd
Otsego Rd
Cumberland Ave
Derwent Ave
Linn Dr
Fairview Ave
Grove Ave
Lynwood Rd
Ann St
Cypress Ave
Ozone Ave
W Bradford Ave
E Bradford Ave
Devonshire Dr
Ridge Rd
Lynwood Rd
Highland Ave
Prospect Ave
Upper Mountain Ave
N Mountain Ave
Valley Rd
Skyline Dr
Sunrise Ter
Andover Rd
Stony Brook Dr
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Data Sources: NJDEP Site Remediation Program (Active Sites as of March 22, 2018), NJDEP, NJGIN Road Network 2017
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