Environmental Resource Inventory

Update – 2014

for

Township of Stillwater

County of Sussex

Compiled by

The Land Conservancy of New Jersey
An accredited land trust

with

Stillwater Township Environmental Commission

March 2014 - DRAFT

ENVIRONMENTAL RESOURCE INVENTORY UPDATE - 2014

for

Township of Stillwater
County of Sussex

Prepared for:

Township of Stillwater
Environmental Commission

Draft Prepared March 27, 2014 by:

The Land Conservancy of New Jersey
an accredited land trust
19 Boonton Avenue
Boonton, NJ 07005

Barbara Heskins Davis, PP, AICP
NJ Professional Planner (License No.: 5926)

The original document was appropriately signed and sealed in accordance with Chapter 41, Title 13 of the State Board of Professional Planners.

Approved by the Township of Stillwater Planning Board on MONTH DAY, 2014

ENVIRONMENTAL RESOURCE INVENTORY UPDATE - 2014

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Township of Stillwater
County of Sussex

Produced by:

The Land Conservancy of New Jersey's Partners for Greener Communities Team:

"Partnering with Communities to Preserve Natural Treasures"

David Epstein, President

Barbara Heskins Davis, PP, AICP, Vice President, Programs

Kenneth Fung, GIS Manager

Greg Cooper, Planning Intern

For further information please contact:

The Land Conservancy of New Jersey
an accredited land trust

19 Boonton Avenue
Boonton, NJ 07005
Tel: (973) 541-1010
Fax: (973) 541-1131
www.tlc-nj.org

Township of Stillwater
Environmental Commission

964 Stillwater Road
Newton, NJ 07860
Tel: (973) 383-9484
Fax: (973) 383-8059
www.stillwatertownshipnj.com

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Environmental Commission:
Jack Branagan, Chairman
Paul Klimek, Vice Chairman
Anna Marie Fleck
Ed Szabo
Margaret Emmetts
Cindy Tracey
Mike Nystrom
Kathy Fobes-Jacoby, Alternate #1
Ian Blanchard, Alternate #2
Lisa Chammings, Township Committee Liaison
Kathy Wunder, Secretary

Planning Board:
David Emmons, Chairman
Cathy Feenstra, Vice-Chairman
Alfia Schemm, Secretary

Historical Society of Stillwater Township:
Robert Jacoby

Mayor and Township Committee:
George Scott, Mayor
Timmy Fisher, Deputy Mayor
Charles Gross
Lisa Chammings
Anita Straway

Township Staff:
Lynda Knott, Municipal Clerk

TABLE OF CONTENTS

TABLES

FIGURES

Maps

Cover Photographs:

Top: Trout Brook Wildlife Management Area
Center: Trout Brook Wildlife Management Area
Bottom: Quick Pond

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 best known feature of the Stillwater area is probably Swartswood Lake State Park, but there are myriad treasures throughout the rolling hills and three villages in that corner of Sussex County."
--Jane Dobosh, Stillwater, New Jersey's Great Northwest Skylands

Located along the western edge of Sussex County and bordering the Delaware Water Gap National Recreation Area, Stillwater Township is a historic farming community and former vacation spot for visitors from Brooklyn, New York. Approximately 28.5 square miles in size, it is located 50 miles from New York City. Its neighbors are Walpack Township to the northwest, Hampton Township to the northeast, Fredon Township to the southeast and Frelinghuysen and Hardwick Townships, in Warren County, to the southwest.

The Township has many beautiful lakes and ponds that provide important wildlife habitat and offer excellent recreational opportunities for the public. Agriculture is the way of life for the majority of residents in Stillwater Township. Even those not actively involved in farming typically move to Stillwater for the rural, agricultural way of life. Historically, the first residents were farmers, beginning with the German settlers who cleared the land in the mid-1700s to set up their farms and homes. The historic sites within the community, as well as the farmland, numerous parks, camps and trails, are enriched by Stillwater's diverse and abundant natural resource base.

Stillwater Township's original Environmental Resources Inventory (ERI) was completed in 1998. The Township has undertaken this 2014 report to provide an update to the 1998 document.

The *Environmental Resource Inventory (ERI) Update* is based on available data from federal and state resources, as well as municipal resources. 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*. *Map 1* in the *Maps* section is the base map for this report, identifying the roadway system for the municipality. 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.

GEOLOGY

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. Stillwater Township is located in the Valley and Ridge Province.

The Valley and Ridge Physiographic Province in New Jersey covers an area of about 530 square miles and encompasses the land west of the Highlands Province up to the Delaware River. This region is primarily underlain by sedimentary rocks deposited in and along the coast of ancient seas from 540 to 400 million years ago. These sedimentary rocks, tilted, folded, and fractured during past mountain-building events to form parallel to subparallel northeast trending belts that are younger towards to the northwest. This congruent alignment and the varied susceptibility of the rocks to erosion have resulted in a very distinctive, northeasterly topographic grain that consists of long linear valleys and ridges. Based on similarity of topography, bedrock, and geographic setting, New Jersey's Valley and Ridge consists of three distinct physiographic regions: Kittatinny Valley, Kittatinny Mountain, and Delaware Valley which includes Wallpack Ridge and Wallpack Valley. Stillwater Township falls primarily within the Kittatinny Valley region.

The Kittatinny Valley is the broad lowland between the New Jersey Highlands and Kittatinny Mountain. Erosion of dolomite, limestone, slate, siltstone, and sandstone, all of the Lower Paleozoic age and glacial modification have given the valley a varied topography. Dolomite and limestone, rocks that are readily soluble, typically underlie the Paulins Kill, Pequest, and Wallkill River Valleys. The land surface is very rugged, consisting of many small rocky knolls and ridges, sinkholes, and streamless valleys. Springs are common and in places large, irregular depressions cover the valley floor. The largest of these depressions, Swartswood, Newton Meadows, and Great Meadows were formed by the extensive dissolution of carbonate bedrock and by glacial scour. Glacial lake deposits of silt, clay, sand, and gravel laid down during the last ice age about 20,000 years ago, fill these karst basins, and many parts of the river valleys. (*NJGS Information Circular, Geologic History of New Jersey's Valley and Ridge Physiographic Province)*

Bedrock Geology

The bedrock of Stillwater Township is primarily sedimentary rock formed during the Paleozoic Age formed somewhere between 600 to 430 million years before present. These sediments were initially laid down horizontally but while the Appalachian Mountain were formed these rock formation became deeply folded and tilted relative to their initial form. (*1998 Environmental Resource Inventory*)

The geology of Stillwater Township can be classified into two layers: bedrock geology and surficial geology. Bedrock geology is the consolidated, underlying rock that extends deep into the earth's crust, and surficial geology is the unconsolidated sedimentary materials overlaying bedrock formations, and which are the parent materials for soils. The properties of these layers "determine the physical extent of aquifers and the chemical quality of the 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 storm water and surface runoff, and the stability of foundations for buildings, bridges, tunnels, and other structures". *(New Jersey Geological Survey, Information Circular – Geologic Mapping in New Jersey)*

The *Bedrock Geology* map *(Map 2* in the *Maps* section*)* depicts the distribution of bedrock types within the Township and *Table 1* shows the frequency of occurrence. The predominant bedrock types are the Ramseyburg Member (Omr) (9,084 acres or 50% of the Township) and Allentown Dolomite (OCa) (3,314 acres or 18% of the Township).[1] Both the Ramseyburg Member (Omr) and Bushkill Member (Omb) are part of the larger Martinsburg Formation that traverses the region (Parris 1992).

Table 1. Bedrock Geology for Stillwater Township

Abbrev.	*Geologic Name*	*Lithology*	*Acres*	*Percent*
Obl	Lower Part of Beekmantown Group	dolomite and minor limestone	1,410.39	7.8%
Obu	Upper Part of Beekmantown Group	dolomite and minor limestone	974.87	5.4%
OCa	Allentown Dolomite	dolomite, and less abundant quartzite and shale	3,314.68	18.3%
Oj	Jacksonburg Limestone	shaly limestone, arenaceous limestone, and minor dolomite-cobble conglomerate	351.58	1.9%
Omb	Bushkill Member	shale, slate, less abundant siltstone, and minor dolomite lens	2,842.98	15.7%
Omr	Ramseyburg Member	graywacke sandstone and siltstone, shale and slate	9,084.26	50.3%
Ow	Wantage Sequence	limestone, dolomite, conglomerate, siltstone, and shale	14.26	0.1%
Ss	Shawangunk Formation	sandstone, pebble conglomerate, shale, and quartzite	83.17	0.5%
Source: USGS		**Total:**	**18,076.20**	**100.0%**

[1] *The ArcGIS mapping software calculates the acreages for the municipality based upon the specific dataset being utilized and this can vary slightly for each individual analysis.*

Carbonate Rock Formations

Carbonate Rock Formation are any areas of bedrock primarily composed of limestone or dolostone (dolomite). These rock formations are readily dissolved or precipitated by groundwater that is slightly acidic resulting in cavities within the bedrock. Karst formations are a unique landscape typically found in areas overlying solutioned Carbonate Bedrock and are characterized by sinkholes, caves, springs, disappearing springs and an irregular bedrock surface often with protruding rock. Approximately one third of Stillwater Township is underlain with carbonate rock. These areas are primarily found in a band that originates in the southwestern portion of the Township extending northeast and surrounding Swartswood Lake where examples of a Karst Landscape can be found.

Table 2 shows the Carbonate Rock Formations found in Stillwater Township.

Map 3 in the *Maps* section illustrates the location of these areas.

Table 2. Carbonate Rock Formations in Stillwater Township

Abbrev.	*Geologic Name*	*Acres*	*Percent*	% of Township
Obl	Lower Part of Beekmantown Group	1410.39	23.3%	7.8%
Obu	Upper Part of Beekmantown Group	974.87	16.1%	5.4%
OCa	Allentown Dolomite	3314.68	54.8%	18.3%
Oj	Jacksonburg Limestone	351.58	5.8%	1.9%
	Total	**6051.52**	**100.0%**	**33.5%**

Source: USGS

Surficial Geology

Surficial geology is the unconsolidated materials overlaying bedrock formations. *Table 3* details the surficial geology. The majority of the Township (82% or 14,202 acres) is Kittatinny Mountain Till (Qwtk).

The *Surface Geology* map (*Map 4* in the *Maps* section) details the surficial geology in Stillwater Township.

Table 3. Surficial Geology of Stillwater Township						
Abbrv.	*Name*	*Lithology*	*Age*	*Notes*	*Acres*	*Percent*
Qal	Alluvium	Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray. As much as 20 feet thick.	Holocene and late Pleistocene	Contains variable amounts of organic matter. Deposited in modern floodplains and channels.	647.88	3.7%
Qs	Swamp And Marsh Deposits	Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick.	late Pleistocene and Holocene	Deposited in modern freshwater wetlands.	674.79	3.9%
Qst	Postglacial Stream Terrace Deposits	Sand, silt, pebble-to-cobble gravel; yellowish brown to reddish brown. As much as 20 feet thick.	Holocene and late Pleistocene	Form stream terraces with surfaces up to 40 feet above the modern floodplain. Where more than one terrace occurs, the youngest is designated Qst1; the older, higher terrace is Qst2. Laid down after late Wisconsinan glacial deposition ended.	180.52	1.0%
Qta	Talus	Angular blocks and boulders of gneiss, quartzite, or diabase (depending on location) with little or no matrix material; gray, white, and reddish-purple. As much as 20 feet thick.	late Pleistocene-Holocene	Forms steep aprons at the base of cliffs. Deposited by rock fall after retreat of the late Wisconsinan glacier.	92.25	0.5%
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	Deposited in deltas and other ice-contact landforms in glacial lakes during the late Wisconsinan glaciation.	995.89	5.8%
Qwft	Late Wisconsinan Glaciofluvial Terrace Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 40 feet thick.	late Pleistocene, late Wisconsinan	Form terraces deposited by glacial streams during the late Wisconsinan glaciation.	218.20	1.3%

Table 3. Surficial Geology of Stillwater Township						
Abbrv.	*Name*	*Lithology*	*Age*	*Notes*	*Acres*	*Percent*
Qwfv	Late Wisconsinan Glaciofluvial Plain Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 80 feet thick.	late Pleistocene, late Wisconsinan	Form plains deposited by glacial streams during the late Wisconsinan glaciation.	181.07	1.0%
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	Form knolls and ridges higher than adjacent glacial-lake levels or glaciofluvial plains. Deposited in ice-walled basins during the late Wisconsinan glaciation.	31.20	0.2%
Qwmrk	Late Wisconsinan Recessional Moraine Deposits, Kittatinny Mountain Till	Kittatinny Mountain Till as in unit Qwtk forming morainic ridges and knolls. As much as 80 feet thick.	late Pleistocene, late Wisconsinan	Deposited directly from glacial ice along recessional ice margins during the late Wisconsinan glaciation.	63.27	0.4%
Qwtk	Kittatinny Mountain Till	Clayey silt to silty sand with some to many pebbles and cobbles and few to many boulders; olive brown, brown, gray, reddish brown. As much as 150 feet thick, generally less than 40 feet thick.	late Pleistocene, late Wisconsinan	Deposited directly from glacial ice during the late Wisconsinan glaciation.	14,201.53	82.2%
				Total:	**17,286.59**	**100.0%**
Source: USGS						

GEOGRAPHY & TOPOGRAPHY

The lowest elevations found in Stillwater Township, around 400 feet, are located within the Paulins Kill Valley in the southeast portion of the Township. Stillwater's highest elevations are close to 1,400 feet and can be found on the Kittatinny Ridge that forms the northwestern border of the Township. Other high point locations in Stillwater are unnamed, scattered knolls with elevations between 800 and 900 feet that are found throughout the central part of the Township. (*1998 Environmental Resource Inventory*) These geologic features have relatively steep slopes and have therefore affected development due to risk of soil erosion (See *Map 5, Topography,* in the *Maps* section).

Limiting the disturbance of steep slope is important in preventing soil loss, erosion, excessive storm water 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 amount 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 lead to, or exacerbate, flooding downstream. In addition, an increase in the volume entering streams through runoff means less water is percolating through the soil and back into the groundwater to replenish drinking water supplies or provide base flow for streams during drier periods. 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 decrease a stream's aesthetic appearance.

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. (*NJGS Information Circular, Geologic Mapping in New Jersey*)

Soil Classifications

The official Soil Survey for Sussex County was updated in 2008 by the National 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. 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 both their *soil series* classification(s), such as Arnot-Lordstown, and by characteristics that range from very stony with slopes of 0 to 15 percent to rock outcrop with slopes of 35 to 60 percent.

Each map unit name has an associated abbreviation that offers a shorthand version of the naming/classification system. The 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 phase, with "A" being less steep and "E" being steeper. An example is the Wurtsboro-Swartswood complex, which includes WusBc, WusCc and WusDc.
- The lowercase letters "a", "b" or "c" following these capital letters indicate the degree of stoniness: stony, very stony, and extremely stony, respectively. An example is the Alden series AhbBc and the Hazen Hoosic Complex HdxAb.
- The lowercase letter "t" at the end of the abbreviation indicates "frequently flooded." An example is the Adrian series; AdrAt.

The Soil Survey also categorizes each map unit as one of four *map unit types*: consociations, complexes, associations and undifferentiated groups. The soils in Stillwater fall into the first two groups, which are defined as follows:

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 (8%) of Stillwater's total area. Examples are Alden silt loam (AhbBc) and Catden mucky peat (CatbA).

Complexes (Cx) and **Associations (An)** 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. The major components of an association can be separated at the scale of mapping, while the major components of a complex cannot. Complexes often make up one of the major components of an association. Complexes account for (92%) of Stillwater's total area. Some examples of Complexes in Stillwater are the Nassau-Manlius Complex (NauCh) and the Wurtsboro-Swartswood Complex (WusCc).

The soils types of Stillwater Township are shown in *Map 6* in the *Maps* section. *Table 4* identifies the soils in Stillwater Township. *Table 5* identifies the major soil series table and provides descriptions to give further information about these soils.

Table 4. Soils of Stillwater Township

Abbrv.	*Map Unit (MU) Name*	*MU Type*	*Acres*	*% of Twsp*
AhbBc	Alden silt loam, 0 to 8 percent slopes, extremely stony	Cn	247.3537	1.37%
AruCh	Arnot-Lordstown complex, 0 to 15 percent slopes, very rocky	Cx	8.0554	0.04%
ArvD	Arnot-Lordstown-Rock outcrop complex, 15 to 35 percent slopes	Cx	70.6300	0.39%
ArvE	Arnot-Lordstown-Rock outcrop complex, 35 to 60 percent slopes	Cx	69.9422	0.39%
CatbA	Catden mucky peat, 0 to 2 percent slopes	Cn	210.1237	1.16%
FdwB	Farmington-Wassaic-Rock outcrop complex, 0 to 8 percent slopes	Cx	953.6263	5.28%
HdxAb	Hazen-Hoosic complex, 0 to 3 percent slopes, very stony	Cx	198.2889	1.10%
HdxBb	Hazen-Hoosic complex, 3 to 8 percent slopes, very stony	Cx	391.1043	2.16%
HopEb	Hoosic-Otisville complex, 25 to 60 percent slopes, very stony	Cx	29.1288	0.16%
NauBh	Nassau-Manlius complex, 0 to 8 percent slopes, very rocky	Cx	411.6071	2.28%
NauCh	Nassau-Manlius complex, 8 to 15 percent slopes, very rocky	Cx	1771.1781	9.80%
NauDh	Nassau-Manlius complex, 15 to 35 percent slopes, very rocky	Cx	1634.0734	9.04%
NavE	Nassau-Rock outcrop complex, 35 to 60 percent slopes	Cx	413.8297	2.29%
PHG	Pits, sand and gravel	Cn	58.0412	0.32%
RnaF	Rock outcrop-Arnot-Rubble land complex, 60 to 80 percent slopes	Cx	84.9056	0.47%
RnfC	Rock outcrop-Farmington-Galway complex, 8 to 15 percent slopes	Cx	1592.3997	8.81%
RnfD	Rock outcrop-Farmington-Galway complex, 15 to 35 percent slopes	Cx	823.3973	4.56%
SwfCc	Swartswood loam, 8 to 15 percent slopes, extremely stony	Cn	5.4374	0.03%
SwfDc	Swartswood loam, 15 to 35 percent slopes, extremely stony	Cn	39.9132	0.22%
USFARC	Urban land-Farmington-Rock outcrop complex, 0 to 15 percent slopes	Cx	212.8954	1.18%
USFARD	Urban land-Farmington-Rock outcrop complex, 0 to 35 percent slopes	Cx	72.0100	0.40%
USFAWB	Urban land-Farmington-Wassaic complex, 0 to 8 percent	Cx	63.4022	0.35%

Table 4. Soils of Stillwater Township				
Abbrv.	*Map Unit (MU) Name*	*MU Type*	*Acres*	*% of Twsp*
	slopes			
USNAMC	Urban land-Nassau-Manlius complex, 0 to 15 percent slopes	Cx	9.5901	0.05%
USWUSB	Urban land-Wurtsboro-Swartswood complex, 0 to 8 percent slopes	Cx	22.9305	0.13%
WATER	Water	Cn	901.9399	4.99%
WusBc	Wurtsboro-Swartswood complex, 0 to 8 percent slopes, extremely stony	Cx	2825.0626	15.64%
WusCc	Wurtsboro-Swartswood complex, 8 to 15 percent slopes, extremely stony	Cx	3159.2347	17.49%
WusDc	Wurtsboro-Swartswood complex, 15 to 35 percent slopes, extremely stony	Cx	1786.3877	9.89%
		Total Land	18066.4890	100.00%
Source: NRCS Web Soil Survey				

Major Soil Series

The three most prevalent soil series in Stillwater Township account for approximately 80% of the total land area with 20% of the Township comprised of soils series that each account for less than 10% of the total acreage. Urban Land and Water from the table above are not considered soil series and are excluded.

The ***Wurtsboro-Swartswood Series*** accounts for roughly 43% of the township, covering 7,771 acres. The second most prevalent soil series is the ***Nassau-Manlius Series*** which covers 4,231 acres or 23% of the Township. ***Rock Outcrops*** are third, covering 2,500 acres, or 14% of Stillwater.

The soils within each series vary in characteristics. For example, in the Nassau-Manlius Series, the characteristics range from very rocky to rock outcrop and from 0% slope to 60% slope. The major soil series *Table 5* summarizes individual soil types within each series and the *Soil Series Map (Map 6 in the Maps Section)* plots their locations.
The following are descriptions of the major soil series in Stillwater Township, abstracted from the NRCS Soil Survey:

Wurstboro-Swartswood – The Wurstboro-Swartswood series consists of deep and very deep well drained and moderately well drained soils formed in *till* on irregular hilly glaciated topography. They are relatively shallow to a fragipan, or dense, hard subsoil. In Stillwater, slope ranges from 0-35% but commonly is 8-15%. *Permeability*, how well water can flow through, is moderately high to high above the fragipan and moderately low to moderately high in the fragipan. Mean annual temperature ranges from 45-52 degrees Fahrenheit and mean annual precipitation ranges from 34-46 inches. The frost free season ranges from 130-150 days.

Rockaway soils developed in boulder quartzose course-loamy drift derived from gray and brown quartzite, conglomerate and sandstone. Most areas are nearly level to very steep with stones and boulders common at the surface in wooded areas. Natural vegetation is largely woodland dominated by maple, beech and birch.

Depth to bedrock varies from 3.5 to 20 feet. Depth to the fragipan is 20 to 36 inches and the thickness ranges from 40 to 70 inches. Rock fragments range from 3% to 40% of the soil's makeup above the fragipan and vary from less than 4 inches to boulders in size. Reaction is strongly acid to extremely acid throughout, except where limed.

Wurtsboro-Swartswood soils are found in northwestern New Jersey, northeastern Pennsylvania and southeastern New York. The Wurtsboro-Swartswood series is a major soil in Stillwater Township and covers 43% of the total area. This soil type covers much of the Northwestern edge of the Township.

Nassau-Manlius - The Nassau-Manlius Complex series consists of shallow, somewhat excessively drained soils that formed in till derived from slate and shale. They occur on nearly level to steep slopes of bedrock controlled, glacially modified landforms. Slopes range from 0 to 70 percent. In Stillwater the slopes are most commonly between 8 and 35%. Mean annual temperature ranges from 45 to 51 degrees Fahrenheit and mean annual precipitation ranges from 30 to 50 inches. Frost free period ranges from 130 to 190 days. Nassau-Manlius soils are formed in residuum derived from slate and shale. A large acreage of Nassau-Manlius soils are in woodlots with a large portion in idle or unimproved pasture, areas associated with deeper soils are used for growing corn, oats and hay. In forested areas sugar maple, red oak, American beech and other hardwoods are prominent with Hemlocks common on north-facing slopes.

Depth to solid bedrock ranges from 10 to 40 inches. Rock fragments range from 10 to 70 percent by volume throughout the soil. Rock fragment sizes commonly range from channers to flagstones. Rock fragments on the soil surface range from very stony to extremely stony. The soil is very strongly acid or strongly acid unless limed.

Nassau-Manlius soils are found in northern New Jersey, Vermont, Massachusetts and New York. This is another major soil in Stillwater Township and comprises 23% of the total area. This soil type can be found in the central part of the township extending southwest from Swartswood Lake.

Rock Outcrops- These areas are simply places where the bedrock is exposed with very little soil coverage. Approximately, 14% of Stillwater Township has exposed rock outcrops.

Complete soil series descriptions can be found on the NRCS site at: https://soilseries.sc.egov.usda.gov/osdname.asp

Soil Characteristics

Agricultural Soils

Prime Farmland is defined by the USDA as land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage and oilseed crops. This classification of soil accounts for over 3% of the land in Stillwater. Areas of Prime Farmland in Stillwater Township include very stony soils with slopes of 8% or less in the Hazen-Hoosic complex. Farmlands of Statewide Importance contain soils that are also highly productive under the right circumstances but not considered Prime Farmland, there are no occurrences of these soils in Stillwater.

Farmland of Unique Importance can be used for the production of specific high value food and fiber crops (ex. Cranberries, fruits & vegetables, etc.) but not considered Prime Farmland. This type of soil accounts for about 1% of the area of Stillwater and is the Catden Mucky Peat soil type. In Stillwater Township areas of ideal soils or Agriculture can be found along the Paulinskill in the southeastern portion of the township and in various pockets in the northwestern part of the township. Altogether the soils rated for Agricultural Use account for less than 5% of Stillwater's total area (*Table 6*).

Table 6. Soils Rated for Agricultural Use

Arability Potential	*Acres*	*% of Twsp*
All Areas are Prime Farmland	589.3931	3.26%
Farmland of Statewide Importance	0.0000	0.00%
Farmland of Unique Importance	210.1237	1.16%
Not Prime Farmland	16365.0323	90.58%
Water	901.9399	4.99%
Total	**18066.4890**	**100.00%**

Source: NRCS Web Soil Survey

Table 5. Soil Series of Stillwater Township						
Abbrv.	*Map Unit (MU) Name*	*Type*	*Farmland Type*	*Erodibility (K-Factor)*	*Acres*	*Series %*
Alden Silt Series						
AhbBc	Alden silt loam, 0 to 8 percent slopes, extremely stony	Cn	Not Prime Farmland	Potentially Highly Erodible	247.3537	
				Total Alden Silt	**247.3537**	**1.37%**
Catden Series						
CatbA	Catden mucky peat, 0 to 2 percent slopes	Cn	Farmland of Unique Importance	Not Highly Erodible	210.1237	
				Total Catden	**210.1237**	**1.16%**
Farmington-Wassaic Series						
FdwB	Farmington-Wassaic-Rock outcrop complex, 0 to 8 percent slopes	Cx	Not Prime Farmland	Potentially Highly Erodible	953.6263	
				Total Farmington-Wassaic	**953.6263**	**5.28%**
Hazen-Hoosic Series						
HdxAb	Hazen-Hoosic complex, 0 to 3 percent slopes, very stony	Cx	Prime Farmland	Not Highly Erodible	198.2889	
HdxBb	Hazen-Hoosic complex, 3 to 8 percent slopes, very stony	Cx	Prime Farmland	Potentially Highly Erodible	391.1043	
				Total Hazen Hoosic	**589.3931**	**3.26%**
Nassau- Manlius Series						
NauBh	Nassau-Manlius complex, 0 to 8 percent slopes, very rocky	Cx	Not Prime Farmland	Potentially Highly Erodible (.32)	411.6071	
NauCh	Nassau-Manlius complex, 8 to 15 percent slopes, very rocky	Cx	Not Prime Farmland	Highly Erodible Land (.32)	1771.1781	
NauDh	Nassau-Manlius complex, 15 to 35 percent slopes, very rocky	Cx	Not Prime Farmland	Highly Erodible Land (.32)	1634.0734	
NavE	Nassau-Rock outcrop complex, 35 to 60	Cx	Not Prime	Highly Erodible Land	413.8297	

Table 5. Soil Series of Stillwater Township						
Abbrv.	*Map Unit (MU) Name*	*Type*	*Farmland Type*	*Erodibility (K-Factor)*	*Acres*	*Series %*
	percent slopes		Farmland			
				Total Nassau-Manlius	**4230.6883**	**23.42%**
Rock Outcrop Series						
RnaF	Rock outcrop-Arnot-Rubble land complex, 60 to 80 percent slopes	Cx	Not Prime Farmland	Highly Erodible Land	84.9056	
RnfC	Rock outcrop-Farmington-Galway complex, 8 to 15 percent slopes	Cx	Not Prime Farmland	Highly Erodible Land	1592.3997	
RnfD	Rock outcrop-Farmington-Galway complex, 15 to 35 percent slopes	Cx	Not Prime Farmland	Highly Erodible Land	823.3973	
				Total Rock Outcrop	**2500.7026**	**13.84%**
Urban Land Series						
USFARC	Urban land-Farmington-Rock outcrop complex, 0 to 15 percent slopes	Cx	Not Prime Farmland	Potentially Highly Erodible	212.8954	
USFARD	Urban land-Farmington-Rock outcrop complex, 0 to 35 percent slopes	Cx	Not Prime Farmland	Highly Erodible Land	72.0100	
USFAWB	Urban land-Farmington-Wassaic complex, 0 to 8 percent slopes	Cx	Not Prime Farmland	Potentially Highly Erodible	63.4022	
USNAMC	Urban land-Nassau-Manlius complex, 0 to 15 percent slopes	Cx	Not Prime Farmland	Potentially Highly Erodible	9.5901	
USWUSB	Urban land-Wurtsboro-Swartswood complex, 0 to 8 percent slopes	Cx	Not Prime Farmland	Potentially Highly Erodible	22.9305	
				Total Urban	**380.8281**	**2.11%**
Wurtsboro-Swartswood Series						
WusBc	Wurtsboro-Swartswood complex, 0 to 8 percent slopes, extremely stony	Cx	Not Prime Farmland	Potentially Highly Erodible	2825.0626	
WusCc	Wurtsboro-Swartswood complex, 8 to 15 percent slopes, extremely stony	Cx	Not Prime Farmland	Highly Erodible Land	3159.2347	

Table 5. Soil Series of Stillwater Township						
Abbrv.	*Map Unit (MU) Name*	*Type*	*Farmland Type*	*Erodibility (K-Factor)*	*Acres*	*Series %*
WusDc	Wurtsboro-Swartswood complex, 15 to 35 percent slopes, extremely stony	Cx	Not Prime Farmland	Highly Erodible Land	1786.3877	
				Total Wurstboro Swartswood	**7770.6851**	**43.01%**
Other						
AruCh	Arnot-Lordstown complex, 0 to 15 percent slopes, very rocky	Cx	Not Prime Farmland	Highly Erodible Land	8.0554	
ArvD	Arnot-Lordstown-Rock outcrop complex, 15 to 35 percent slopes	Cx	Not Prime Farmland	Highly Erodible Land	70.6300	
ArvE	Arnot-Lordstown-Rock outcrop complex, 35 to 60 percent slopes	Cx	Not Prime Farmland	Highly Erodible Land	69.9422	
HopEb	Hoosic-Otisville complex, 25 to 60 percent slopes, very stony	Cx	Not Prime Farmland	Highly Erodible Land	29.1288	
PHG	Pits, sand and gravel	Cn	Not Prime Farmland	Not Highly Erodible	58.0412	
SwfCc	Swartswood loam, 8 to 15 percent slopes, extremely stony	Cn	Not Prime Farmland	Potentially Highly Erodible	5.4374	
SwfDc	Swartswood loam, 15 to 35 percent slopes, extremely stony	Cn	Not Prime Farmland	Highly Erodible Land	39.9132	
WATER	Water	Cn	Not Prime Farmland		901.9399	
				Total Other	**1183.0880**	**6.55%**
				Total Land	**18066.4890**	**100.00%**
Source: NRCS Web Soil Survey						

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 shown in *Table 5* for each soil type. 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. In Stillwater the only soil K-values available is 0.32 which represent relatively slight risks of erosion for the Nassau-Manlius Complex soils. However, the slope must also be considered in the erodibility potential and the *Erodibility Potential of Soils in Stillwater Township* table below shows the percentages of soils within Stillwater characterized as highly erodible (68.42%), potentially highly erodible (28.80%), and not highly erodible (2.78%). These classifications are determined by the slope that the soils are found upon with the steeper slopes being more susceptible to erosion than shallow slopes.

Table 7. Erodibility Potential of Soils in Stillwater Township

Erodibility of Rated Land	*Acres*	*% of Rated Land*
Highly Erodible Land	11,483.0758	68.42%
Potentially Highly Erodible Land	4,834.1914	28.80%
Not Highly Erodible Land	466.4538	2.78%
Total Rated Land*	**16,783.7210**	**100.00%**

**Rated land does not include water or urban land.* *Source: NRCS Web Soil Survey*

Hydric Soils

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation (NRCS). Hydric soils are an important element of wetland areas and naturally support wetland vegetation. If a soil is classifiable as hydric, Federal/State Wetland Law may restrict land use due to the relationship of hydric soils to wetlands and wetland preservation. The NRCS Soil Survey for Sussex County reveals that nearly 3% of Stillwater's soils are hydric. These soils represent depressions and are typically found in small pockets in the northwestern part of the Township. The hydric soils, their acreage and typical landform association can be found in *Table 8.*

Table 8. Hydric Soils of Stillwater Township					
Abbrv.	**Map Unit (MU) Name**	**Typical Landform**	**Acres**	**% Hydric Soils**	**% of All Soils***
AhbBc	Alden silt loam, 0 to 8 percent slopes, extremely stony	Depressions	247.3537	54.07%	1.44%
CatbA	Catden mucky peat, 0 to 2 percent slopes	Depressions	210.1237	45.93%	1.22%
			457.4774	**100.00%**	**2.67%**
		Total Soils Excluding Water	**17164.5491**		
Source: NRCS Web Soil Survey					

Other Soil Characteristics and Limitations for Use

Other characteristics of soil that determine suitability for development include 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 a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations." The *Soil Limitations Table* (*Table 10*) explores the following characteristics:

Depth to restrictive feature is the vertical distance from the soil surface to the upper boundary of a restrictive layer. The restrictive feature 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 that can restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, fragipan (dense slowly permeable subsoil layers) and frozen layers. Though not shown in this table, information on the hardness and thickness of the restrictive feature, 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. These classes range from excessively drained (water is removed very rapidly and the soils are commonly course-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 depths to a saturated zone in the soil, known as the 'water table', that occurs during several months during most years. A saturated zone that lasts for less than a month is not considered a water table.

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 inches of water per inch of soil in 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 or irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Ponding is standing water in a closed depression. Unless a drainage system is installed the water is removed only by deep percolation, transpiration, or evaporation or by a combination of these processes. Ponding frequency classes are based on the number of times that ponding occurs over a given period and is expressed as none, rare, occasional, and frequent and are defined as follows:

- None - Ponding is not probable. The chance of ponding is nearly 0% in any year.
- Rare - Ponding is unlikely but possible under unusual weather conditions. The chance of ponding is nearly 0% to 5% in any year.
- Occasional - Ponding occurs, on the average, once or less in 2 years. The chance of ponding is 5%-50% in any year.
- Frequent - Ponding occurs, on the average, more than once in 2 years. The chance of ponding is more than 50% in any year.

Flooding is the temporary inundation of an area caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after a 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 and are defined as follows:

- None- Flooding is not probable. The chance of flooding is nearly 0% in any year. Flooding occurs less than once in 500 years.
- Very Rare- Flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1% in any year.
- Rare- Flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1% to 5% in any year.
- Occasional- Flooding occurs infrequently under normal weather conditions. The chance of flooding is 5% to 50% in any year.
- Frequent- 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- Flooding is likely to occur very often under normal weather conditions. The chance of flooding is more than 50% in all months of any year.

Frost Action Potential is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses and the subsequent collapse of the soil and loss of strength on thawing (frost heave). 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 can cause damage to pavements, foundations 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 are more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or with 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 tiles 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 a 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 soils in Stillwater are rated very limited (*USDA NRCS*).

Soil Limitations for Building Site Development

Stillwater Township has a number of soils that are rated by the NRCS Web Soil Survey as having no limits or some limits on their ability to support dwellings with or without basements and small commercial buildings.

For the purposes of these ratings, dwellings are defined as single-family houses of three stories or less and small commercial buildings are structures that are less 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 footings 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 on undisturbed soil at a depth of about 7 feet." The ratings for dwellings are based on the

soil properties that affect the capacity of the soil to support a load without movement and on the 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 a cemented pan, and the amount and size of rock fragments. (*NRCS Web Soil Survey*)

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 the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fait 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. (*NRCS Web Soil Survey*)

About 5% of the Township is covered by soil types that are not rated for building dwellings with basements or small commercial structures, 14% is not rated for dwellings without basements these soils are typically rock outcrops, water or sand and gravel pits. A little over 3% of the soils have no limitations for construction of dwellings with and without basements but there is only one soil type that is without limitations for construction of small commercial buildings (HdxAb). Around a third of the land is somewhat limited for construction of dwellings without a basement, approximately 18% of the towns acreage is considered somewhat limited for small commercial buildings and there are no soil types considered somewhat limited for dwellings with basements. The remainder of soils is considered very limited for construction. *Table 9* found below outlines the breakdown of these ratings.

Township Initiatives

The Township revised general ordinances adopted through December 18th 2012 includes a chapter that address soil-related concerns:

- Chapter 338: Soil Removal; requires a permit to be filed prior to removing any soil from the township. Prohibits the removal of any arable soil and requires arable soil to be reapplied where soil has been removed.

Table 9. Soil Limitations for Building Site Development in Stillwater Township			
Rating	*Dwellings without Basements*	*Dwellings with Basements*	*Small Commercial Buildings*
Not Rated	PHG, RnfC, Water Total Acres: 2552.3808 % of Twp: 14.13%	PHG, Water Total Acres: 959.9811 % of Twp: 5.31%	PHG, Water Total Acres: 959.9811 % of Twp: 5.31%
Not Limited	HdxAb, HdxBb Total Acres: 589.3931 % of Twp: 3.26%	HdxAb, HdxBb Total Acres: 589.3931 % of Twp: 3.26%	HdxAb Total Acres: 198.2889 % of Twp: 1.10%
Somewhat Limited	SwfCc, USWUSB, WusBc, WusCc Total Acres: 6012.6652 % of Twp: 33.28%	None Total Acres: 0 % of Twp: 0.00%	HdxBb, USWUSB, WusBc Total Acres: 3239.0974 % of Twp: 17.93%
Very Limited	All Other Soils Total Acres: 8912.0498 % of Twp: 49.33	All Other Soils Total Acres: 16517.11 % of Twp: 91.42%	All Other Soils Total Acres: 13669.1216 % of Twp: 75.66%
Source: NRCS Web Soil Survey			

Table 10. Soil Limitations of Stillwater Township									
Abbrv.	*Depth to Restrictive Feature (in)*	*Drainage*	*Capacity to Transmit Water (in/hr)*	*Depth to Water Table (in)*	*Available Water Capacity (in)*	*Ponding/ Flooding*	*Frost Action Potential*	*Risk of Corrosion Steel-Concrete*	*Septic Limitations*
AhbBc	>80	Very Poorly Drained	ML-MH (0.06-0.57)	0	H (9.9)	Frequent/None	H	H-L	Very Limited
AruCh	10-20 to Lithic Bedrock	Somewhat Excessively	VL-MH (0.00-0.20)	>80	VL (2.1)	None/None	M	L-H	Very Limited
ArvD	10-20 to Lithic Bedrock	Somewhat Excessively	VL-MH (0.00-0.20)	>80	VL (2.1)	None/None	M	L-H	Very Limited
ArvE	10-20 to Lithic Bedrock	Somewhat Excessively	VL-MH (0.00-0.20)	>80	VL (2.1)	None/None	M	L-H	Very Limited
CatbA	>80	Very Poorly Drained	MH-H (0.20-5.95)	0	VH (26.8)	Frequent/None	H	H-L	Very Limited
FdwB	10-20 to Lithic Bedrock	Well Drained	VL-MH (0.00-0.60)	>80	VL (2.2)	None/None	M	L-M	Very Limited
HdxAb	>80	Well Drained	MH-H (0.57-5.95)	>80	L (4.9)	None/None	M	L-L	Very Limited
HdxBb	>80	Well Drained	MH-H (0.57-5.95)	>80	L (4.9)	None/None	M	L-L	Very Limited
HopEb	>80	Somewhat Excessively	H-VH (1.98-19.98)	>80	L (4.5)	None/None	L	L-H	Very Limited

Table 10. Soil Limitations of Stillwater Township									
Abbrv.	*Depth to Restrictive Feature (in)*	*Drainage*	*Capacity to Transmit Water (in/hr)*	*Depth to Water Table (in)*	*Available Water Capacity (in)*	*Ponding/ Flooding*	*Frost Action Potential*	*Risk of Corrosion Steel-Concrete*	*Septic Limitations*
NauBh	10-20 to Lithic Bedrock	Somewhat Excessively	VL-ML (0.00-0.06)	>80	VL (1.7)	None/None	M	L-H	Very Limited
NauCh	10-20 to Lithic Bedrock	Somewhat Excessively	VL-ML (0.00-0.06)	>80	VL (1.7)	None/None	M	L-H	Very Limited
NauDh	10-20 to Lithic Bedrock	Somewhat Excessively	VL-ML (0.00-0.06)	>80	VL (1.7)	None/None	M	L-H	Very Limited
NavE	10-20 to Lithic Bedrock	Somewhat Excessively	VL-ML (0.00-0.06)	>80	VL (1.9)	None/None	M	L-H	Very Limited
PHG								L-H	Not Rated
RnaF	0 to Lithic Bedrock		VL-MH (0.00-0.20)		VL (0.0)		None		Very Limited
RnfC	0 to Lithic Bedrock		VL-MH (0.00-0.60)		VL (0.0)		M	L	Very Limited
RnfD	0 to Lithic Bedrock		VL-MH (0.00-0.60)		VL (0.0)		M	L	Very Limited
SwfCc	20-36 to Fragipan	Well Drained	ML-MH (0.06-0.57)	20-36	VL (2.4)	None/None	M	L-H	Very Limited
SwfDc	20-36 to Fragipan	Well Drained	ML-MH (0.06-0.57)	20-37	VL (2.4)	None/None	M	L-H	Very Limited

Table 10. Soil Limitations of Stillwater Township									
Abbrv.	*Depth to Restrictive Feature (in)*	*Drainage*	*Capacity to Transmit Water (in/hr)*	*Depth to Water Table (in)*	*Available Water Capacity (in)*	*Ponding/ Flooding*	*Frost Action Potential*	*Risk of Corrosion Steel-Concrete*	*Septic Limitations*
USFARC	6-20 to Lithic Bedrock		VL-MH (0.00-0.60)		VL (0.0)		None	L-M	Very Limited
USFARD	6-20 to Lithic Bedrock		VL-MH (0.00-0.60)		VL (0.0)		None	L-M	Very Limited
USFAWB	6-20 to Lithic Bedrock		VL-MH (0.00-0.60)		VL (0.0)		M	L-M	Very Limited
USNAMC	6-20 to Lithic Bedrock		VL-MH (0.00-0.60)		VL (0.0)		None	L-M	Very Limited
USWUSB	6-48 to Fragipan		ML-MH (0.06-0.20)	15-26	VL (0.0)		M	L-H	Very Limited
WATER									Not Rated
WusBc	17-28 to Fragipan	Moderately Well	ML-MH (0.06-0.20)	15-26	L (3.1)	None/None	M	H-H	Very Limited
WusCc	17-28 to Fragipan	Moderately Well	ML-MH (0.06-0.20)	15-26	L (3.1)	None/None	M	H-H	Very Limited
WusDc	17-28 to Fragipan	Moderately Well	ML-MH (0.06-0.20)	15-26	L (3.1)	None/None	M	H-H	Very Limited
Source: NRCS Web Soil Survey; accessed 1/06/14									

AIR

Air Quality: 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.

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 New Jersey Department of Environmental Protection (NJDEP) Division of Air Quality (DAQ) and its Bureau of Air Monitoring (BAM), which monitors the State's ambient air monitoring network.

Regional / Local Statistics

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. (*www.njaqinow.net*) 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 1990-2010, total emissions of these air pollutants have decreased by more than 41% nationally. (*EPA*)

In New Jersey, according to the NJDEP DAQ website, air quality has improved significantly over the last 40 years since the first Earth Day, in 1970, but exceeds the current NAAQS standards for ozone throughout the state and for fine particulates in urban areas (13 counties). New Jersey has attained sulfur dioxide (except for a portion of Warren County), lead, carbon monoxide, and nitrogen dioxide standards.

Additional air pollutants that may cause adverse health effects but are not criteria pollutants are referred to as Hazardous Air Pollutants (HAPs) or air toxics. The NJDEP DAQ also regulates emissions of these HAPs. For many toxins the State has set its own standards, with stricter requirements than the EPA.

Criteria Pollutants

Each of the six criteria pollutants is discussed below. Information on national and state standards and localized air monitoring results (using those monitoring stations closest to

Stillwater Township) are provided based on the most recent NJDEP reports available data at the time of publication. In the discussions of the individual criteria pollutants, primary standards are those associated with health effects and secondary standards are based on "welfare" effects (e.g. damage to trees, crops and materials).

Ozone

Ozone (O_3) is defined by the NJDEP *2012 Ozone Summary* 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. Therefore, as a result of the sunlight and heat necessary for ground-level ozone production, measurements are taken between April 1st and October 31st.

The EPA revised National Ambient Air Quality Standards (NAAQS) for ozone in 2008, having determined that the previous standard of 0.08 parts per million (ppm) maximum daily eight-hour averages did not sufficiently protect public health. The revised standard of 0.075 ppm maximum daily 8-hour average went into effect on May 27, 2008. 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.

New Jersey standards are based on 1-hour averaging, with primary standards set at 0.12 ppm and secondary standards set at 0.08 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 NOx. Levels of NOx 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 for the 2010-2012 period, with an overall score between 0.085 and 0.092 ppm. The ozone monitoring stations closest to Stillwater reported levels close to NAAQS for the period 2010-2012, with Columbia WMA in Warren County with insufficient data, Chester in Morris County, exceeding the standard, and Ramapo in Passaic County, meeting the standard. The Chester reporting station recorded 4 days above the standard, and Ramapo and Columbia each reported 1day above the threshold, as shown in *Table 11.*

Table 11. Ozone 2012						
8-hour averages in Parts per Million (ppm) Standard: 0.075 ppm						
Station	*1st*	*2nd*	*3rd*	*4th*	*Avg. of 4th Highest 8-hr Avgs 2010-12*	*# days with 8-hr Avg above 0.075 ppm*
Columbia WMA* (c. 13mi)	0.079	0.07	0.07	0.07		1
Chester (c. 20mi)	0.088	0.09	0.08	0.08	0.078	4
Ramapo (c. 35mi)	0.087	0.08	0.07	0.07	0.075	1
State	0.086	0.084	0.082	0.080	0.081	23
Source: NJDEP 2012 Ozone Summary;						
**Only has 2 years of data reporting and does not have valid design value for 2010-2012*						

Sulfur Dioxide

NJDEP's *2011 Sulfur Dioxide Summary* 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. New Jersey's standards differ slightly from national standards, as shown in *Table 12*.

Table 12. National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide
ppm= parts per million; ppb=part per billion; µg/m³=micrograms per cubic meter

Averaging Period	*Type*	*New Jersey*	*National*[a]
12 – month average	Primary	80 µg/m³ (0.03 ppm)[3]	0.03 ppm
12 – month average	Secondary	60 µg/m³ (0.02 ppm)	---
24 – hour average	Primary	365 µg/m³ (0.14 ppm)	0.14 ppm
24 – hour average	Secondary	260 µg/m³ (0.10 ppm)	---
3 – hour average	Secondary	1300 µg/m³ (0.5 ppm)	0.5 ppm
1 – hour average[b]	Primary	---	75 ppb
a-National standards are block averages rather than moving averages. b-Final rule signed June 2, 2010 and effective on August 23, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hr average at each monitor within area must not exceed 75 ppb.			
Source: NJDEP 2011 Sulfur Dioxide Report			

Regulations requiring the use of low sulfur fuels in New Jersey have been effective in lowering SO_2 concentrations. No monitoring sites recorded exceedances of the primary or secondary SO_2 NAAQ standards during 2011. The last year an exceedance of the national SO_2 standards was recorded in the state was 1980. *Table 13* shows data for the monitoring sites closest to Stillwater that capture SO_2 data.

Table 13. Sulfur Dioxide 2011

parts per billion=ppb; parts per million=ppm

Monitoring Site	*3-year Avg. 99th %-ile of Daily Max 1-Hour Avg (ppb)*	*3-hour Avg Max (ppm)*	*24-hour Avg Max (ppm)*	*12-month Avg Max (ppm)*
Columbia WMA (c. 13 mi)	*	0.107	0.027	0.002
Chester (c. 20 mi)	27	0.052	0.013	0.001

** three year data unavailable*

Source: NJDEP 2011 Sulfur Dioxide Summary

Carbon Monoxide

According to the NJDEP *2011 Carbon Monoxide Summary,* 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 14*). In addition, New Jersey standards are not to be exceeded more than once in any 12-month period.

Table 14. National and New Jersey Ambient Air Quality Standards of Carbon Monoxide
mg/m3 = milligrams per cubic meter; ppm = parts per million

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 2011 Carbon Monoxide Summary

According to the NJDEP report, "carbon monoxide levels have improved dramatically over the past 20 years. The last time the CO standard was exceeded in New Jersey was in January of 1995, and the entire state was officially declared as having attained the CO standard on August 23, 2002." Because on-road vehicle emissions form the major contributor to CO levels, there is a variation throughout the day, with the highest peaks around 7 to 8am, and another, lower but more extended rise between 4 and 8pm.

In 2011, of the CO monitoring stations closest to Stillwater, the highest concentrations were reported in East Orange (see *Table 15*). The highest 8-hour concentration was found in East Orange which also was the highest concentration in the State. All concentrations are well below the national and state standards.

Table 15. Carbon Monoxide - 2011

1-Hour and 8-Hour Averages in Parts per Million (ppm)
1-hour standard = 35 ppm; 8 hour standard = 9 ppm

Monitoring Sites	*Maximum 1-hr Avg*	*2nd Highest 1-hr Avg*	*Maximum 8-hr Avg*	*2nd Highest 8-hr Avg*
*Morristown (c. 26 mi)	1.8	1.6	1.3	1.1
East Orange (c. 40 mi)	3.7	3.6	3.1	2.6

Source: NJDEP 2011 Carbon Monoxide Summary
**Closed in June 2011*

Nitrogen Dioxide

According to the NJDEP *2011 Nitrogen Dioxide Summary*, 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, and 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, it 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 16*). 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 16. National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO_2)			
ppm = Parts per Million; $\mu g/m^3$ = Micrograms per Cubic Meter			
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 µg/m3)
12-month average	Secondary	100 $\mu g/m^3$ (0.053 ppm)	
Annual average	Secondary		0.053 ppm (100 µg/m3)
1-hour average	Primary		0.100 ppm (190 µg/m3)
Source: NJDEP 2011 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. Of the eight reporting stations in 2011, Columbia WMA, Chester, and East Orange are the closest to Stillwater. Chester reported the lowest levels of NO_2 for these three stations while East Orange and Columbia reported the highest levels (*Table 17*). Although NO_2 concentrations score well within the NAAQS, oxides of nitrogen continue to be of concern because of their role in the formation of other pollutants, particularly ozone and fine particles.

Table 17. Nitrogen Dioxide (NO_2) and Nitric Oxide (NO)- 2011				
ppm = parts per million				
National Standards: 1-Hour = 0.100 ppm; 12-Month = 0.053 ppm				
	Nitrogen Dioxide			*Nitric Oxide*
Monitoring Station	*1-hr Avg 2011 98th %-ile*	*1-hr Avg 2009-2011 98th %-ile*	*12-Mo Avg*	*12- Mo Avg*
Columbia WMA (c. 13 mi)	0.050	*	0.022	0.027
Chester (c. 20 mi)	0.041	0.037	0.005	0.000
East Orange (c. 40 mi)	0.062	0.064	0.021	0.015
* Does not have enough data for a 3 year average				
Source: NJDEP 2011 Nitrogen Dioxide Summary				

Particulate Matter

Particulate matter 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. At greatest risk are children, the elderly, and individuals with heart and lung diseases, such as asthma.

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. Although the EPA abandoned standards for TSPs in favor of the smaller PM_{10} and $PM_{2.5}$ particulates, New Jersey still maintains TSP standards, as shown in *Table 18.*

Table 18. Particulate Matter- 2011 National and New Jersey AAQs
$\mu g/m^3$ = micrograms per cubic meter

Standard	*Averaging Period*	*Type*	*New Jersey*	*National*
Total Suspended Particulates (TSP)	12-Month	Primary	75 $\mu g/m^3$	---
	24-Hour	Primary	260 $\mu g/m^3$	---
	12-Month	Secondary	60 $\mu g/m^3$	---
	24-Hour	Secondary	150 $\mu g/m^3$	---
Inhalable Particulates (PM_{10})	Annual	Primary & Secondary	---	50 $\mu g/m^3$
	24-Hour Average	Primary & Secondary	---	150 $\mu g/m^3$
Fine Particulates ($PM_{2.5}$)	Annual	Primary & Secondary	----	15.0 $\mu g/m^3$
	24-Hour Average	Primary & Secondary	----	35 $\mu g/m^3$

Source: NJDEP 2010 Particulate Summary

In 2011, two New Jersey air monitoring stations measured PM_{10}, 24 measured $PM_{2.5}$ and three monitored what is known as smoke shade or the coefficient of haze (COH), for which no standard is set. Several stations use the EPA sanctioned Federal Reference Method (FRM) sampling, based on a 24-hour period, but New Jersey also has additional monitors that continuously measure particulate concentrations (TEOMs), providing the real-time data that the FRM cannot. TEOM data is made available to the public via the Air Quality Index (*www.njaqinow.net*).

In 2011, all areas of the State were in attainment for Inhalable Particulates, PM_{10}. The closer of the two PM_{10} monitoring stations to Stillwater is in Jersey City, where the highest daily concentration was 63$\mu g/m^3$, versus the national standard of 150$\mu g/m^3$, and the annual mean was 30$\mu g/m^3$, versus the national standard of 50$\mu g/m^3$.

All sites met the annual and 24-hour standard for Fine Particulates, $PM_{2.5}$. The sites closest to Stillwater include Columbia WMA, Chester and Morristown which had 9.0 $\mu g/m^3$, 7.9 $\mu g/m^3$ and 8.7 $\mu g/m^3$ annual mean concentrations respectively, well below the National Standard of 15.0 $\mu g/m^3$. These sites were also below the 24-hour National Standard of 35$\mu g/m^3$ with 27.8 in Columbia, 24.4$\mu g/m^3$ in Chester and 21.0$\mu g/m^3$ in Morristown. Sussex County is within attainment for Fine Particle Matter.

Further breaking down the Fine Particulate contribution to air pollution, four stations, including Chester and Elizabeth, measure 39 components. The five highest contributors

are organic carbon, sulfate, nitrate, elemental carbon and sulfur. The Elizabeth Lab reported the highest concentrations of each of these five particulates. Both organic and elemental carbon is sourced primarily from motor vehicles, and the Elizabeth Lab is located in a high traffic area. Chester scored lowest for each of the top 5 components.

"Smoke shade" is an indirect measurement of particles in the atmosphere and is used for daily reporting in the Air Quality Index. Smoke shade is measured as a Coefficient of Haze (COH), with a benchmark set at 2.0. Readings above this level are deemed "Unhealthy for Sensitive Groups." The closest station is Jersey City and the levels reported were well below the benchmark (*Table 19*).

Table 19. Particulate Material 2011

	$PM_{2.5}$ Data			PM_{10} Data		Smoke Shade	
	Measured in µg/m³=micrograms per cubic meter					*Coefficient of Haze*	
Station	*Annual Mean Conc.*	*98th %-ile 24-hr Conc.*	*Number of Unhealthy Air Quality Days*	*Annual Mean Conc.*	*Highest 24-hr Conc.*	*Annual Mean Conc.*	*Highest 24-hr Average*
Jersey City (c. 24mi)	10.8	28.2	3	30	63	0.29	0.9
Columbia WMA (c. 13mi)	9.0	27.8	0				
Chester (c. 20mi)	7.9	24.4					
Morristown (c. 26mi)	8.7	21					

Source NJDEP 2011 Particulate Summary

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 our soils. 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 in 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 $0.15\mu g/m^3$ for a rolling 3 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 (*EPA*).

The NJDEP has data for New Jersey stations monitoring lead in the air from 1990 to 1995-96. Although some stations exceeded NAAQS levels in the early 1990's, all were

below the standards by 1996. Although no stations reporting to the NJDEP BAM were monitoring lead in recent years, a monitoring site is proposed for Paterson (*NJDEP*).

Data available from the EPA includes information for a monitoring site in New Brunswick (see *Figure 1*) that includes statistics through 2007, indicating that levels were close to or above the national standards in several years during the 1999-2006 period.

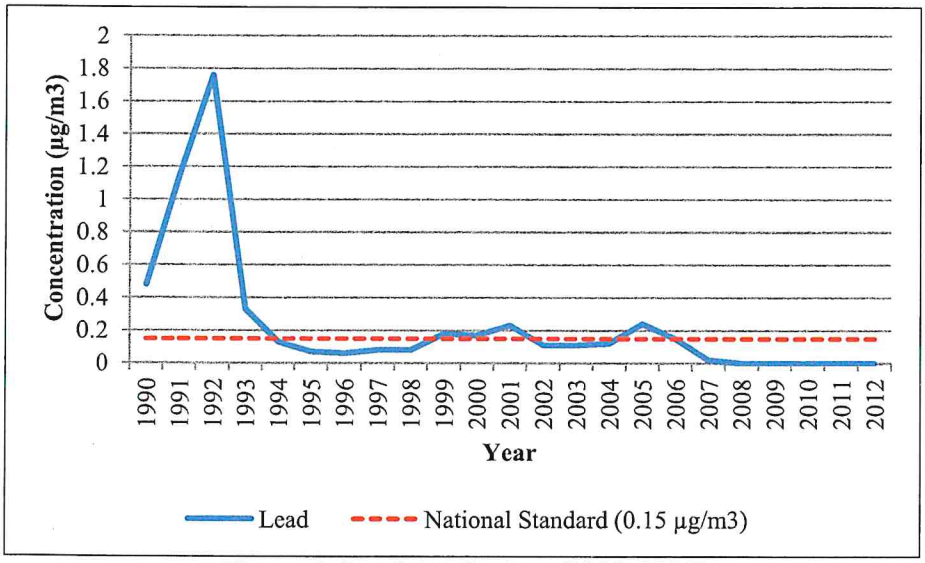

Figure 1. Lead Air Quality (1990-2012)
Source: US EPA

Air Toxics

Almost 200 air toxics have been indentified 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 2011, 12 air toxins measured in Chester exceeded the health benchmarks set by the EPA. These results can be seen in *Table 20.*

Table 20. Air Toxics for Chester above the Health Benchmark			
Pollutant	*Annual mean ($\mu g/m^3$)*	*Health Benchmark ($\mu g/m^3$)*	*Annual Mean Risk Ratio*
Acetaldehyde	1.61	0.45	4
Acrolein	1.19	0.02	59
Acrylonitrile	0.1	0.015	7
Arsenic	0.0003	2.30E-04	1.3
Benzene	0.52	0.13	4
Cadmium	0.002	2.40E-04	10
Carbon tetrachloride	0.62	0.17	4
Chloroform	0.1	0.043	2
Chloromethane	1.23	0.56	2
Chromium	0.004	8.30E-05	48
Cobalt	0.0004	1.10E-04	4
Formaldehyde	2.37	0.077	31
Source: NJDEP 2011 Air Toxics Summary			

The four chemicals with the highest risk ratios reported at the Chester site are Acrolein (59), Chromium (48), Formaldehyde (31) and Cadmium (10).

Acrolein. Acrolein is primarily used as an intermediate in the manufacture of acrylic acid. It can be formed from the breakdown of certain pollutants in outdoor air or from forest and wildfires, as well as vehicle exhaust. In spite of the high levels reported by Chester, Acrolein will be excluded from commentary because of problems with current collection and analysis resulting in uncertain concentrations.

Chromium. Chromium sources of emissions include the combustion of coal and oil, electroplating, vehicles, iron and steel plants, and metal smelters. In Sussex County, background and secondary sources account for 92% of chromium. According to 2005 NATA Stillwater's projected risk ratio is 0.5 to 1.0 times the benchmark and Sussex County is projected at 1.3 times the benchmark. In 2011, Chester reported levels of chromium 48 times the health benchmark.

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. In Sussex County, background sources and secondary sources account for 95% of sources. Stillwater's projected risk ratios according to 2005 NATA range from 10-20 times the benchmark. The countywide score is 19. The 2011 report indicates that Chester reported formaldehyde levels 31 times the health benchmark.

Cadmium. Cadmium emissions are mainly from the burning of fossil fuels such as coal or oil, and the incineration of municipal waste. Cadmium may also be emitted into the air from zinc, lead, or copper smelters. According to the 2005 NATA projections background sources account for 74% of cadmium. The projected risk ratio for Stillwater is under 0.5 times the benchmark and county wide was projected to be 0.3 times the benchmark. According to measurements in 2011 by Chester cadmium levels are at 10 times the health benchmark.

Diesel particulate matter. Diesel Particulate Matter is a mixture of particles and gases that is a component of diesel exhaust. Diesel exhaust is listed as a mobile source air toxic due to the cancer and non-cancer health effects associated with exposure to whole diesel exhaust. According to the 2005 NATA projections Sussex County was projected to be 40 times the benchmark with Stillwater projected to fall between 10 and 50 times the benchmark. In Sussex County, 54% of DPM comes from on-road mobile sources and 46% from non-road sources. NATA estimates that concentrations of diesel particulate matter (DPM) in New Jersey are at levels that potentially pose a higher cancer risk than the other air toxics combined. However, actually measuring diesel in the ambient air is problematic. It is difficult to distinguish particulate matter from diesel engines from other types of particulate matter. Diesel emissions consist of agglomerated and condensed fine particles and gases, onto which are adsorbed potentially hundreds of compounds formed by incomplete combustion, such as polycyclic aromatic hydrocarbons (PAHs) and nitrated PAHs. Some of these very specific compounds have been suggested as indicators for DPM, but sampling technologies and costs continue to be obstacles.

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, ATV's and construction vehicles. Nonpoint sources of emission 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 *Known Contaminated Sites* chapter).

Sussex County's toxic emissions come mostly from on-road and non-point sources, followed by non-road mobile sources, with a very low contribution by point sources (see *Figure 2*).

Other contributors of emissions are background and secondary sources. Background concentrations generally cannot be sourced to current, local emissions. Secondary formation, or atmospheric transformation, refers to chemicals that have been transformed in the air from an air pollutant into another chemical, which may have a different level of toxicity.

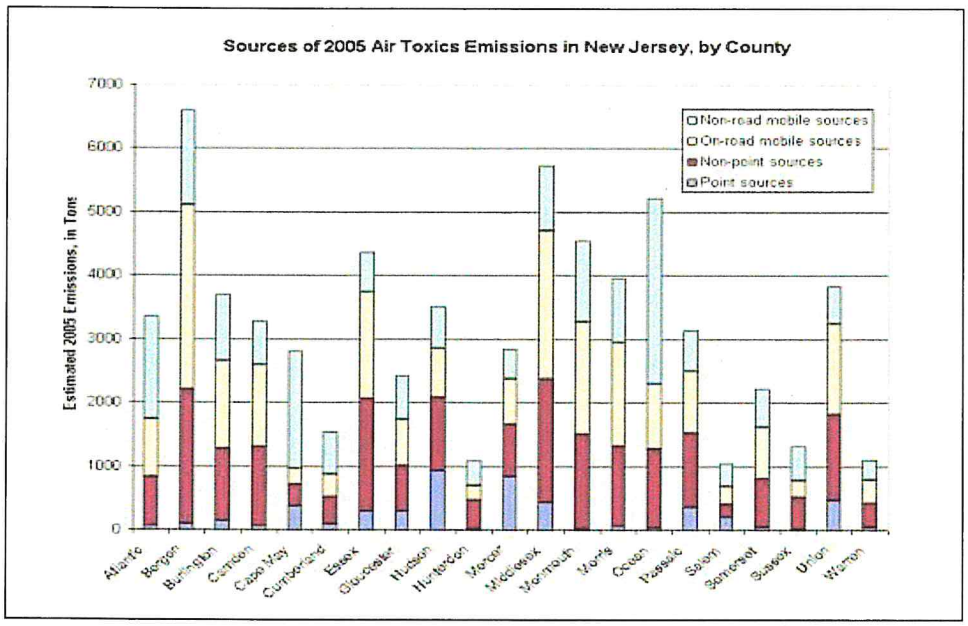

Figure 2. 2005 Air Toxics in New Jersey by County
Source: NJDEP

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.

The Reading Prong, which stretches from Pennsylvania to southern New York State, is particularly uranium rich. As a result of this Uranium rich belt, Sussex County is considered a high risk county for radon presence. Municipalities in the County, including Stillwater Township, rank as Tier 1 (higher radon potential). For more information on radon, visit *http://www.njradon.org/index.htm.*

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, railroad, highway, commercial/industrial, or residential noise and nuisances. (*NJDEP http://www.state.nj.us/dep/enforcement/contact-noise.html*)

In Stillwater Township, restrictions against excessive noise exist in the Town Ordinances. *Chapter 272* states that it is 'unlawful for a person to make, continue or cause to be made or continued any loud, unnecessary or unusual noise or any noise which does or is likely to annoy, disturb, injure or endanger the comfort, repose, health, peace or safety of others.' (*Township of Stillwater Municipal Code*)

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 unreasonable 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. In Stillwater Township municipal code, restrictions against odors include Chapter 289-8 which prohibits smoking in any public parks. (*Township of Stillwater Municipal Code*)

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. Weather phenomena, such as precipitation and solar radiation, 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 Columbia WMA station monitors barometric pressure, relative humidity, temperature, wind direction and wind speed while the Chester meteorological station monitors solar radiation. (*NJDEP DAQ*)

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."

Climate Zone

New Jersey is divided into five climate zones, with Stillwater lying in the Northern Zone. According to the ONJSC publication, "*The Climate of New Jersey*," the Northern Climate Zone usually has the shortest growing season, 155 days. The average date for the last killing spring frost is May 4 and the first frost in the fall occurs around October 7. These dates vary from year to year and from place to place within the region. Valley locations may have killing frosts in mid-September and as late as mid-June. The average number of freeze free days in the northern Highlands is 163. Snow may fall from October 15th to April 30th, and annual snowfall averages 40 to 50 inches. The ONJSC reports a historic median annual snowfall of 35.4 inches at the Sussex weather station based on readings from and1892-2014 and 34 inches in Newton based on readings from 1893-2004. In addition, "The highlands and mountains in this area play a role in making the climate of the Northern Zone different from the rest of the state. For instance, following a cold frontal passage, air forced to rise over the mountains, produces clouds, and even precipitation, while the rest of the state observes clear skies" (*ONJSC*). During the warm season, thunderstorms, many of them spawned in Pennsylvania and New York are responsible for most of the rainfall. Averages of 25 to 35 thunderstorms occur in year and reach a maximum development in the evening. Tropical cyclones are less frequent in Stillwater and other inland areas than along the coast. Tornadoes are infrequent and generally weak (*ONJSC*).

Temperature and Precipitation

The ONJSC maintains temperature and precipitation data from monitoring stations around the state. Some of these records go back to the 1890's. The ONJSC has compiled a northern New Jersey regional report, with values calculated from an average of monthly temperatures. *Figure 3, Figure 4, Figure 5* and *Figure 6* show an overall upward trend in mean temperature between 1895 and 2013 and this region is both warmer and wetter than in the preceding periods. The long-term mean temperature average is 50.9°F and the long-term mean total precipitation is 46.69 inches for the period 1895-2013.

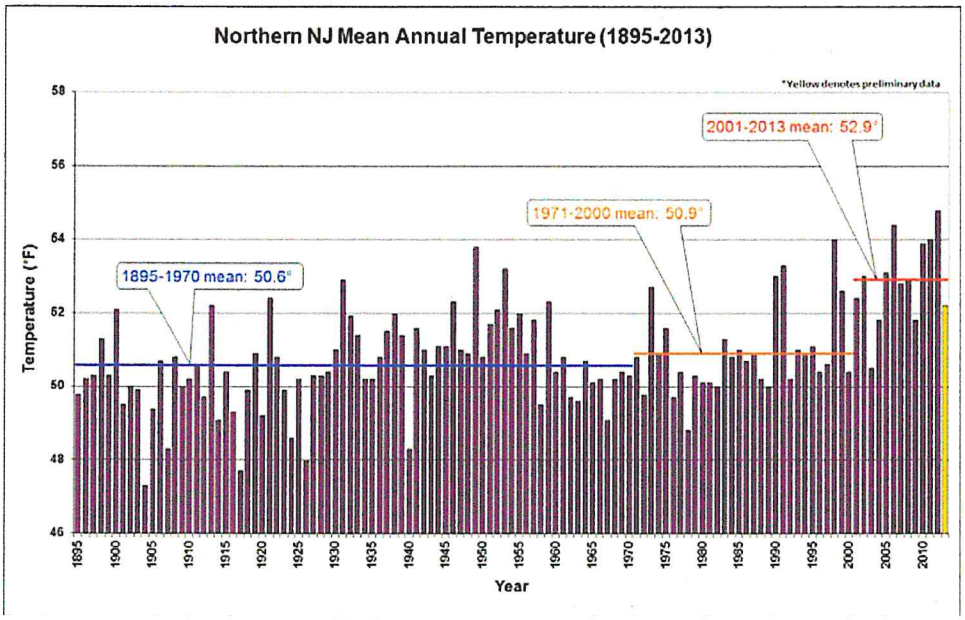

Figure 3. Northern New Jersey Mean Annual Temperature (1895-2013) (ONJSC)

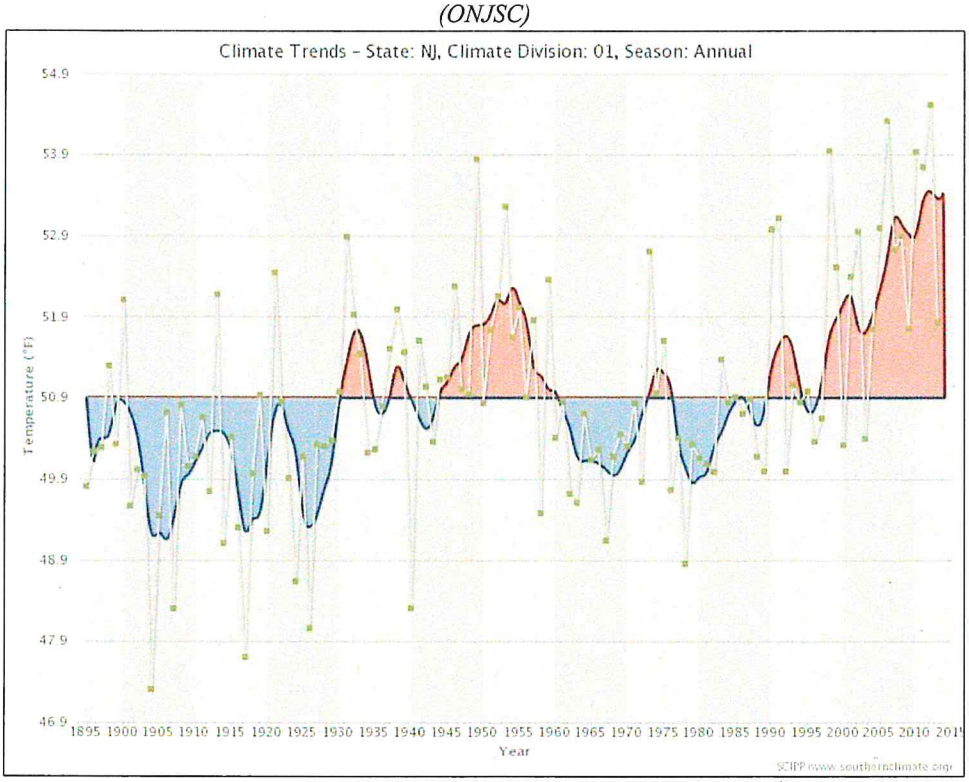

Figure 4. Northern New Jersey Temperature Trends (1895-2013) (SCIPP)

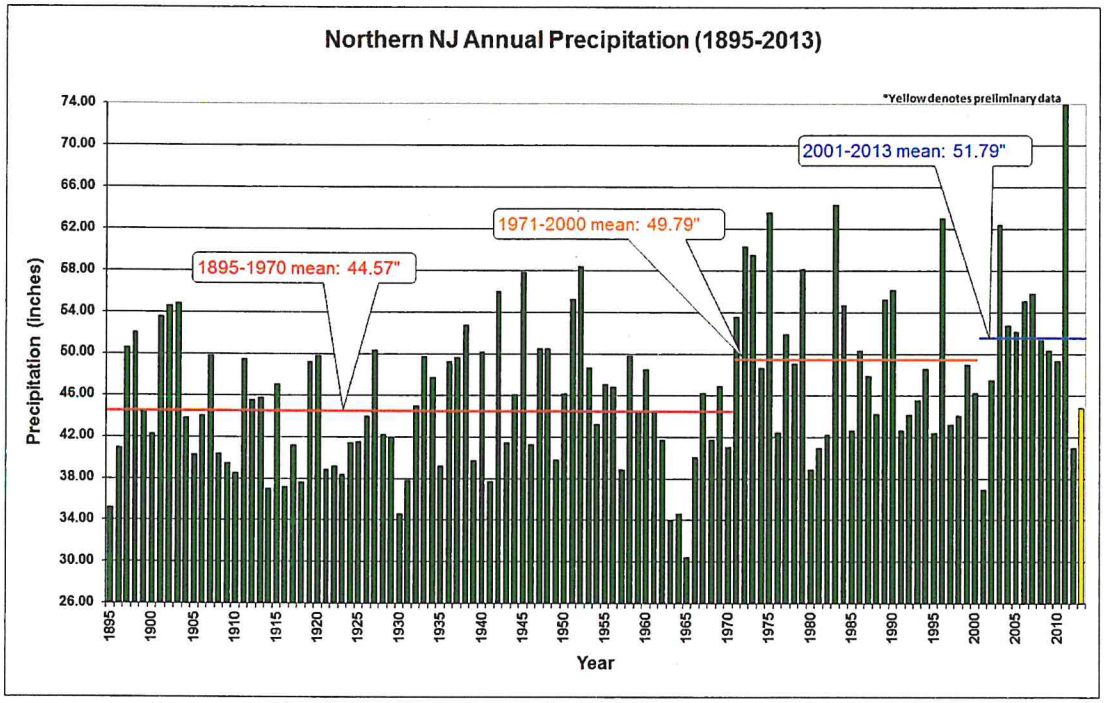

Figure 5. Northern New Jersey Annual Precipitation (1895-2013) (ONJSC)

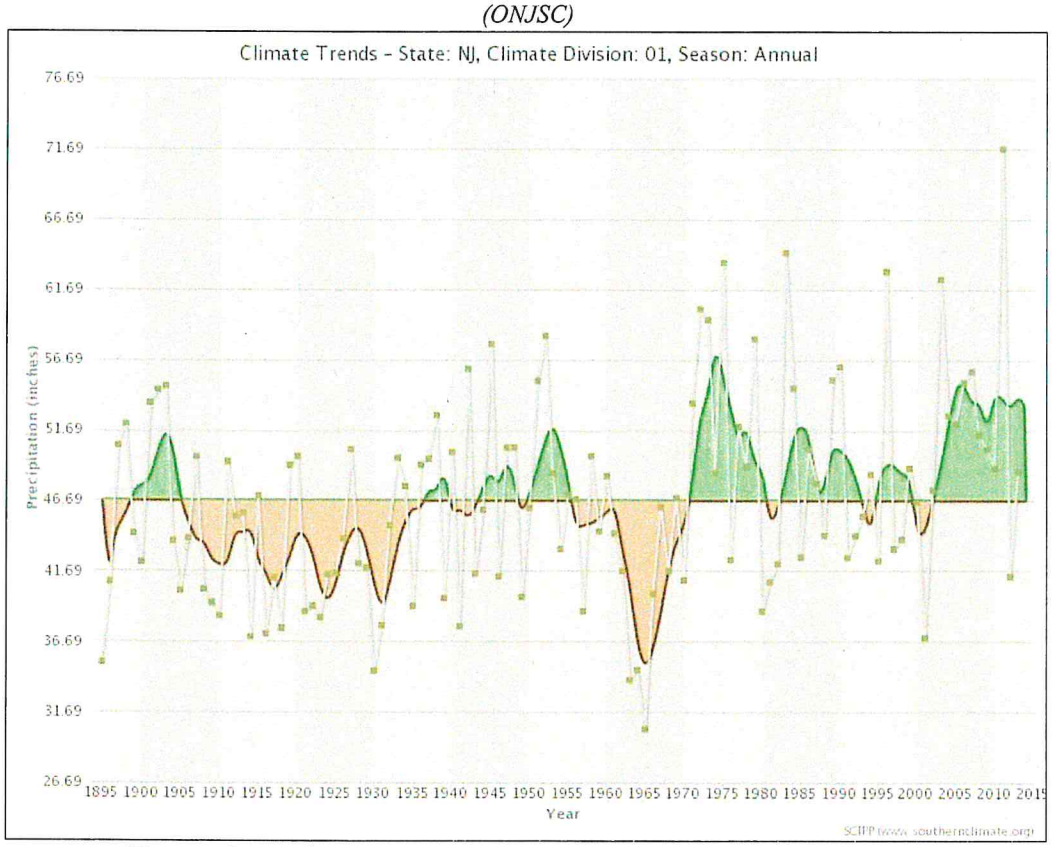

Figure 6. Northern New Jersey Precipitation Trends (1895-2013) (SCIPP)

Local Historic Averages

The two ONJSC reporting stations closest to Stillwater Township are located in Newton Township and the Sussex Weather Station in Wantage Township. *Table 21* shows the monthly and annual historic averages for maximum, minimum and mean temperatures for these two stations, as computed over a period greater than 100 years. The historic average of annual mean temperatures for Newton is 48.8°F and for Sussex is 49°F, which are both cooler than the 50.9°F computed for all of Northern New Jersey for a similar period (1895-2013).

Table 21. Monthly and Annual Mean Temperatures- Historic Averages for Newton and Sussex

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Newton 1893-2004													
Max	34.9	36.6	46.6	59.3	70.8	78.9	83.7	81.7	74.7	63.6	50.5	38.6	60.1
Min	16.3	17.1	26.3	36.1	46.1	54.9	59.7	57.7	50.4	39.5	31.1	21.0	37.8
Mean	25.6	26.8	36.6	47.6	58.4	66.8	71.7	69.7	62.6	51.5	40.7	29.8	48.8
Sussex 1893-2013													
Max	35.5	37.5	47.4	60.3	71.6	79.4	83.9	81.9	75.0	64.3	51.4	38.9	60.3
Min	16.3	16.9	25.8	35.8	45.5	54.6	59.7	57.9	50.4	39.4	30.8	21.1	38
Mean	26.0	27.2	36.7	48.0	58.5	66.9	71.8	69.9	62.6	51.9	41.1	30.0	49

Source: NJ State Climatologist, Rutgers University. Accessed January 29, 2014

Mean temperatures by year are plotted in *Figure 7*, along with the historic mean averages for each station as stated in *Table 21*. The data for the Newton station was recorded from 1893 to 2004 and the Sussex station from 1893 to 2013. Extreme spikes and drops can be the result of incomplete data for the monitoring period.

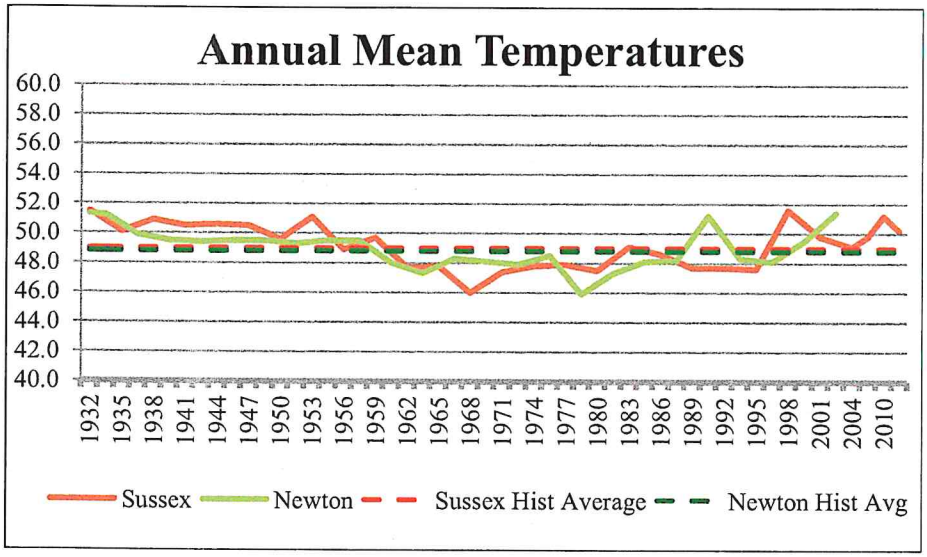

Figure 7. Annual Mean Temperatures in Newton and Sussex
Source: ONJSC

Table 22 details monthly and annual historic averages for all precipitation. Historic annual mean precipitation for Newton is 44.29 inches and for Sussex 45.30 inches which are slightly below the long-term average of 46.68 for all of Northern New Jersey.

Table 22. Precipitation for Newton and Sussex (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Newton 1893-2004													
Mean	3.18	2.83	3.42	3.74	3.91	4.35	4.58	4.41	3.92	3.42	3.45	3.34	44.29
Median	2.91	2.57	3.28	3.61	3.60	4.01	3.95	3.85	3.40	3.12	3.31	3.17	43.22
Max	10.51	7.77	7.61	8.97	9.28	12.83	12.52	15.19	10.52	9.99	9.33	8.06	61.00
Min	0.62	0.54	0.99	0.83	0.28	0.43	0.38	1.04	0.19	0.15	0.67	0.51	27.79
Sussex 1893-2013													
Mean	3.29	2.90	3.49	3.89	3.91	4.24	4.40	4.52	4.08	3.60	3.60	3.48	45.30
Median	2.99	2.64	3.17	3.66	3.75	3.83	3.91	4.11	3.31	3.32	3.52	3.23	44.18
Max	10.17	7.93	8.85	10.00	10.58	11.18	12.77	17.30	14.51	14.58	10.20	8.48	77.36
Min	0.71	0.70	0.60	0.80	0.78	0.21	0.62	0.57	0.29	0.50	0.24	0.70	29.56

Source: NJ State Climatologist, Rutgers University, Accessed January 29th, 2014

Snowfall amounts are shown in *Table 23* for both Newton and Sussex with the latter receiving 39 inches of snow annually as compared to the 37 inches that Newton receives on average.

Table 23. Historic Snowfall Averages for Newton and Sussex (inches)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Annual
Newton 1893-2004													
Mean	0.0	0.0	0.0	0.1	2.3	7.5	10.6	10.9	7.0	1.9	0.0	0.0	37
Median	0.0	0.0	0.0	0.0	0.9	6.0	8.4	9.5	5.0	0.0	0.0	0.0	34
Max	T	0.0	0.0	2.0	20.6	24.0	39.0	32.0	27.3	16.0	T	0.0	80.3
Min	0.0	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.0	0.0	0.0	6.4
Sussex 1893-2013													
Mean	0.0	0.0	0.0	0.2	2.1	7.2	11.0	10.3	6.2	1.8	0.0	0.0	39
Median	0.0	0.0	0.0	0.0	0.1	5.2	8.0	8.5	4.3	0.0	0.0	0.0	35.4
Max	T	0.0	0.0	6.5	16.5	35.0	49.5	35.8	36.0	18.5	T	T	83.3
Min	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	8.9

Source: NJ State Climatologist, Rutgers University, Accessed January 29, 2014

T= Trace

Annual precipitation and snowfall by year for the Sussex station are shown in *Figure 8,* for the period 1931-2013, along with the historic average for each category. Extreme spikes and drops may be the result of incomplete data for the monitoring period.

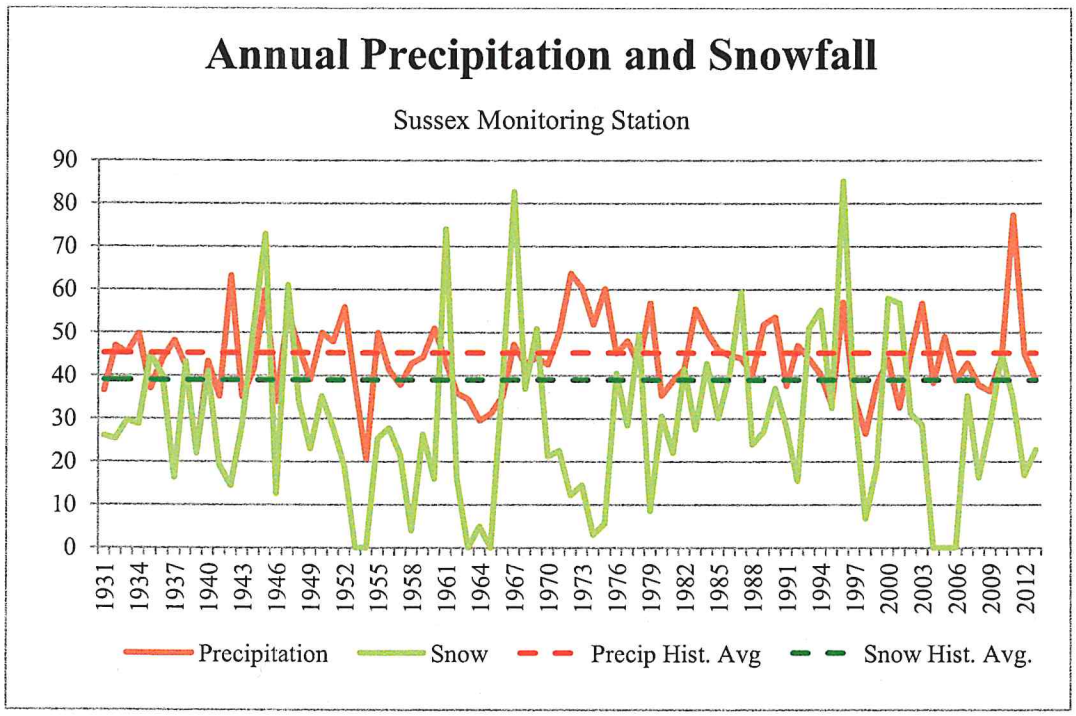

Figure 8. Annual Precipitation and Snowfall in Sussex (1931-2013)
Source: ONJSC

Current Normals

Table 24 shows the maximum, minimum and mean temperatures; precipitation; and heating and cooling degree day normals, or averages, for the 30-year period from 1984-2013. Heating degree days are the number of degrees the average daily temperature is below 65°F. Cooling degree days are the number of degrees the average daily temperature is above 65°F.

Table 24. Monthly Station Normals* 1984-2013 Sussex Station

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*
Temperature Normals (Deg F)													
Mean	25.8	28.5	37.6	48.0	58.0	66.7	71.7	70.5	62.0	51.3	41.1	30.7	49.3
Maximum	35.9	39.4	48.7	60.3	71.1	79.1	83.8	82.4	74.5	63.7	52.0	40.0	60.9
Minimum	15.8	17.7	26.1	35.7	45.1	54.3	59.7	58.2	49.5	38.7	30.2	21.4	37.7
Precipitation Normals (inches)													
Precipitation	3.22	2.84	3.77	4.12	4.11	4.62	4.26	4.70	5.02	4.41	3.38	3.70	44.04
Heating Degree Days (the number of degrees the average daily temp is below 65° F)													
Heating	1,143	990	809	494	228	50	7	14	129	406	669	999	5427
Cooling Degree Days (the number of degrees the average daily temp is above 65° F)													
Cooling	0	0	0	7	28	107	212	182	49	4	0	0	481
*Source: ONJSC *Normal= 30 year average 1984-2013*													

Comparison of Current Normals with Historic Averages

Table 25 compares the annual historic averages for the Sussex station against the current normals (i.e. the averaged for the current 30-year period 1984-2013) for temperature and precipitation. In comparison the Sussex station recorded higher current normal max temperatures and overall mean temperatures while the minimum temperature is lower and precipitation has also seen a decrease.

Table 25. Historic Averages vs. Station Normals

Annual Historic Averages 1893-2013;
Station Normals 1984-2013
Sussex

	Historic Avg.	Current Normals*	Difference
Temperature (°F)			
Max	60.3	60.9	0.6
Min	38	37.7	-0.3
Mean	49	49.3	0.3
Precipitation (inches)	45.3	44.04	-1.26

**Current Normals= 30-year average for period 1984-2013*

Source: ONJSC

Figure 9 shows annual heating degree days (HDD) and cooling degree days (CDD) from 1984-2013 for Sussex. The general trend is toward fewer heating degree days and nearly no change in cooling degree days, indicating that temperatures are generally trending warmer. The 1984 statistics show HDD of 6,276, or 849 DD above the 30-year average of 5,427, and CDD of 538, or 57 DD above the 30-year average of 481. By comparison, the 2013 statistics show HDD of 6,086, or 659 DD above the 30-year average, and CDD of 826, or 345 DD above the 30 year average.

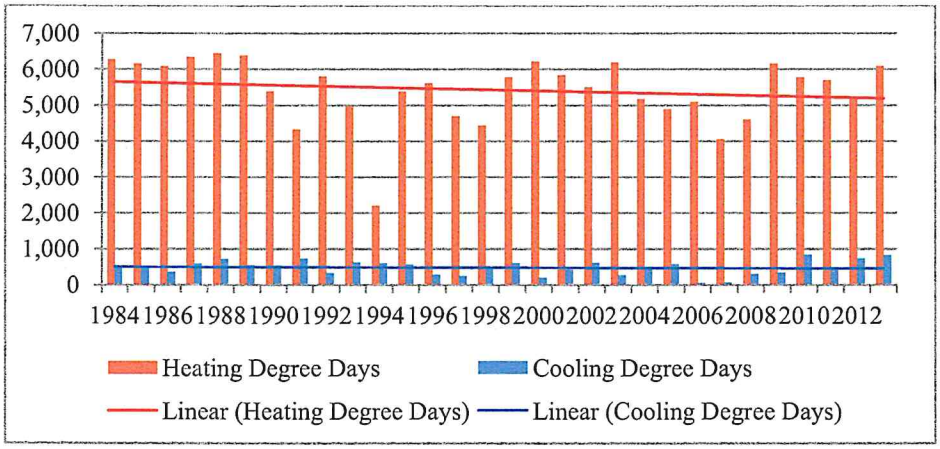

Figure 9. Heating and Cooling Degree Day Trends for Sussex
Source: ONJSC

Topographic Protection (Wind)

According to the Natural Resource Conservation Service (NRCS), the soils of Stillwater are not subject to erosion by wind. In part, this is because much of the soil is covered by vegetation, particularly forest cover. Wind erosion most often affects soils on bare lands, where the sheer force of wind detaches particles protruding from the soil surface. Conservation measures that can minimize damage due to wind erosion can include maintaining a surface cover (*NRCS*).

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. 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. In Stillwater, Hurricane Irene's heavy rains caused severe local damage that affected roads and bridges, as well as structures and trees, as rivers overflowed their banks. Hurricane Sandy's high winds resulted in many downed trees. Both storms, as well as the snowstorm of October 2011, resulted in widespread power outages.

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.

Trend Comparison: For 2012, both the frequency and the accumulated energy (duration and strength) of tropical cyclones in the Atlantic Basin exceeded 1981-2010 averages. In October, there were five reported storms (two reaching hurricane status) against an historic average of two. For the year, the accumulated tropical cyclone energy exceeded the average by 30% (NOAA).

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 June 2012, there were 233 landslides in all of New Jersey as reported by the New Jersey Department of Environmental Protection (NJDEP). No landslides have occurred in Stillwater Township. Several surrounding municipalities have experienced occasional landslides mostly in the form of debris flows due to heavy rain and sometimes rock falls due to weathering. Of the 233 landslides recorded in New Jersey from 1887 to 2012, nearly 10% (21) occurred during the heavy rains of Hurricane Irene in August 2011. Nearby Ogdensburg Boro, Vernon and Sparta townships experienced landslides during this storm. One fatality has occurred in Sussex County during a rockslide in 1952 in Byram Township (*NJDEP*).

Earthquakes

The NJDEP maintains a database of recorded earthquakes in New Jersey totaling 179 as of June 2013. They occur more frequently along the fault lines in north central New Jersey than in other parts of the state. These earthquakes are generally 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 neighboring 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 (*NJDEP*).

In New Jersey damage from earthquakes is rare or minor. According to the United States Geological Survey (USGS), on a scale of 0-100%, the section of Northern New Jersey where Stillwater is located has a relatively low seismic hazard ranking between 8-16%. The baseline for the hazard ranking is the levels 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" (*USGS Earthquakes Hazard Program*).

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, e.g., along a fault line, slips over another, causing the ground to vibrate) (*USGS*). The magnitude scale begins at 0 and the highest magnitude ever recorded was 9.5. Of the 179 earthquakes recorded in the NJDEP database, 60% had a magnitude of 2 or less and are considered "micro earthquakes". *Table 26* shows the magnitude summary for New Jersey.

Table 26. Magnitude Summary for Earthquakes in New Jersey

Range	*Count*	*% of Total*
< 2.0	107	60%
2.1-3.0	59	33%
3.1-4.0	11	6%
4.1-5.0	1	1%
> 5.1	1	1%
Total	179	100%

Source: NJDEP

Generally, the intensity of an earthquake relates to its magnitude, with a higher level 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 - 0-70km deep; intermediate - 70-300km deep; and deep - 300-700km. 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 10* shows the frequency of earthquakes in New Jersey from 1983-2013. The highest annual count was 13 in 1984, and no earthquakes were reported in either 1985 or 2000.

Earthquakes epicentered in or around Stillwater are listed in *Table 27*. The strongest earthquake recorded on New Jersey had a magnitude of 5.3 and occurred in 1783 several miles to the east of Stillwater in an area just north of the present day Picatinny Arsenal and along the Longwood Valley Fault. The second highest was a 2.8, one in 1980 in Hainesburg and another in 1986 in Tranquility. Most of the other earthquakes in the vicinity of Stillwater had magnitudes below 2.0 (see *Figure 11*).

Many occurred in the vicinity of the Byram Township and Newton. NJDEP shows no earthquakes occurred within Stillwater Township and 28 in nearby municipalities (*NJDEP Earthquakes Epicentered in New Jersey*).

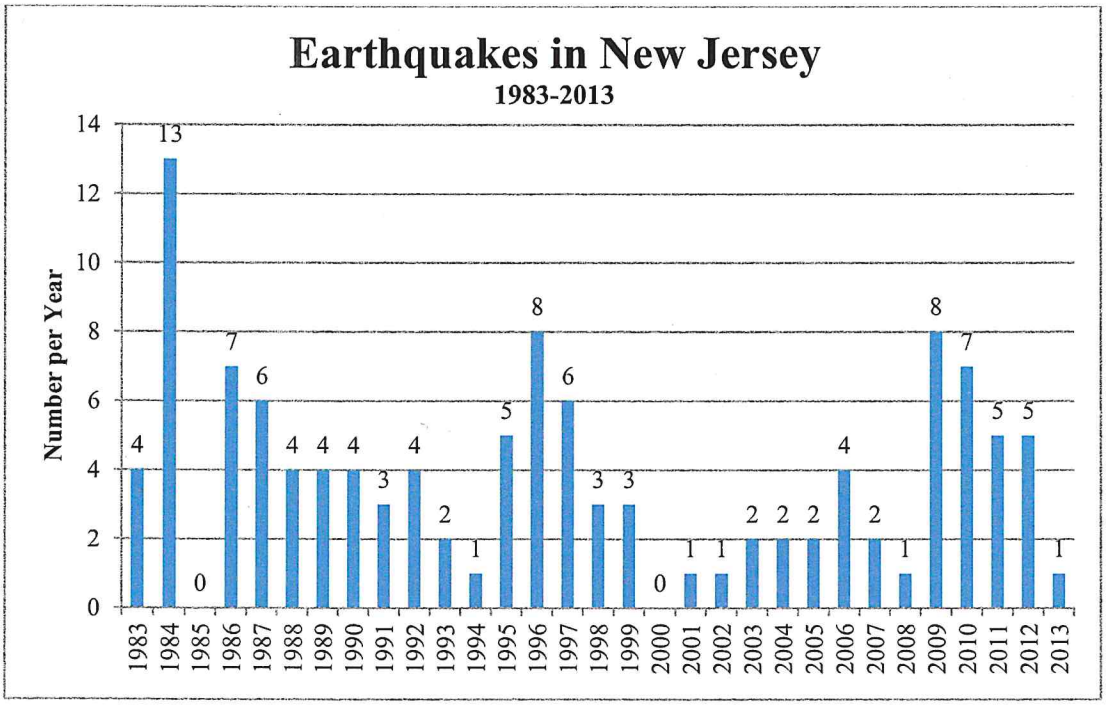

Figure 10. Earthquakes Epicentered in New Jersey
Source: NJDEP

Table 27. Earthquakes Epicentered in and Around Stillwater 1783-2013

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
29	4/25/1969	0:14	41.020	74.110	25.00	0.0	Near Sussex, NJ
30	10/6/1969	02:27	40.950	74.630	0.00	2.1	Ogdensburg, NJ
40	10/27/1977	9:22	41.100	74.600	6.00	1.5	Sparta, NJ
46	6/16/1978	4:49	41.000	74.600	0.00	0.0	Sparta, NJ
52	3/25/1980	18:54	40.970	75.020	5.00	2.8	Hainesburg, NJ
70	8/2/1984	1:03	40.900	74.710	5.70	1.7	Mount Olive, NJ
71	8/12/1984	21:03	40.920	74.730	3.10	2.4	Byram, NJ
72	8/12/1984	21:12	40.910	74.720	4.66	2.1	Byram, NJ
73	10/25/1984	7:18	40.890	74.700	7.10	2.0	Near Mt. Olive, NJ
74	12/3/1984	1:52	40.930	74.730	1.00	1.5	Byram, NJ
75	12/13/1984	20:13	40.920	74.730	3.70	1.7	Byram, NJ
77	12/15/1984	14:02	40.900	74.710	7.80	1.8	Byram, NJ
78	12/17/1984	6:52	40.930	74.730	4.80	1.6	Byram, NJ
85	11/23/1986	21:29	40.960	74.820	7.36	2.8	Tranquility, NJ

Table 27. Earthquakes Epicentered in and Around Stillwater 1783-2013							
ID	*Date*	*Time*	*Lat_N*	*Long_W*	*Depth (km)*	*Magnitude*	*Location*
86	4/24/1987	7:07	40.930	74.730	3.40	1.9	South of Lake Mohawk, NJ
88	8/5/1987	4:47	40.920	74.790	2.60	1.7	SW of Newton
89	8/6/1987	0:07	40.900	74.780	1.79	1.1	SW of Newton
90	8/6/1987	0:25	40.910	74.790	1.92	1.1	SW of Newton, NJ
109	6/7/1992	23:51	40.964	74.564	6.00	0.4	Jefferson Township, NJ
117	10/27/1995	1:46	41.148	74.548	7.00	1.3	NE of Newton, NJ
118	10/27/1995	6:52	41.153	74.560	8.00	1.4	NE of Newton, NJ
123	2/26/1996	16:00	40.930	74.630	6.00	0.0	Near Mt. Arlington, NJ
125	11/12/1996	6:37	41.169	74.554	1.00	1.3	21 km NE Newton, NJ
126	11/12/1996	11:23	41.163	74.549	1.00	0.8	21 km NE Newton, NJ
147	02/16/2006	23:43:23	41.161	74.535	8.00	2.6	22km NE of Newton, NJ
148	02/17/2006	00:00:30	41.159	74.557	8.00	0.9	20km NE of Newton, NJ
149	02/21/2006	00:31:19	41.163	74.554	5.00	1.3	20.4km NE of Newton, NJ
Source: NJDEP							

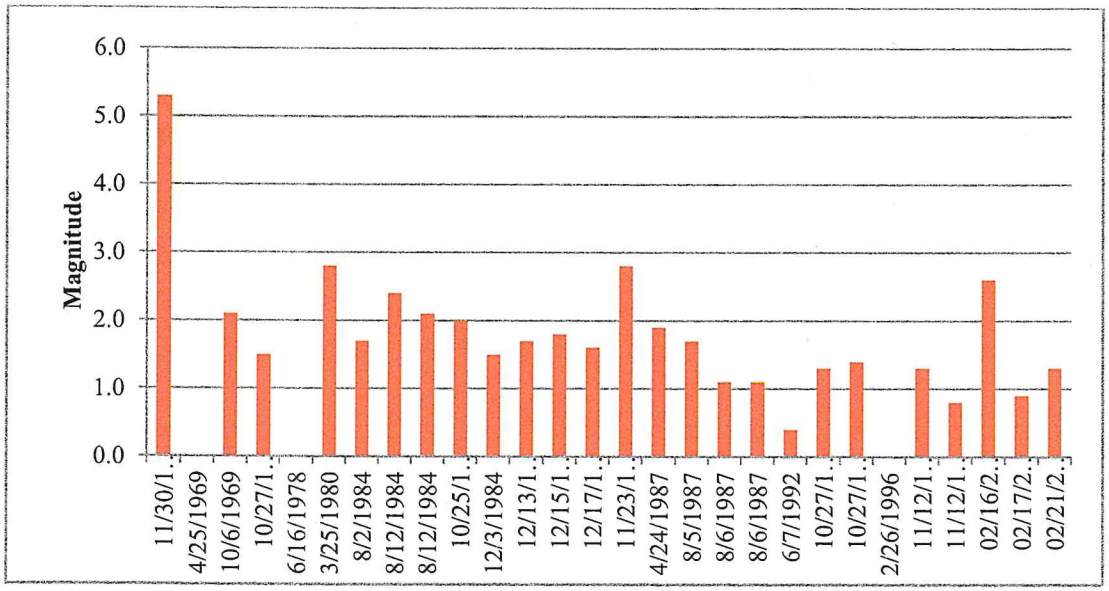

Figure 11. Magnitude of Earthquakes in the Vicinity of Stillwater.
Source: NJDEP

Climate Change

In 2007, the International 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 Emissions (GHGs), average temperatures may rise by up to 14°F. 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.

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 we breathe 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. (*NJDEP*)

A Greenhouse Gas (GHG) is defined by the NJDEP as:

> "An atmospheric gas that slows the rate at which heat radiates into space, this having a warming effect on the atmosphere. GHGs include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide, chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and some other halogenated gases."

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 2009, the latest year for which major sector estimates are available, total estimated emissions were 112.1 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, which is the strategic vision for the use, management, and development of energy in New Jersey over the next decade. Because fossil fuels like 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. (*NJDEP*)

The transportation sector continues to be the major contributor to GHGs (47.3% in 2009) and vehicle miles traveled continue to increase while fuel efficiencies have leveled off. In 2009, electricity generation was the second largest contributor at 23.5%, followed by residential at 15.2%, commercial at 10.8%, and industrial at 10.6%. Highly warming gases, waste management and land clearing contributed approximately 23%, while terrestrial carbon sequestration (forests absorbing carbon) provided an offset of -7.6%.

The NJDEP predicts that major new initiatives and technologies will be required to reduce GHGs. On a local level, Stillwater Township is using an Energy Efficiency and Conservation Block Grant (EECBG) to audit and retrofit existing county buildings with energy efficient components, promote greenhouse gas emissions inventories for public buildings and develop smart vehicle routing system for its recycling vehicles to reduce transportation demands. One effect of these initiatives will be to avoid 75,290 metric tons of CO_2 emissions. (*EECBG*)

The Sustainable Jersey program is a certification program that acknowledges communities that complete qualifying actions toward sustainability. Stillwater is a participating community that is working towards certification. Among the qualifying actions are a number of Greenhouse Gas initiatives that can be undertaken by a municipality.

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), administered by the New Jersey Board of Public Utilities. Commercial, industrial and local government programs are also available (*NJCEP*).

HYDROLOGY

Watersheds

"A watershed is a topographic area within which apparent surface water runoff drains into a specific point on a stream or to a water body such as a lake." (*EPA, Ecoregions and Watersheds, 1997*). The NJDEP has divided the state into Watershed Management Areas (WMAs). A watershed-based approach to natural resource management is considered by state and national agencies to be the most appropriate unit for managing complex environmental problems.

Stillwater is part of WMA 1, which comprises the basins of the Upper Delaware River, Flat Brook, Paulins Kill, Pequest, Lopatcong and Pohatcong River Drainage, and the Musconetcong River. The Paulins Kill is the major river in Stillwater Township, flowing northeast to southwest through the southeastern edge of the Township. The northern part of the township drains into Trout Brook and Swartswood Creek (also known as Spring Brook) which subsequently flow into the Paulins Kill. The western portion of the Township primarily flows into the Paulins Kill via Blair Creek. The Paulins Kill drains 172 square miles in Warren and Sussex County and 29 square miles in Stillwater (*1998 ERI*). Eventually, the Paulins Kill joins the Delaware River in Knowlton Township and eventually drains into the Atlantic Ocean via the Delaware Bay. A very small portion of the Township (0.06 acres) drains into Flat Brook which drains into the Delaware River

Every WMA is composed of multiple watersheds and sub watersheds. The United States Geological Survey (USGS) has mapped and identified watersheds using a hierarchical numbering system. This system identifies watersheds using hydrological unit code (HUC) consisting of up to 14 digits for the smallest watersheds. The HUC14 watersheds for Stillwater Township are identified on the *Watershed Map* (*Map 7* in the *Maps Section*) and listed in *Table 28.*

Table 28. HUC14 Watershed in Stillwater Township

WMA	*WMA Name*	*Sub Watershed*	*Acres*	*Percent of Twp.*
01	Upper Delaware	Flat Brook (Tillman Brook to Confluence)	0.0622	0.00%
01	Upper Delaware	Swartswood Trib (41-06-06 thru Lk Owassa)	2720.3895	15.05%
01	Upper Delaware	Paulins Kill (PK Lk outlet to Dry Brook)	250.6459	1.39%
01	Upper Delaware	Swartswood Lake and tribs	3260.7124	18.04%
01	Upper Delaware	Trout Brook	3934.9828	21.77%
01	Upper Delaware	Blair Creek	2022.3665	11.19%
01	Upper Delaware	Jacksonburg Creek	109.1199	0.60%
01	Upper Delaware	Paulins Kill (Blairstown to Stillwater)	3841.6631	21.25%
01	Upper Delaware	Paulins Kill (Stillwater Vil to PK Lake)	1936.2564	10.71%
		Total	**18076.1986**	**100.00%**

Source: NJDEP

Surface Water

Surface water is water that collects on the ground or in a stream, river, lake, wetland, or ocean. Stillwater's lakes, ponds and streams are central to life and have supported tourism and recreation since the early 1900's when weekend travelers took the train into nearby Blairstown. As time passed, and the region developed, these summer cabins eventually turned into year round homes (*Stillwater, Skylands Visitor*). Major recreational water bodies in Stillwater include Paulinskill Lake, Swartswood Lake, Little Swartswood Lake, Plymouth Lake, Lake Kathryn, and Fairview Lake.

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)."

Any FW1 surface water is considered to be an Outstanding Natural Resource Water (ONRW) and incurs the highest level of protection from the state. There are no waterways designated ONRW in Stillwater Township but there are ONRW waterways present in neighboring Walpack Township in the upper tributaries of Flat Brook.

The general classification for other fresh waters in the State is Fresh Water 2 (FW2). Further classifying these water bodies, the presence of trout in a stream means that the waters are relatively free of chemical or biological contaminants. 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 for 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.

The rivers and streams of Stillwater Township are among the most pristine in the state and several have been classified by the NJDEP as Category One (C1) waterways. These high quality waterways are protected from measurable changes in water quality characteristics as determined by their clarity, color, scenic setting, aesthetic value, exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resource(s). The C1 classification signifies the second highest level of protection for a stream in New Jersey; among other regulations, no new development can occur within 300 feet of Category One waterways. All other waters in Stillwater Township are classified at Category Two waterways (C2). As with Category One waters, Category Two waters are protected from any measurable change in existing water quality; however, some lowering of existing water quality may be allowed by the Department based on a social or economic justification.

In Stillwater Township, Trout Brook, an unnamed tributary of the Paulins Kill in the southern part of the town, and Swartswood Lake have been designated as Category One waterways. Trout Brook and the unnamed tributary are trout production waterways while Swartswood Lake is designated for trout maintenance. Most of the other waterways have been classified as Category Two Trout Maintenance. Most ponds and lakes as well as Blair Creek do not support trout. See *Surface Water Quality* map (*Map 8* in the *Maps Section*) and *Table 29* for the surface water quality designations.

The quality of surface waters can be affected by point sources and non-point sources of pollution as well as from erosion and sedimentation. Point Source means any discernible, confines and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged (*Clean Water Act, 1972*). This includes discharges from sewage treatment plants and factories, storm water runoff, illegal dumping, and malfunctioning underground storage tanks and septic systems. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

Table 29. Surface Water Quality Standards in Stillwater Township

Category One		*Category Two*	
Trout Production	*Trout Maintenance*	*Trout Maintenance*	*Non-Trout*
Paulins Kill UNT*	Swartswood Lake	Blair Creek UNT*	Blair Creek
Trout Brook		Paulins Kill	Blair Creek UNT*
Trout Brook UNT*		Paulins Kill UNT	Lower Crandon Lake
		Swartswood Creek	Paulins Kill Lake
		Swartswood Creek UNT*	Plymouth Lake
		Swartswood Lake UNT*	Plymouth Pond
			Pond Brook
			Quick Pond
			Willow Crest Lake

*Source: NJDEP; *UNT-Unnamed Tributary*

As opposed 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 groundwater. The effects of pollutants on specific waterways can vary, but are manifested in drinking water supplies, recreation, fisheries, and wildlife. One of these effects is eutrophication, which, in freshwater systems, is the addition of substances, either man-made or natural, to a water body affecting the primary productivity of that body of water. Substances such as nitrates and phosphates promote excessive algae and phytoplankton growth. These "blooms" can have negative effects on the ecosystem. These negative impacts can include a clouding of the water, which limits sunlight penetration, stopping 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, which is the 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 reduces 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 will easily become eroded which then 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.

Groundwater Recharge Areas

Groundwater is the primary drinking and agricultural water source for the residents of New Jersey, and is the main source of drinking water for residents of Stillwater Township. Groundwater recharge is the process in which surface water, from lakes, streams, or rainwater runoff, flows or seeps downwards beneath the ground surface, saturating soil or rock. Groundwater is contained in porous rocks and sediments. An aquifer is where porous rocks or unconsolidated materials yield a usable quantity of water from which wells can draw water. Protecting the land's capacity to recharge its aquifers, and limiting development to stay within the capacity of local water resources, is critical to maintaining the quality of the water supply.

Aquifer-recharge potential is calculated through the combination of a standardized statewide aquifer ranking system and the particular groundwater recharge coverage in the area of interest. Aquifer recharge or recharge to water-bearing geologic units is defined as the groundwater that reached the water table in the uppermost geologic unit with a thickness of 50 feet or greater. Groundwater recharge potential is ranked by average annual infiltration. The composite aquifer/groundwater recharge potential rank highlights the multiple relationships between the groundwater-recharge area ranks (indicative of the infiltration rate) and the underlying water-table aquifer ranks (indicative of the aquifer's capacity to absorb, transmit and supply water) and provides a guide to how well the system in any given area allows groundwater to reach and recharge the aquifer. *Table 30* depicts the ranking system.

Table 30. Statewide Aquifer and Sussex County Groundwater Rankings

Aquifer Rank	*Median Well Yield (Gallons/Minute)*	*Groundwater Rank*	*Avg. Annual Infiltration (In/Yr)*
A	>500	A	20-23
B	>250-500	B	15-19
C	>100-250	C	10-14
D	25-100	D	1-9
E	<25	D	0

There are also hydric soils (L/L), wetlands and open water (W/W) and instances where no recharge is calculated (X/X)

Source: NJDEP NJGS

The *Aquifer Recharge Potential* map (*Map 9* in the *Maps Section*) shows the distribution of rankings for Stillwater Township. This map shows the potential for an aquifer to recharge in a given area. The area with the highest potential for recharge would be ranked A/A (>500gpm/20-23 in/yr). In Stillwater there is no area that is ranked A/A. 41% ranks at D/B (25-100 gpm/15-19 in/yr) and another 22% at level C/B (>100-250 gpm/15-19 in/yr). The acres associated with each aquifer/groundwater recharge ranking in Stillwater are shown in *Table 31*.

Table 31. Aquifer/Groundwater Recharge Rankings in Stillwater Township

Alpha Rank	*Numeric Rank*	*Acres*	*Percent of Township*
B/B	22	524.9366	2.91%
B/C	23	38.9243	0.22%
C/B	32	3945.6723	21.84%
C/C	33	327.6915	1.81%
C/D	34	18.3192	0.10%
D/B	42	7383.3550	40.87%
D/C	43	1156.8023	6.40%
E/B	52	4.3641	0.02%
L/L	97	1809.1404	10.01%
W/W	98	2857.3242	15.82%
	Total	**18066.5298**	**100.00%**

Source: NJDEP

Aquifer Identification

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 consolidated rock formations that contain water in fractures within the rock while surficial aquifers are formed from unconsolidated materials such as sand or gravel or glacial sediment and contain water in the spaces between particles. In Carbonate Rock formations, water in the soil becomes slightly acidic and slowly dissolves the limestone or dolostone as it percolates down through joints and fractures in the bedrock forming large channels and caverns. These channels are usually more abundant in valleys, depressions and near streams and rivers. The distribution of these channels can be difficult to predict but the presence sinkholes can be connected with large solution channels in the underlying limestone or dolostone. Wells drilled into these solution channels can produce large quantities of water. (*Feenstra 1998*) The majority of Stillwater Township is serviced by bedrock reservoirs through the Martinsburg Formation

and Jutland Sequence (11,938 acres). Bedrock and Surficial aquifers with Stillwater Township are shown on the map *Bedrock and Surficial Aquifer Rankings* maps (*Maps 10 and 11* in the *Maps Section*) and detailed in *Table 32* and *Table 33* .

Table 32. Surficial Aquifers of Stillwater Township			
Name	*Rank*	*Acres*	*Percent*
Sand and Gravel	B	1093.6015	24.86%
Till	D	3038.5612	69.08%
Morainic Deposits	D	33.0329	0.75%
Lake-bottom Sediment	E	233.1322	5.30%
	Total	**4398.3277**	**100.00%**
Source: NJDEP			

Table 33. Bedrock Aquifers in Stillwater Township			
Name	*Rank*	*Acres*	*Percent*
Jacksonburg Limestone, Kittatinny Supergroup, and Hardyston Quartzite	C-B	6030.8097	33.36%
Martinsburg Formation and Jutland Sequence	D	11937.9477	66.04%
Rocks of the Green Pond Mt. Region, Kittatinny Mt., and Minisink Valley	D	107.4412	0.59%
	Total	**18076.1986**	**100.00%**
Source: NJDEP			

Public Water Supply and Wellhead Protection

The 1986 Federal Safe Drinking Water Act Amendments (*Section 1428, P.L. 23-523, 42 USC 300 et seq.*) direct 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.

Well Head Protection Areas (WPAs) are delineated for both public community and non-community wells. The delineations for these wells are the two, five, and twelve year tiers. Each tier represents the horizontal extent of groundwater captured by a well pumping at a specific rate over those periods of time (NJDEP). There are seven public community wells in Stillwater Township owned by the Stillwater Water District.

Riparian Zones

In order to better protect the public from the 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. A riparian zone is land and vegetation within and adjacent to surface waters.

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:

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 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 subjected only to a regulated 50-foot riparian zone, measured from the top of the bank, along both sides of all waters.

WETLANDS

Wetlands are important natural resources that contribute significantly to an area's social, economic, and environmental health. Among the services they provide are filtration of chemicals, pollutants, and sediments from water; flood control; critical habitat for wildlife; 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." (*N.J.A.C. 7:7A*) NJDEP has adopted this manual as the technical basis for identifying and delineating wetlands.

The NJDEP regulates virtually all activities in a wetland, including removing vegetation, 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. For example, a wetland containing an 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, and intermediate resource value. The criteria for these classifications are described below:

Exceptional Resource Value Wetland

- Discharges 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 which remains suitable for breeding, resting, or feeding by these 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* and is:
- An isolated wetland, as defined at *N.J.A.C. 7:7A-1.4*; which
- Is smaller than 5,000 square feet; and
- 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, the Department 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 rights-of-way
- Graveled or stoned parking/storage areas and roads
- A drainage ditch
- A swale; or
- A detention facility created by humans in an area that was upland at the time the facility was created regardless of the wetland resource classification of the wetland under these rules, or the classification of the body of water, as FW-1 or FW-2 trout production, to which it discharges.

Intermediate Resource Value Wetland

- Any wetland not defined as *Exceptional Resource Value* or *Ordinary Resource Value*.

According to the NJDEP 2007 Land Use/Land Cover data, there are 2,063 acres of wetlands within Stillwater Township occupying 11.4% of the Township. The *Wetlands* map (*Map 12* in the *Maps* section) shows the locations of wetlands in Stillwater. *Table 34* presents a summary of wetlands by type. The dominant type of wetland in Stillwater is deciduous wooded wetlands, comprising 67% of the Township's total wetlands. Though this information is based on NJDEP mapped wetlands, unmapped wetlands, which are still subject to NJDEP regulation, may exist in Stillwater. Wetlands would require a professional delineation before a regulated activity could occur in or around them.

Table 34. Wetland Classifications in Stillwater Township

Classification	*Acres*	*% of Wetlands*	*% of Stillwater*
Agricultural Wetlands (Modified)	119.53	5.79%	0.66%
Coniferous Scrub/Shrub Wetlands	9.04	0.44%	0.05%
Coniferous Wooded Wetlands	23.35	1.13%	0.13%
Deciduous Scrub/Shrub Wetlands	97.01	4.70%	0.54%
Deciduous Wooded Wetlands	1,390.08	67.37%	7.69%
Disturbed Wetlands (Modified)	4.44	0.22%	0.02%
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	38.56	1.87%	0.21%

Table 34. Wetland Classifications in Stillwater Township			
Classification	*Acres*	*% of Wetlands*	*% of Stillwater*
Herbaceous Wetlands	289.59	14.04%	1.60%
Managed Wetland In Built-Up Maintained Rec Area	1.57	0.08%	0.01%
Managed Wetland In Maintained Lawn Greenspace	1.95	0.09%	0.01%
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	10.91	0.53%	0.06%
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	14.20	0.69%	0.08%
Mixed Wooded Wetlands (Coniferous Dom.)	28.46	1.38%	0.16%
Mixed Wooded Wetlands (Deciduous Dom.)	20.80	1.01%	0.12%
Phragmites Dominate Interior Wetlands	6.76	0.33%	0.04%
Wetland Rights-Of-Way	7.09	0.34%	0.04%
Total	**2,063.32**	**100.00%**	**11.41%**
Source: NJDEP LULC 2007			

WILDLIFE

Critical Habitat

Much of Stillwater Township may provide habitat that is suitable for threatened or endangered species. The Landscape Project (*Version 3.1 2012*) ranks patched of habitat using a numeric system (0 through 5), for the purpose of identifying habitat which may be suitable for threatened and endangered species. Habitat identified as Ranks 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 and 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.

Rank 1 is assigned to species-specific patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species.

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* Stillwater contains habitat patches of all ranks. *Table 35* presents a summary of habitat patches within Stillwater Township and the *Patches with Endangered Species Habitats* map (*Map 13* in the *Maps* section) illustrates the distribution within the Township. The majority of Stillwater has been identified as Rank 4 (76%), state endangered species habitat that primarily covers all parts of the Township. There is a small portion (2%) of land designated Rank 5 for Federally Endangered Species in three clustered areas in the central part of the Township. Rank 3 (7%) designated land consists of small patches of land throughout the Township. Ranks 2 and 1 designated for species of state special concern and land suitable for endangered/threatened/special concern species make up 7% of the Township and can be found primarily in the southern part of the township close to Swartswood Lake and south of the Paulins Kill. Rank 0, which is land with no species occurrences and without suitable habitat, makes up 7.5% of Stillwater Township.

Table 35. Critical Species Habitat in Stillwater Township		
Rank	*Acres*	*Percent*
0	1,351.05	7.5%
1	248.07	1.4%
2	1,062.27	5.9%
3	1,304.07	7.2%
4	13,800.06	76.4%
5	300.97	1.7%
Total	18,066.49	100.0%
Source: NJDEP Landscape Project (Version 3.1 2012)		

Threatened and Endangered Species

Stillwater is home to a wide array of wildlife including endangered and threatened species listed on both state and federal registers. The Bog Turtle, a federally listed Threatened Species, occupies fens, bogs and wet meadows in the Township of Stillwater. There are seven state listed Endangered Species that inhabit Stillwater, the Bald Eagle, Bobcat, Blue-spotted Salamander, Golden-winged Warbler, Northern Goshawk, Red-shouldered Hawk, and Timber Rattlesnake. In addition there are also eleven State Threatened Species and an additional 33 species are listed in the state as being of Special Concern. A full list of these species can be found in *Table 3.*

Table 36. Threatened and Endangered Species in Stillwater Township					
Common Name	*Scientific Name*	*Class*	*Landscape Project Rank*	*Federal Status*	*NJ Status*
A Silver-bordered Fritillary	Boloria selene myrina	Insecta	3	NA	Threatened
American Kestrel	Falco sparverius	Aves	3	NA	Threatened
Arrowhead Spiketail	Cordulegaster obliqua	Insecta	2	NA	Special Concern
Bald Eagle	Haliaeetus leucocephalus	Aves	4	NA	Endangered
Barred Owl	Strix varia	Aves	3	NA	Threatened
Black-billed Cuckoo	Coccyzus erythropthalmus	Aves	2	NA	Special Concern
Blackburnian Warbler	Dendroica fusca	Aves	2	NA	Special Concern
Black-throated Blue Warbler	Dendroica caerulescens	Aves	2	NA	Special Concern
Black-throated Green Warbler	Dendroica virens	Aves	2	NA	Special Concern
Blue-headed Vireo (Solitary Vireo)	Vireo solitarius	Aves	2	NA	Special Concern
Blue-spotted Salamander	Ambystoma laterale	Amphibia	4	NA	Endangered

Table 36. Threatened and Endangered Species in Stillwater Township					
Common Name	*Scientific Name*	*Class*	*Landscape Project Rank*	*Federal Status*	*NJ Status*
Bobcat	Lynx rufus	Mammalia	4	NA	Endangered
Bobolink	Dolichonyx oryzivorus	Aves	3	NA	Threatened
Bog Turtle	Glyptemys muhlenbergii	Reptilia	5	Threatened	Endangered
Brook Snaketail	Ophiogomphus aspersus	Insecta	3	NA	Threatened
Brown Thrasher	Toxostoma rufum	Aves	2	NA	Special Concern
Brush-tipped Emerald	Somatochlora walshii	Insecta	2	NA	Special Concern
Canada Warbler	Wilsonia canadensis	Aves	2	NA	Special Concern
Cerulean Warbler	Dendroica cerulea	Aves	2	NA	Special Concern
Cobra Clubtail	Gomphus vastus	Insecta	2	NA	Special Concern
Cooper's Hawk	Accipiter cooperii	Aves	2	NA	Special Concern
Eastern Box Turtle	Terrapene carolina carolina	Reptilia	2	NA	Special Concern
Eastern Meadowlark	Sturnella magna	Aves	2	NA	Special Concern
Golden-winged Warbler	Vermivora chrysoptera	Aves	4	NA	Endangered
Grasshopper Sparrow	Ammodramus savannarum	Aves	3	NA	Threatened
Great Blue Heron	Ardea herodias	Aves	2	NA	Special Concern
Harpoon Clubtail	Gomphus descriptus	Insecta	3	NA	Threatened
Hooded Warbler	Wilsonia citrina	Aves	2	NA	Special Concern
Hudsonian Whiteface	Leucorrhinia hudsonica	Insecta	2	NA	Special Concern
Jefferson Salamander	Ambystoma jeffersonianum	Amphibia	2	NA	Special Concern
Kentucky Warbler	Oporornis formosus	Aves	2	NA	Special Concern
Least Flycatcher	Empidonax minimus	Aves	2	NA	Special Concern
Longtail Salamander	Eurycea longicauda longicauda	Amphibia	3	NA	Threatened
Maine Snaketail	Ophiogomphus mainensis	Insecta	2	NA	Special Concern
Marbled Salamander	Ambystoma opacum	Amphibia	2	NA	Special Concern
New England Bluet	Enallagma laterale	Insecta	2	NA	Special Concern
Northern Copperhead	Agkistrodon contortrix mokasen	Reptilia	2	NA	Special Concern
Northern Goshawk	Accipiter gentilis	Aves	4	NA	Endangered
Northern Metalmark	Calephelis borealis	Insecta	2	NA	Special Concern
Northern Parula	Parula americana	Aves	2	NA	Special Concern
Red-headed Woodpecker	Melanerpes erythrocephalus	Aves	3	NA	Threatened

Table 36. Threatened and Endangered Species in Stillwater Township					
Common Name	*Scientific Name*	*Class*	*Landscape Project Rank*	*Federal Status*	*NJ Status*
Red-shouldered Hawk	Buteo lineatus	Aves	4	NA	Endangered
Sable Clubtail	Gomphus rogersi	Insecta	2	NA	Special Concern
Savannah Sparrow	Passerculus sandwichensis	Aves	3	NA	Threatened
Spatterdock Darner	Rhionaeschna mutata	Insecta	2	NA	Special Concern
Tiger Spiketail	Cordulegaster erronea	Insecta	2	NA	Special Concern
Timber Rattlesnake	Crotalus horridus horridus	Reptilia	4	NA	Endangered
Veery	Catharus fuscescens	Aves	2	NA	Special Concern
Williamson's Emerald	Somatochlora williamsoni	Insecta	2	NA	Special Concern
Wood Thrush	Hylocichla mustelina	Aves	2	NA	Special Concern
Wood Turtle	Glyptemys insculpta	Reptilia	3	NA	Threatened
Worm-eating Warbler	Helmitheros vermivorum	Aves	2	NA	Special Concern
Source: NJDEP Landscape Project (Version 3.1 2012)					

Vernal Habitat

Stillwater has many beautiful vernal habitats, also referred to as vernal pools. These natural wetland depressions fill with water during the rainy season in fall and remain ponded until the dry weather in early summer causes them to dry out. These 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 reproduce 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:

- The wetland must consist of or contain a confined basin or depression without a permanently flowing outlet;
- 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*, and listed in *Table 37* below);
- The area must maintain ponded water for at least two continuous months between March and September of a normal rainfall year, and;
- 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, which is available online on NJ-GeoWeb at http://www.nj.gov/dep/gis/geowebsplash.htm. 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 pools, 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 area- These 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 include sites that 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 area- These are areas that contain pools that have been field-verified by the NJDEP and have been determined to meet both the physical and biological characteristics of a vernal habitat in accordance with *N.J.A.C. 7:7A-1.4*.

Note that if the mapped location of a confirmed ("certified") vernal habitat area overlaps the mapped location of a "potential vernal habitat area," the combined area is mapped as "vernal habitat area." It is likely that the species confirmed in the "certified" pool are also present in any nearby pools, though these adjacent pools may not have formally been inspected by the NJDEP.

In Stillwater Township the Landscape Project mapping identifies 32 separate vernal habitat polygons. Nine represent vernal pools that have been field inspected and confirmed to meet certification requirements. These confirmed vernal pool sites comprise 891 acres of habitat associated with wetland and dispersal areas. The other 23 vernal habitat polygons are sites that are deemed suitable but are unconfirmed by the NJDEP. These sites comprise 2,688 acres in the Township of Stillwater.

The obligate and facultative species specified in Appendix 1 of *N.J.A.C. 7:7A* are listed below. Obligate species (those dependent on vernal pools for the completion of their lifecycle) observed in the Township include Wood Frogs (*Lithobates sylvatica*) and Spotted Salamander (*Ambystoma maculatum*); facultative species (those which may use vernal pool habitat but do not necessarily rely on it) include, but are not limited to: Red-Spotted Newt (*Notophthalmus v. viridescens*), Northern Spring Peeper (*Pseudacris c. crucifer*) and Green Frog (*Lithobates clamitans*). The Landscape Project database confirms the occurrences of one additional facultative species within the Township which is the Wood Turtle (State Threatened). However, this species has not been specifically associated with vernal pool certification to date. *Table 37* lists obligate and facultative fauna species found in vernal habitats within New Jersey.

Table 37. Obligate and Facultative Fauna Species Found in New Jersey Vernal Pools		
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
Fair Shrimp (Order *Arnostraca*)	Fowler's Toad***	Four-toed Salamander
	Pine Barrens Treefrog**	Northern Spring Peeper
	Northern Gray Treefrog	Long-tailed Salamander**
	Southern Gray Treefrog*	Wood Turtle**
State Endangered; ** State Threatened; * State Special Concern*		
Source: NJDEP		

Descriptions of the 71 species of reptiles and amphibians found in New Jersey, including the obligate and facultative species listed above, can be found on the NJDEP Division of Fish and Wildlife website at *http://www.state.nj.us/dep/fgw/ensp/vernalpool.htm.*

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. Vernal habitat areas and potential vernal habitat areas in Stillwater Township are shown on the *Vernal Habitats* map (*Map 14* in the *Maps* section).

Wild Trout

Wild trout are another form of wildlife that is a valuable natural resource in New Jersey and in the Township of Stillwater. According to the NJDEP:

> Trout that are able to complete their life cycle in a natural aquatic habitat, and maintain a population through natural reproduction, are termed *wild trout.* The survival of self-sustaining populations of wild trout is not dependent upon the stocking of hatchery-reared trout. Because of their high water quality and habitat requirements, trout are valuable indicators of healthy aquatic ecosystems. The importance of water quality, as related to the ability of a stream or lake to support wild (reproducing) trout populations is recognized in New Jersey through the State's surface water classification system. Waters that support reproducing trout populations are referred to as "trout production waters" and are classified as FW2-Trout Production Category 1 (FW2-TPC1). Through this classification trout production waters receive one of the highest levels of protection available from activities that could potentially impact coldwater quality and habitat, through a variety of NJDEP regulatory programs. (See *Table 29. Surface Water Quality Standards in Stillwater Township* on 54 for a list of trout production waters in Stillwater).

Freshwater Mussels

Stillwater Township is home to waterways that serve as suitable habitat for several species of State Threatened and Endangered freshwater mussels. According to the NJDEP, Freshwater mussels are among the oldest living organisms on Earth with individuals reaching ages in excess of a century. As vital ecosystem components, they are food sources for wildlife such as raccoons and muskrats and young mussels are eaten by ducks, herons and fishes. They are often referred to as nature's vacuum cleaners because they improve water quality by straining particles and pollutants from rivers. In addition, since mussels have a low tolerance for water-borne pollutants, they are excellent indicators of water quality. (*NJ Division of Fish and Wildlife*)

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 2007. 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, water and wetlands. Forested area represents 62% of Stillwater's land cover, providing critical habitat for wildlife. Agricultural land represents about 9% of land cover. Urban land, which has been developed for residential or commercial use, accounts for 12%, wetlands for 11%, and water for 5% of land cover. Together, wetlands and streams provide riparian corridors providing a different type of habitat for wildlife species.

Table 38 shows the percentage and acreage covered by each land cover type and the *Land Use/Land Cover* map (*Map 15* in the *Maps* section) shows their distribution throughout the Township.

Table 38. Land Cover Type in Stillwater Township

Type	*Acres*	*Percent*
Agriculture	1,626.59	9.00%
Barren Land	27.47	0.15%
Forest	11,158.62	61.72%
Urban	2,221.40	12.29%
Water	982.21	5.43%
Wetlands	2,063.32	11.41%
Total	**18,079.62**	**100.00%**

Source: NJDEP LULC 2007

Forest Types

According to the 2007 LU/LC data, 11,159 acres, or 62% of Stillwater, is classified as forested, with 76% of the forests classified as deciduous forest with >50% crown closure. The second most prevalent category is mixed forest with greater than 50% deciduous trees and greater than 50% crown closure followed by mixed forest with greater than 50% coniferous trees and greater than 50% crown closure. See *Table 39* for the complete breakdown.

Table 39. Forest Types in Stillwater Township			
Forest Type	*Acres*	*Percent*	*% of Stillwater*
Coniferous Brush/Shrubland	125.46	1.12%	0.69%
Coniferous Forest (>50% Crown Closure)	246.84	2.21%	1.37%
Coniferous Forest (10-50% Crown Closure)	117.63	1.05%	0.65%
Deciduous Brush/Shrubland	76.09	0.68%	0.42%
Deciduous Forest (>50% Crown Closure)	8,493.74	76.12%	46.98%
Deciduous Forest (10-50% Crown Closure)	292.67	2.62%	1.62%
Mixed Deciduous/Coniferous Brush/Shrubland	225.48	2.02%	1.25%
Mixed Forest (>50% Coniferous With >50% Crown Closure)	432.55	3.88%	2.39%
Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	116.25	1.04%	0.64%
Mixed Forest (>50% Deciduous With >50% Crown Closure)	716.08	6.42%	3.96%
Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	116.53	1.04%	0.64%
Old Field (< 25% Brush Covered)	132.81	1.19%	0.73%
Plantation	66.47	0.60%	0.37%
Total	**11,158.62**	**100.00%**	**61.72%**
Source: NJDEP LULC 2007			

The following definitions set the classification parameters:

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 tree species to be placed in this category

Deciduous, >50% Crown Closure- This category contains deciduous stands with crown closures greater than 50%. Crown closure is the percentage of a forest area occupied by the vertical projections of tree crowns. Crown closure percentages provide a reasonable

estimate of stand density. The majority of the deciduous forests in New Jersey are in this category.

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

Coniferous- This category includes forested lands that contain coniferous tree species. Coniferous species are those trees commonly known as evergreens. They do not lose their leaves (needles) at the end of the growing season but retain them through the year. Conifers can easily be distinguished from deciduous trees on wintertime color infrared photography because of their high infrared reflectance due to their leaf retention. The stand must be 20 feet high and must be stocked by at least 75% conifers to be labeled as a coniferous stand.

Coniferous, >50% Crown Closure- This category contains coniferous stands with crown closures greater than 50%.

Coniferous, 10-50% Crown Closure- This category contains natural coniferous stands with crown closure >10%, but less than 50%.

When neither coniferous nor deciduous represents 75% or more of the forested area, it is classified as Mixed Forest. This category is further broken down according to which species is 50% or greater in prevalence, conifers or deciduous trees, and the extent of crown closure.

Brush/Shrubland – When the vegetation is less than 20 feet high, the area is categorized as brush/shrubland. The following types have been identified in Stillwater:

Coniferous Brush/Shrubland- This category contains natural forested areas with coniferous species less than 20 feet high.

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 agricultural.

Vegetation

The New Jersey Natural Heritage Program maintains a database of rare and endangered plant species and ecological communities reported throughout New Jersey. A number of the species are ranked by the state as endangered and/or imperiled because of extreme rarity often due to habitat destruction. For a fee the Natural Heritage Program offers to search the database for records of rare or endangered species and natural communities on or near a site that is being considered for development or other modification. The Natural Heritage Program "provides the information in order to assist the requestor in preserving habitat for rare and endangered species and natural communities." *(NJDEP)* Stillwater Township is home to seven Natural Heritage Priority sites which are some of the most important sites in the State for endangered and threatened plants, animals and ecosystems.

LAND USE AND LAND COVER

The NJDEP periodically compiles information on land use and land cover (LULC) in New Jersey using aerial photography in the spring of each update year. Comparing data over time provides information on the changes in land use cover. *Table 40* below compares the LULC categories for the last four updates and the following text describes the characteristics of the categories. The most significant changes are the 62.2% reduction in barren land from 1986 to 2007 and the 26.7% increase in urban land from 1986 to 2007. Additionally, the 12.5% decrease in agricultural lands from 1986-2007 is significant. *Map 15*, the *Land Use/Land Cover* map illustrates the 2007 data (*Maps* section).

Table 40. Land Use/Land Cover Change in Stillwater Township

	1986	1995/1997		2002		2007	
Type	*Acres*	*Acres*	*% Change**	*Acres*	*% Change**	*Acres*	*% Change**
Agriculture	1858.04	1694.51	-8.8%	1,626.00	-12.5%	1,626.59	-12.5%
Barren Land	72.67	67.78	-6.7%	37.72	-48.1%	27.47	-62.2%
Forest	11323.46	11303.96	-0.2%	11,243.04	-0.7%	11,158.62	-1.5%
Urban	1753.74	1935.87	10.4%	2,113.81	20.5%	2,221.40	26.7%
Water	998.96	1003.21	0.4%	965.43	-3.4%	982.21	-1.7%
Wetlands	2059.66	2061.21	0.1%	2,080.53	1.0%	2,063.32	0.2%

*Source: NJDEP LULC *Percent Change from 1986*

Following is a summary of the NJDEP 2007 LULC categories.

Agriculture – includes all lands used primarily for the production of food and fiber and some of the structures associated with this production. The 1,627 acres of agricultural land in Stillwater are classified in the sub-categories of cropland and pastureland, orchards/vineyards/nurseries/horticultural, and other agriculture areas. *Table 41* below shows the breakdown of agricultural land classifications in Stillwater. Agricultural land represents 9% of Stillwater's total area.

Table 41. Agricultural Land Classifications in Stillwater Township

Classification	*Acres*	*Percent*	*% of Stillwater*
Cropland And Pastureland	1,409.30	86.64%	7.79%
Orchards/Vineyards/Nurseries/Horticultural Areas	43.39	2.67%	0.24%
Other Agriculture	173.91	10.69%	0.96%
Total	**1,626.59**	**100.00%**	**9.00%**

Source: NJDEP LULC 2007

Barren Land –The sub-categories of barren land that are identified in Stillwater include altered lands and transitional areas. Extraction mining operations, landfills and other

disposal sites compose the majority of man-altered barren lands. The 2007 LULC identified 16.7 acres of *extractive mining lands* in Stillwater Township. *Transitional areas* encompass lands on which site preparation for a variety of development types has begun. However, the intended future land use has not been realized. Included are residential, commercial and industrial areas under construction, areas under construction for unknown use, and abandoned structures. The 2007 LULC identified 6.8 acres of transitional areas in Stillwater. The category of *bare exposed rock, rock slides, etc.* are areas lacking vegetation and composed of talus slopes, bare rock or rock faces. These areas compose 4 acres of Stillwater's total area. See *Table 42* below for a breakdown of the LULC barren land classifications in Stillwater. Barren land represents 0.15% of Stillwater's total area.

Table 42. Barren Land Classifications of Stillwater Township

Type	*Acres*	*Percent*	*% of Stillwater*
Bare Exposed Rock, Rock Slides, Etc	3.9414	14.35%	0.02%
Extractive Mining	16.7241	60.89%	0.09%
Transitional Areas	6.8020	24.76%	0.04%
Total	**27.4676**	**100.00%**	**0.15%**

Source: NJDEP LULC 2007

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 ecology of an area. Forest totals 11,159 acres and covers 62% of the Township according to the 2007 LULC data. See *Forest Types* section on *page 70* for a detailed description of forest types in Stillwater Township.

Wetlands – are areas that are inundated or saturated by surface or ground waters at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. Included in this category are naturally vegetated swamps, marshes, bogs and savannas which are normally associated with topographically low elevations but may be located at any elevation where water perches over an aquiclude (or bed of low permeability). Wetlands that have been modified for recreation, agriculture, or industry will not be included here but described under the specific use category such as urban land.

The wetlands of New Jersey are located around the numerous interior stream systems, and along coastal rivers and bays. New Jersey supports diverse wetland habitats dependent upon physiographic and geological variables. According to the 2007 LULC data, wetlands in Stillwater occupy 2,063 acres, representing 11% of the Township's total area. See *Wetlands* on *page 59* for a detailed discussion of wetlands types in Stillwater Township and the *Wetlands* map (*Map 12* in the *Maps* section) for the location of these wetlands.

Urban Land – Urban or Built-up Land is characterized by intensive land use where the landscape has been altered by human activities. Although structures are usually present,

this category is not restricted to traditional urban areas. Urban or Built-up Land includes Residential; Commercial and Service; Industrial; Transportation, Communication and Utilities; Industrial and Commercial Complexes; Mixed Urban or Built-up; Other Urban or Built-up; and Recreational. Included with each of the above land uses are associated lands, buildings, parking lots, access roads, and other appurtenances, unless these are specifically excluded.

Urban or Built-up Land takes precedence over other categories when the criteria for more than one category are met. For example, recreational areas that have enough tree cover to meet Forest category criteria are classified as Recreational Land in the Urban Land category. **Error! Reference source not found.** below shows the breakdown of Urban Land classifications in Stillwater. While urban land represents 12% of Stillwater, the subcategories are important to recognize. Urban land that is commercial or industrial in nature has more impervious coverage than urban land that is low to medium density residential or recreational.

Table 43. Urban Land Classification in Stillwater Township

Type	*Acres*	*Percent*	*% of Stillwater*
Athletic Fields (Schools)	5.43	0.24%	0.03%
Cemetery	8.90	0.40%	0.05%
Commercial/Services	35.29	1.59%	0.20%
Industrial	10.61	0.48%	0.06%
Mixed Urban or Built-Up Land	14.34	0.65%	0.08%
Other Urban or Built-Up Land	66.08	2.97%	0.37%
Recreational Land	233.37	10.50%	1.29%
Residential, Rural, Single Unit	1,135.63	51.09%	6.28%
Residential, Single Unit, Low Density	436.50	19.64%	2.41%
Residential, Single Unit, Medium Density	218.80	9.84%	1.21%
Transportation/Communication/Utilities	11.98	0.54%	0.07%
Upland Rights-of-Way Developed	0.58	0.03%	0.00%
Upland Rights-of-Way Undeveloped	43.90	1.98%	0.24%
Total	**2,221.40**	**100.00%**	**12.29%**

Source: NJDEP LULC 2007

Water – All areas within the landmass of New Jersey that are periodically water covered are included in this category. All water bodies should be delineated as they exist at the time of data acquisition, except areas in an obvious state of flood. Not included in this category are water treatment and sewage treatment facilities. See *Table 44* below for a breakdown of the LULC water classifications in Stillwater. Water represents 5% of Stillwater's total area.

Table 44. Water Classifications in Stillwater Township			
Type	*Acres*	*Percent*	*% of Stillwater*
Artificial Lakes	744.77	75.83%	4.12%
Bridge Over Water	0.39	0.04%	0.00%
Natural Lakes	162.43	16.54%	0.90%
Streams And Canals	74.63	7.60%	0.41%
Total	**982.21**	**100.00%**	**5.43%**
Source: NJDEP LULC 2007			

FLOOD HAZARD/FLOOD PRONE AREAS

Flood Zones

Federal, state and municipal governments provide oversight regarding 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 deemed subject to 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) and other flood zones, creating official Flood Rate Insurance Mapping (FIRM) 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 regulates 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

At the federal level, the Federal Emergency Management Agency (FEMA) evaluates and maps Special Flood Hazard Areas (SFHAs). These Flood Hazard areas and other flood zones are used to create official Flood Rate Insurance Mapping (FIRM) that can be used in participating communities, such as Stillwater, to determine flood insurance rates. Communities can opt to participate in the National Flood Insurance Program (NFIP), which requires mandatory flood insurance in areas mapped as SFHAs. An SFHA is defined as "an area that would be inundated by the flood having one percent chance of being equaled or exceeded in any given year," also known as the based flood or 100-year flood zone. NFIP mapping also includes information of 500-year flood zones and various sublevels within the 100-year zone (FEMA). *Map 16 FEMA Flood Zones (2010 DFIRM Preliminary)* shows both the 100 year and 500 year thresholds for Stillwater Township. The areas surrounding the Paulins Kill in Stillwater are within the 100 year flood zone with large areas surrounding the river having experienced flooding events in the past.

The Township of Stillwater is a participating community in the NFIP. The effective FEMA Flood Insurance Rate Map (FIRM) mapping is from 2011. FIRM mapping is updated every few years and is first released as preliminary mapping open to public comment. Once that version of the mapping has been adopted as the effective mapping, property owners may still request a review if they believe their property has been incorrectly mapped. Maps can be viewed or purchased online and can be downloaded as pdfs or digital data (DFIRM).

Table 45 below shows the extent of FEMA 100-year and 500-year flood zones in Stillwater. There are 391 acres mapped as 100-year flood zone and 0.37 acres in the area between the limits of the 100-year flood and the limits of the 500-year flood. Together, these flood zones represent 2.16% of the Township's total area. They are located along the Paulins Kill within the Township.

Table 45. FEMA Flood Zones in Stillwater Township		
Flood Hazard	*Acres*	*% of Total Municipal Area*
100-year Flood (1% annual chance)	391.257	2.16%
500-year Flood (0.2% annual chance)	0.371	0.00%
Not in Flood Zone	17,682.301	97.83%
Total Township Acreage	18,073.929	100.00%
Source: FEMA DFIRM 2011		

NJDEP Delineated Water Ways

At the state level, New Jersey regulates flood prone areas through the New Jersey Flood Hazard Area Control Act, *N.J.S.A. 58:16A-50 et seq.*, and its rules, adopted November 5, 2007. The Act recognizes the importance not only of avoiding building in unsafe places but also preserving the vegetation the "is essential for maintaining bank stability and water quality." The rules set standards for development in flood hazard areas and adjacent to surface waters "in order to mitigate the adverse impacts to flooding and the environment that can be caused by such development" As defined by the rules, a flood hazard area exists along every regulated waterway that has a drainage of 50 acres or more. Regulated waters are waters that have been delineated in Appendix 2 of the Flood Hazard Control Act (FHCA) rules. In most cases the delineation includes both the flood hazard area design flood elevation and the floodway limit. To determine which mapping is available for a particular waterway, or to obtain copies of maps or other information regarding the use or revision of these studies, contact the NJDEP as described at *N.J.A.C. 7:13-3.3 (NJDEP Division of Land Use Regulation)*.

A flood hazard area is defined as the area inundated by the flood hazard area design flood, which is equal to the 100-year flood 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 zone 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 a building into a private residence or a public building. (N.J.A.C. 7:13-2.4)

In order to engage in any of these activities in a regulated area, the appropriate permit must be obtained. There are several different categories of permits, including permits by rule, general permits and individual permits.

There are area specific standards, depending on whether the area includes a channel, riparian zone, floodway, flood fringe, fishery resources, threatened & endangered species, or acid producing soils. And there are site specific standards for different facets such as storm water management, excavating, filling, building, roads and parking areas. Construction is not necessarily prohibited in a regulated area but a disturbance must be justified.

KNOWN CONTAMINATED SITES

Soil and groundwater contamination by pollutants is tracked by the state and federal governments at varying degrees of contamination or potential contamination, including brownfields and other extensive or long-term remediation, point source facilities that require continuous monitoring (Community Right to Know) and point source occurrences that are specific and limited (Known Contaminated Sites).

The NJDEP Site Remediation Program currently maintains a list of more than 12,000 New Jersey Sites that have confirmed contamination 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.

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." (*Brownfield and Contaminated Site Remediation Act,* N.J.S.A. 58:10B-1 et seq.) According to the State of New Jersey Brownfields Sitemart, there are no active sites in the Township of Stillwater.

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 specified 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 materials accounting. Pollution prevention progress information is also reported on the RPPR. In 2013, there were no active sites in Stillwater Township that met the threshold for the State CRTK It should be noted that CRTK is a State mandated reporting process and there is no assumption that the site is problematic. This information is important for emergency response and firefighting activities.

Known Contaminated Sites

The Known Contaminated Sites List (KCSL) for New Jersey includes those sites and properties within the State 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, these sites can have one or more active case with any number of pending and closed cases.
- *Pending Sites* with confirmed contamination have one or more pending cases, no active cases, and any number of closed cases.
- *Closed Sites* with remediated contamination have only closed cases. Sites in this category have no active or pending cases.

These lists are produced by the NJDEP in response to the *Brownfield and Contaminated Site Remediation Act, N.J.S.A 58:10-23.16-17,* which requires the preparation of a list of sites affected by hazardous substances. It also satisfies obligations under the New Jersey New Residential Construction Off-Site Conditions Disclosure Act (*N.J.S.A. 46:3C1 et seq.*). Sites included in the KCSL report can undergo a wide variety of remedial activities, ranging from relatively simple "cut and scrape" cleanups to highly complex cleanups. The sites with complex contamination cases 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 and of the environment, and to quickly return underutilized properties to productive use." As of May 7, 2012, with limited exceptions, all remediation in the State of New Jersey, without regard to when remediation was initiated, proceed under the supervision of a Licensed Site Remediation Professional (LSRP), without New Jersey Department of Environmental Protection (NJDEP) approval, following nine requirements set forth at *N.J.S.A. 58:10B-1.3b:1-9.*

As of February 5, 2014, there was 1 active non-homeowner sites in Stillwater Township and 3 pending sites. The active sites are rated with B, C1, C2, C3, or D depending on the type and severity of the contamination defined as follows:

B- Remedial level associated with emergency response, simple removal activities of contaminants usually no impact to soil or ground water

C1- Remedial levels are associated with simple sites with one or two contaminants localized to soil and the immediate spill or discharge area.

C2- Remedial levels are associated with more complicated contaminant discharges such as multiple site spills and discharges, or more than one contaminant, with both soil and groundwater impacted or threatened.

C3- Remedial levels are associated with high complexity and 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".

U- Unknown contamination levels.

(NJDEP. http://www.state.nj.us/dep/gis/digidownload/metadata/statewide/kcsl.htm)

Table 46 lists the active and pending non-homeowner Known Contaminated Sites in Stillwater Township.

Table 46. Active and Pending Known Contaminated Sites		
Site ID	*Location*	*Code*
Active Sites		
535288	924 Dove Island Road	C1-UST*
Pending Sites		
422564	1012 East Shore Rd	B
444173	CR610 MVA Oil Spill	B
G000024136	988 Old Foundry Drive	U
*Source: NJDEP Data Miner *UST=Underground Storage Tank*		

HISTORIC & CULTURAL RESOURCES

"The Village of Stillwater today is physically more than just the houses and properties centered along now Route 610. It is surrounded by a much larger and definable rural historic landscape; integrated with the village's physical core"

Historic Context Statement, The Rural Historic Landscape of the Stillwater Village Area, August 2002

The history of Stillwater is reflected in its buildings and landscapes. Central to the area's historic settlement are its agricultural soils and the Paulins Kill, which was the power source for the early milling and water powered industries.[2]

Early History and Settlement

The Village of Stillwater has strong ties to its German ancestry, which is reflected in the historic landscape. It was first settled by immigrants from the Palatinate region of Germany who were attracted to the limestone-based soils and later by post revolutionary Hessian mercenary soldiers once hired to serve the British Army. (*Jones 2002*) From 1741 to 1742 Palatinate settlers cleared the land and set up farms. Casper Shafer was the most prominent of these settlers and had a leading role in shaping the history of Stillwater Township. After purchasing the site of the Village of Stillwater in 1742 with John P. Bernhardt, Shafer went on to construct a store, a tannery and a gristmill, effectively establishing industry in the village, which he himself named. The Shafer family continued to prosper in Stillwater into the mid-19th century and at their height of influence owned approximately twenty farms as well as the majority of local businesses. (*Stillwater Township Historical Preservation Committee, Recommendations to the Stillwater Township Committee, April 12, 2005*)

German settlers carried with them the traditions of their ancestry and organized the "Dorf" or village in the Strassendorf style. The village core was developed in a linear pattern along one street with fields and woods around the core as much a part of the village as the houses themselves (*Jones 2002*). During this same time period, between 1740 and 1775, agrarian interests also attracted many German families from Pennsylvania to the village.

Growth and Industry

The economic success of the village was due to the water-powered industries established by the Shafer family. From 1783 to 1794 growth and economic prosperity were evident in Stillwater. Grain, at that time, was fetching the highest export prices ever seen which created a boom for grist millers and grain farmers. In 1794 a Hessian fly infestation hit the area's wheat crop and plagued the area for the next twenty-five years. During this time a shift was made to the production of corn, rye and buckwheat. (*Jones 2002*) A rapid social change was also occurring at this time, which resulted in a reduction in the

[2] *Note: This section of the* Environmental Resource Inventory Update *is drawn from the 2006* Open Space and Recreation Plan *and has been updated to reflect current status and available information.*

predominantly Germanic population and increase in the English, Irish, Scotch-Irish and Holland Dutch residents. (*Jones 2002*)

The village of Stillwater continued to grow, despite its setbacks. By 1816, the Shafer family's industry had reached its peak, making Stillwater the rural industrial center of Sussex County. (*Jones 2002*). It was in 1825 that Stillwater Township was incorporated. (*Snell 1881*)

Around 1840, general farming gave way to specialized farming. The "Pennsylvania Rotation" method of farming was now utilized to substitute one crop for another throughout the seasons of the year. During the 1850's competition from the grain farms of the Midwest caused local farmers to expand their operations to include livestock, poultry, table vegetables and fruit. *(Jones 2002)*

Between 1869 and 1920, Stillwater's economic and social infrastructure was almost exclusively based upon agricultural activity. The local setting was one of single-family farms and homesteads. *(Jones 2002)* Between 1876 and 1881, Stillwater needed a railroad in order to have access to outside markets. In 1881, the New York, Susquehanna and Western Railroad opened and ran a direct rail line to Stillwater *(Jones 2002)*. This greatly aided the development of the village's industry by transporting agricultural products to the cities in eastern New Jersey and New York City *(N.J. DEP, Division of Parks and Forestry, Kittatinny Valley State Park Written Description)*. Today, a portion of the right-of-way of the New York, Susquehanna and Western Railroad has been converted into the Paulinskill Valley Trail which serves as a multiple use trail for walking, running, mountain biking, horseback riding, cross-country skiing and snowshoeing. *(N.J.DEP, Division of Parks and Forestry, Kittatinny Valley State Park website)*

From 1920 into the 1950s, Stillwater maintained its agrarian, sylvan character. There were changes in farming practices that were influenced by the advent of the gasoline powered tractor and the introduction of new sanitation requirements for dairy farming. Some of the smaller farms in Stillwater were consolidated into larger, more viable units to provide increased land for pastures, crops and water. At the same time, affluent, ex-urbanites, looking for relief from city life, began to buy farms as a change of lifestyle or to create rural estates. *(Jones 2002)* Swartswood Lake was developed as a major resort community in the early 1900s. Popular hotels included the Northshore Inn, The Club Casino, The Dove Island Inn and Elmer Hill's Boarding House, more recently known as Louie's Lake House which was torn down around the year 2000.

Also during the 1920s, the Paulins Kill was dammed to create Paulinskill Lake. Once a summer resort, this is now a year-round residential community. *(Jane Dobosh, Stillwater, New Jersey's Great Northwest Skylands)*

Historic Landmarks

Middleville, once known as "Gin Point" is a historic hamlet within Stillwater. It is home to the Township municipal building, a former general store building and post office, as well as the former Middleville Inn. At one time, the Middleville Inn was a stagecoach stop. *(Personal correspondence, Joan Teare / Paul Klimek, September 13, 2005)*

Many of the historic buildings that still stand in Stillwater were erected during the last two decades of the 19th century. However, there are three structures remaining in Stillwater that date back to the period between 1740 and 1775. A log plank house dating from 1741, a two and a half story main stone section of a home dating to 1750, and a portion of a house made of limestone masonry dating to 1755 are thought to have been part of either a farm house or mansion owned by the Shafer family. *(Jones 2002)* There are also several mill dams, a German Lutheran/Calvinist cemetery, and several stone fenced field systems that are still visible that date prior to 1775. The cemetery is unique because over half of the original stone from the 18th century still remains and almost all of the Germanic inscriptions on the headstones and footstones have survived the years. *(Jones 2002)*

A slave house owned by the Shafer family and built in 1780 is located at 901 Cedar Ridge Road. The Shafer's Whitehall House, a stone farmhouse built in 1784, shortly before Casper Shafer's death, also still stands. *(Jones 2002)* "The Academy", a schoolhouse built in 1842 that remained in operation until 1909, is located at the northwest end of the main street in the village. The old schoolhouse is now home to the historical society's museum.

Stillwater is home to two sites that are listed on both the New Jersey Register of Historic Places and National Register of Historic Places. The first site is **The Harmony Hill United Methodist Church**, on Fairview Lake Road, which was built in 1833. Prior to this date, the congregation met in private homes in the area (*Jones 2002*). The second site one of the most famous buildings in the town, the **Casper and Abraham Shafer Grist Mill Complex** on Main Street. In 1764, Casper Shafer built the original mill and in 1774 added a sawmill to his gristmill operation. In 1776, he modernized the mill as a gesture to America's new independence. The mill operated until it was destroyed by fire in 1840. The present mill was rebuilt in 1844 using many of the original stones, but fitted with modern conveyors and turbines. The mill was owned and operated by a former suffragist, Jane McCord, from 1926 until 1954. It sat idle until 1972 when two local farmers purchased it. They restored the mill and reopened it to the public on weekends from 1972 to 1977*(Grist Mills in New Jersey Northwest Skylands, Run of the Mills, N.J. Skylands website)*. In 2000 the New Jersey Department of Environmental Protection bought the mill. It is currently managed by the New Jersey Department of Environmental Protection through Swartswood State Park.

The State Historic Preservation Office has issued an opinion for four site for their eligibility for inclusion on the State Register of Historic Places The first site is the right of way for the **Appalachian Trail** (AT) in Stillwater Township. The AT runs along the Kittatinny Ridge in the Delaware Water Gap National Recreation Area in neighboring Walpack Township. Access is limited in Stillwater, however a pedestrian link is located on Fairview Lake Road, near Stillwater's western corner. The second site is the **Keens Grist Mill**, south of Paulinskill Lake, and is located on County Route 521. The **Pennsylvania-New Jersey Interconnection** which runs from Bushkill to Roseland is the third site identified by the SHPO and is currently being dismantled for the construction of a new line. The **Stillwater Historic District** is also listed and includes the historic

buildings surrounding the intersection of County Route 610 and County Route 521 (*NJDEP Historic Preservation Office*).

Table 47. Historic Sites of Stillwater Township				
Historic Site	**Address**	**National Register**	**State Register**	**SHPO Opinion**
Harmony Hill United Methodist Church	919 Fairview Lake Road	9/19/1977 (#77000913)	6/13/1977 (#2632)	
Casper & Abraham Shafer Grist Mill Complex	928 Main Street	12/10/2009 (#09000653)	6/3/2009 (#4899)	
Appalachian Trail	400 foot Right of Way			6/14/1978 (#2778)
Keens Grist Mill	932 Route CR521			11/21/2000 (#4949)
Pennsylvania-NJ Interconnection	Bushkill to Roseland Transmission Line			9/9/2011 (#5117)
Stillwater Historic District	Intersection of CR610 &CR521			3/18/2003 (#4144)
Source: NJDEP Historic Preservation Office				

PUBLIC AND PRESERVED LAND

This section of the *Environmental Resource Inventory Update* inventories the public lands in Stillwater Township as depicted on the *Preserved Land, Non-Profit Camps, and Public Lands* map (*Map 17* in the *Maps* section). These maps were produced using ESRI's ArcGIS 10.2 software. Acreages may vary slightly from the Township's tax records, as they were calculated using the ArcGIS software. Property information was gathered through the New Jersey County Tax Board's database (2013) and confirmed by the Township Tax Assessor when necessary. All acreages below are rounded to the nearest acre unless otherwise stated.

Preserved Land

Stillwater is home to approximately 5,820 acres of preserved open space, making up approximately 32% of the Township's 18,076 acres.

Municipal Parks (ROSI)

The Township of Stillwater has listed 260 acres of Municipal Parks on its Recreation and Open Space Inventory (ROSI) filed with NJDEP Green Acres. Stillwater is home to several municipal parks which are conveniently located close to the population centers of various neighborhoods within the Township. The largest park is Camp Towadena which consists of 166 acres. This is a largely undeveloped, wooded park situated between the Delaware Water Gap National Recreation Area, Blair Creek Preserve and Fairview Lake YMCA Camp that was formerly a Boy Scout Camp but is currently owned and preserved by the Township for natural resource protection.

State of New Jersey

The New Jersey Department of Environmental Protection (NJDEP) owns approximately 4,027 acres within Stillwater that are a part of the Swartswood State Park, Trout Brook State Wildlife Management Area, parts of Blair Creek Preserve, the Casper and Abraham Shafer Grist Mill Complex (*Historic and Cultural Resources* section) and the Paulinskill Valley Trail.

Swartswood State Park was established in 1914 as New Jersey's first state park. It spans the border of Stillwater and Hampton Townships and is comprised of 3,460 acres of which 1,753 are found within Stillwater Township. The central features of the Park are Swartswood Lake and Little Swartswood Lake, both of which were formed by glaciers thousands of years ago. The NJ DEP identifies Swartswood Lake as a National Heritage Priority Site based on the presence of several state endangered and rare plant species. Another National Heritage Priority Site found within the Park is the Swartswood Sinkhole Ponds. These limestone sinkhole ponds are home to various rare species and contain several rare wetland communities. In addition to unique ecological features, the park offers many recreational opportunities including: hiking, camping, picnicking, fishing, hunting, boating and birding. Swartswood Lake is stocked with brown, rainbow and brook trout and is home to many other fish species such as largemouth bass, catfish, perch, walleye and pickerel. There is a public beach for swimming with nearby picnic

areas, concessions and playgrounds. Winter activities such as cross country skiing, sledding and ice fishing are also permitted. The trails within the park include the Spring Lake Trail and Bear Claw Trail which permit mountain biking and horseback riding, the Grist Mill Trail which is over steep rugged terrain and affords rewarding views of the lake, and the Duck Pond Multi-use Trail which is a handicap accessible paved path that is suitable for walking, bicycling, skateboarding and rollerblading. There are 65 tent and trailer campsites around the park, three group sites and six yurts. Boat rentals are also available (*NJDEP Division of Parks and Forestry*).

Trout Brook State Wildlife Management Area encompasses approximately 2,088 acres within Stillwater Township. Trout Brook is a tributary to the Paulins Kill and, as in all Wildlife Management Areas, is specifically managed "to enhance wildlife populations and provide wildlife oriented recreation" (*NJDEP Division of Fish and Wildlife*). Hunting and fishing are permitted in the preserve with licenses as regulated by the State. There is a boat launch at Quick Pond and Trout Brook is stocked each year in the beginning of May. Trout Brook WMA is open to hiking, birding and cross country skiing. There is currently no established trail system within the preserve.

The Paulinskill Valley Trail is a 27-mile trail that is part of Kittatinny Valley State Park. The trail became part of the New Jersey State Park system in 1992 and runs along the border between Stillwater and Fredon Townships and is suitable for walking, biking, and horseback riding. Rain beds of the Former Sussex Railroad and New York, Susquehanna and Western Railroad provide the cinder-based paths for the trail (*NJ DEP*)

Federal

The National Park Service owns 161 acres within Stillwater Township which pertain to the larger Delaware Water Gap National Recreation Area. The Delaware Water Gap NRA encompasses nearly 70,000 acres in northwestern New Jersey and northeastern Pennsylvania along the Delaware River and Kittatinny Ridge. Visitors to the park can canoe, hike, swim, picnic, bicycle, cross country ski, and horseback ride. Fishing and hunting are permitted in season with state licenses. More than 20 bird species have been observed in the park, making it a prime spot for bird watchers. Currently, there is limited pedestrian access from the northernmost point of Fairview Lake Road in Stillwater into the Delaware Water Gap National Recreation Area.

Non-Profit

Three non-profits, The Nature Conservancy, Ridge and Valley Conservancy and Fairview Lake & Watershed Conservation Foundation own land in Stillwater Township. The Nature Conservancy owns 147 acres, the Ridge and Valley Conservancy maintains 373 acres and the Fairview Lake & Watershed Foundation has 9 acres.

The Arctic Meadows Preserve was established in 1990 by The Nature Conservancy. The 82 acre preserve was created to protect the Yellow Spring Beauty (*Claytonia virginica, var. hammondiae*), a rare flower that is found nowhere else in the world. The NJ DEP designates the Preserve as a Natural Heritage Priority Site. This unique area borders an inland acidic seep where cold acidic water intersects the ground surface and creates a unique wetland. Due to the sensitivity of the rare vegetation and ecosystem, visitation of

the preserve is restricted to scientific research by advance arrangement (*The Nature Conservancy*).

Blair Creek Preserve was purchased through the NJ DEP Green Acres Program in 2004 with Ridge and Valley Conservancy and The Nature Conservancy. Warren County and Hardwick Township also contributed to the purchase. Of the 614 acre property 574 acres fall within Stillwater Township and are owned by The Nature Conservancy, the Ridge and Valley Conservancy and the NJ DEP. The Blair Creek Preserve, located at the southwest end of Fairview Lake at the base of the Kittatinny Ridge is rich habitat for interior forest species such as bobcats, black bears, red fox, grey fox and coyote. The preserve is also home to several threatened and endangered species including the Timber Rattlesnake, Wood Turtle, Barred Owl and Red-shouldered Hawk. The preserve is adjacent to several other large parcels of open space including the 495 acre Fairview Lake YMCA Camp, the 163 acre Camp Towadena (owned by Stillwater Township), 71 acres owned by the Bergen Council Boy Scouts (Camp No-Be-Bo-Sco) and the Delaware Water Gap National Recreation Area. Limited hunting is allowed in this preserve. The New Jersey Natural Lands Trist, The Nature Conservancy and the Ridge and Valley Conservancy are jointly managing the land (*NJ DEP*).

The Fairview Lake and Watershed Conservation Foundation own a 9 acre plot of land along the southeastern shore of Fairview Lake that has a deed restricted conservation easement. This land is adjacent to the Fairview Lake YMCA Camp and in proximity to the Blair Creek Preserve.

Preserved Farmland

There are 486 acres of Preserved Farmland in Stillwater Township. These privately owned farms are preserved by an agricultural easement held by the county.

Conservations Easements

Conservation easements exist on 356 acres of private, public and church properties in Stillwater Township.

Public Land

Municipal Land (Non-ROSI)

The Township of Stillwater owns 140 acres of land that is used for general municipal purposes, including the municipal building, public works and municipal court.

Stillwater Water District

The Stillwater Water District owns three properties totaling 1.4 acres for wells, pumps and water towers.

Sussex County

The County of Sussex owns 2.5 acres of land for a county garage on Fredon Road.

State of New Jersey

The State of New Jersey owns 0.5 acres within the Township of Stillwater that are specifically owned by Real Property Management.

Camps

Stillwater Township is also home to several camps that cover 1,213 acres of which 217 have conservation easements.

- The Orange YMCA owns the Fairview Lake YMCA Camp located on Fairview Lake totaling 607 acres.
- The Girl Scouts own the 331 acre Camp Lou Henry Hoover located on by Swartswood Lake.
- The Commission on Camps (affiliated with the United Methodist Church) owns the Aldersgate Camp and Retreat Center on Mount Benevolence Road with a parcel on the shore of Swartswood Lake for a total of 122 acres.
- The Bergen Council of Boy Scouts of America own Camp No-Be-Bo-Sco; a 380 acre camp in Stillwater and Hardwick Townships of which 79 acres fall within Stillwater. This camp is located in the southwest corner of the Township.
- The Camp Nejeda Foundation owns Camp Nejeda, a 73.5 acre parcel on Saddleback Road.
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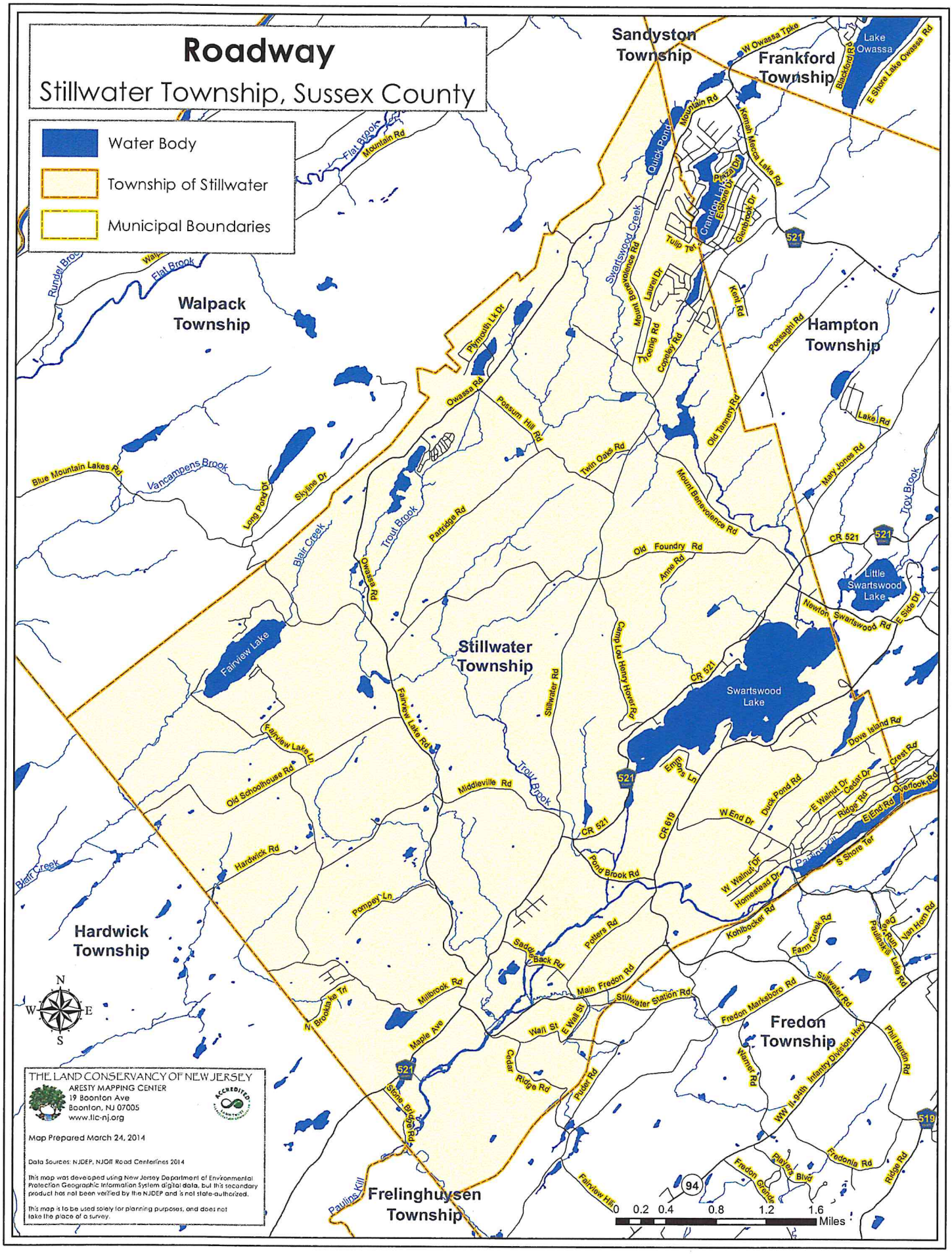
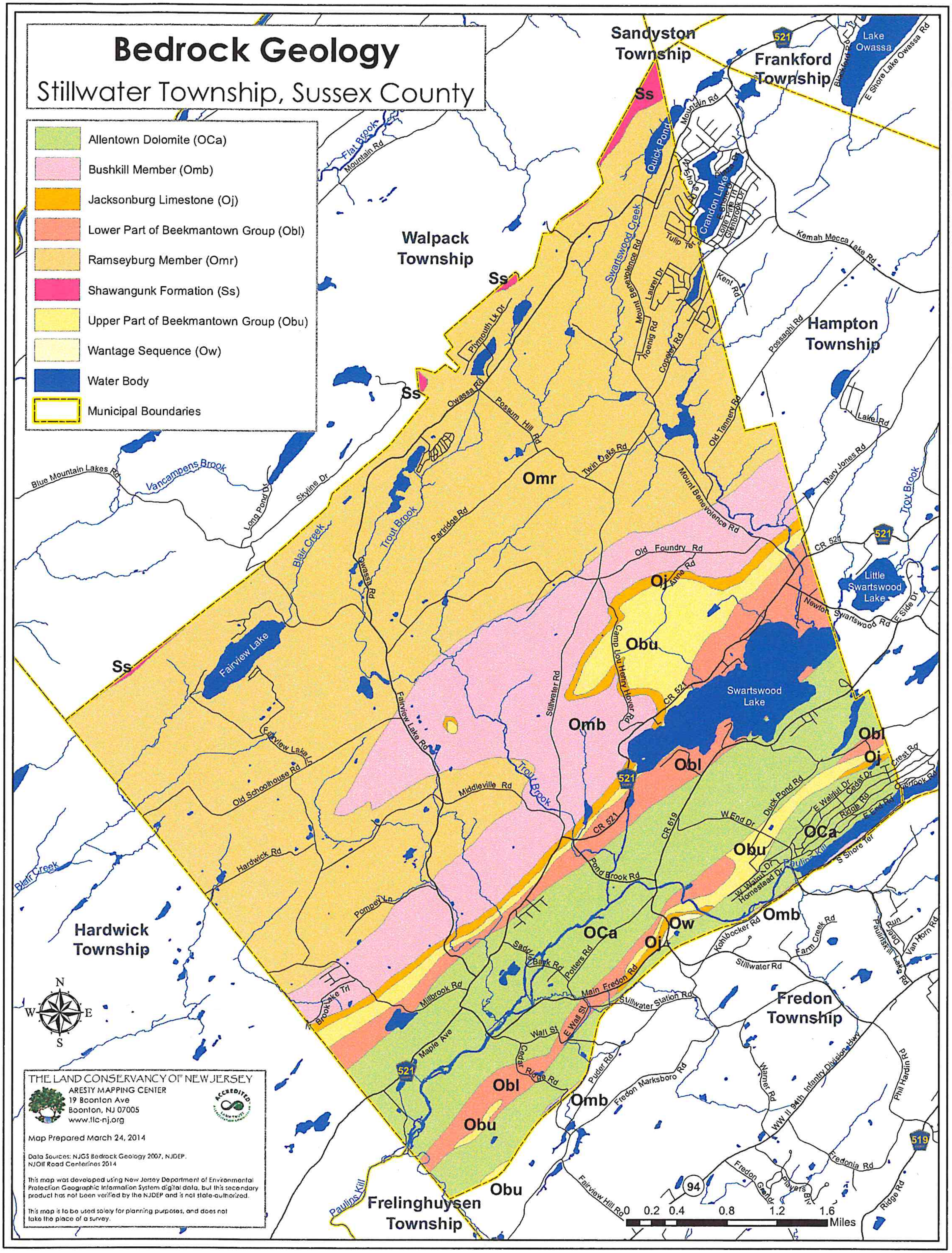
MAPS

1. Roadway
2. Bedrock Geology
3. Carbonate Rock Areas
4. Surface Geology
5. Topography
6. Soil Series
7. Watershed
8. Surface Water Quality
9. Aquifer Recharge Potential
10. Bedrock Aquifer Rankings
11. Surficial Aquifer Rankings
12. Wetlands
13. Patches with Endangered Species Habitats Identified by the Landscape Project
14. Vernal Habitats Identified by the Landscape Project
15. Land Use/Land Cover 2007
16. FEMA Flood Zones
17. Preserved Land, Non-Profit Camps, and Public Lands

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.*

Map 1. Roadway




Bedrock Geology
Stillwater Township, Sussex County
Allentown Dolomite (OCa)
Bushkill Member (Omb)
Jacksonburg Limestone (Oj)
Lower Part of Beekmantown Group (Obl)
Ramseyburg Member (Omr)
Shawangunk Formation (Ss)
Upper Part of Beekmantown Group (Obu)
Wantage Sequence (Ow)
Water Body
Municipal Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Swartswood Lake
Little Swartswood Lake
Fairview Lake
Lake Owassa
Crandon Lake
Quick Pond
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared March 24, 2014
Data Sources: NJGS Bedrock Geology 2007, NJDEP, NJOIT Road Centerlines 2014
This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
This map is to be used solely for planning purposes, and does not take the place of a survey.
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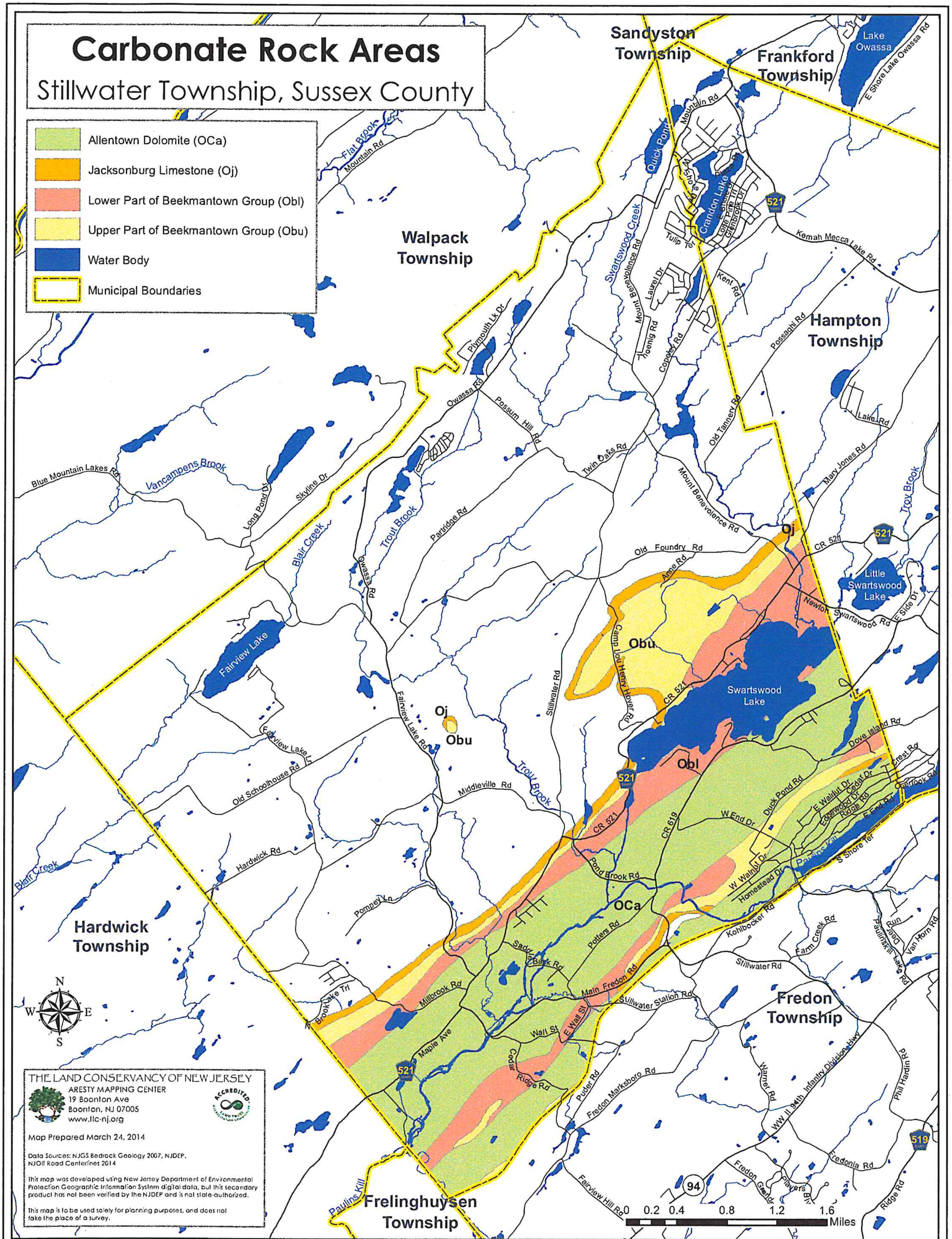
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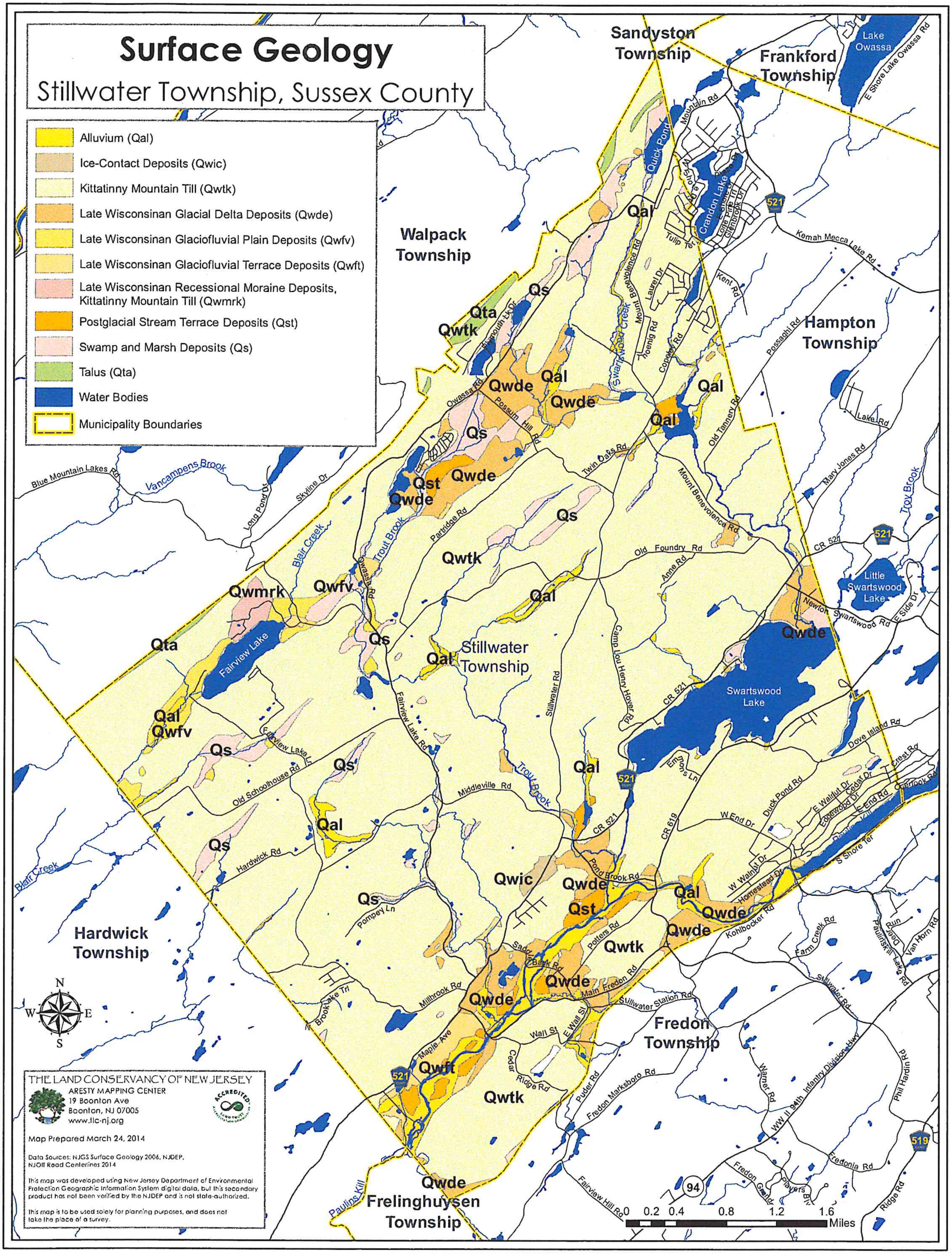
Surface Geology
Stillwater Township, Sussex County
Alluvium (Qal)
Ice-Contact Deposits (Qwic)
Kittatinny Mountain Till (Qwtk)
Late Wisconsinan Glacial Delta Deposits (Qwde)
Late Wisconsinan Glaciofluvial Plain Deposits (Qwfv)
Late Wisconsinan Glaciofluvial Terrace Deposits (Qwft)
Late Wisconsinan Recessional Moraine Deposits, Kittatinny Mountain Till (Qwmrk)
Postglacial Stream Terrace Deposits (Qst)
Swamp and Marsh Deposits (Qs)
Talus (Qta)
Water Bodies
Municipality Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Stillwater Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Lake Owassa
Little Swartswood Lake
Swartswood Lake
Fairview Lake
Crandon Lakes
Quick Pond
Blair Creek
Trout Brook
Swartswood Creek
Vancampens Brook
Troy Brook
Paulins Kill
Qal
Qwic
Qwtk
Qwde
Qwfv
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Blue Mountain Lakes Rd
Long Pond Dr
Skyline Dr
Owassa Rd
Partridge Rd
Possum Hill Rd
Mount Benevolence Rd
Laurel Dr
Copeley Rd
Old Tannery Rd
Twin Oaks Rd
Kemah Mecca Lake Rd
Kent Rd
Possaghi Rd
Lake Rd
Mary Jones Rd
Mountain Rd
Tulip Ter
E Shore Lake Owassa Rd
Old Foundry Rd
Anne Rd
CR 521
Newton Swartswood Rd
E Side Dr
Camp Lou Henry Hoover Rd
Stillwater Rd
Fairview Lake Rd
Fairview Lake Ln
Old Schoolhouse Rd
Middleville Rd
Hardwick Rd
Pompey Ln
Dove Island Rd
Crest Rd
Duck Pond Rd
W End Dr
E Walnut Dr
Cedar Dr
E End Rd
S Shore Ter
W Walnut Dr
Homestead Dr
Kohlbocker Rd
CR 619
Pond Brook Rd
Potters Rd
Saddle Back Rd
Main Fredon Rd
Stillwater Station Rd
Millbrook Rd
Brook Lake Trl
Maple Ave
Wall St
E Wall St
Cedar Ridge Rd
Puder Rd
Fredon Marksboro Rd
Fairview Hill Rd
Farm Creek Rd
Paulinskill Lake Rd
Van Horn Rd
Deer Run
Warner Rd
WW II 94th Infantry Division Hwy
Phil Hardin Rd
Fredonia Rd
Fredon Graded
Ridge Rd
521
519
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THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
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ACCREDITED
Map Prepared March 24, 2014
Data Sources: NJGS Surface Geology 2006, NJDEP, NJOIT Road Centerlines 2014
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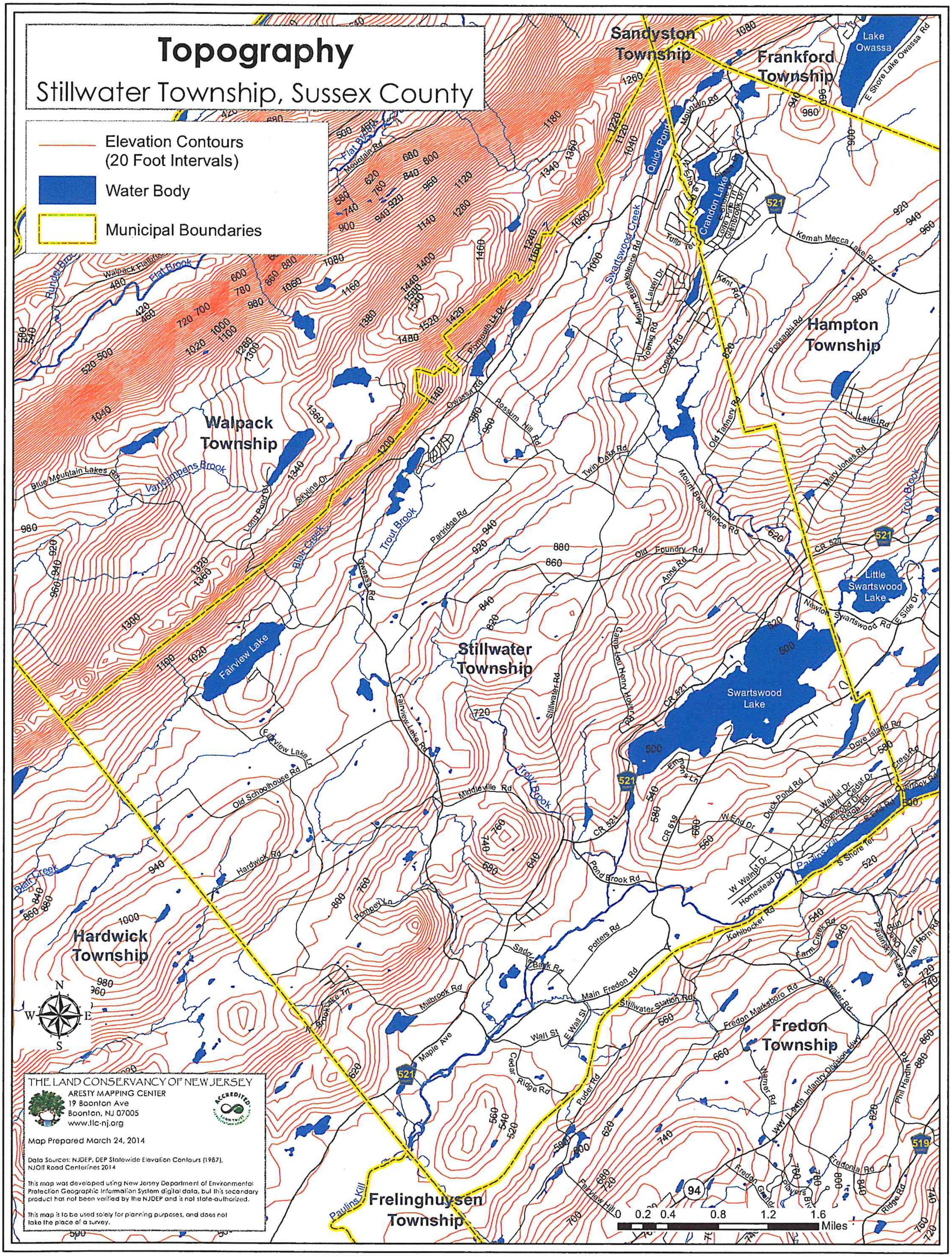
Topography
Stillwater Township, Sussex County
Elevation Contours (20 Foot Intervals)
Water Body
Municipal Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Stillwater Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Lake Owassa
Little Swartswood Lake
Swartswood Lake
Fairview Lake
Crandon Lake
Quick Pond
Trout Brook
Swartswood Creek
Blair Creek
Flat Brook
Vancampens Brook
Paulins Kill
0 0.2 0.4 0.8 1.2 1.6 Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared March 24, 2014
Data Sources: NJDEP, DEP Statewide Elevation Contours (1987), NJOIT Road Centerlines 2014
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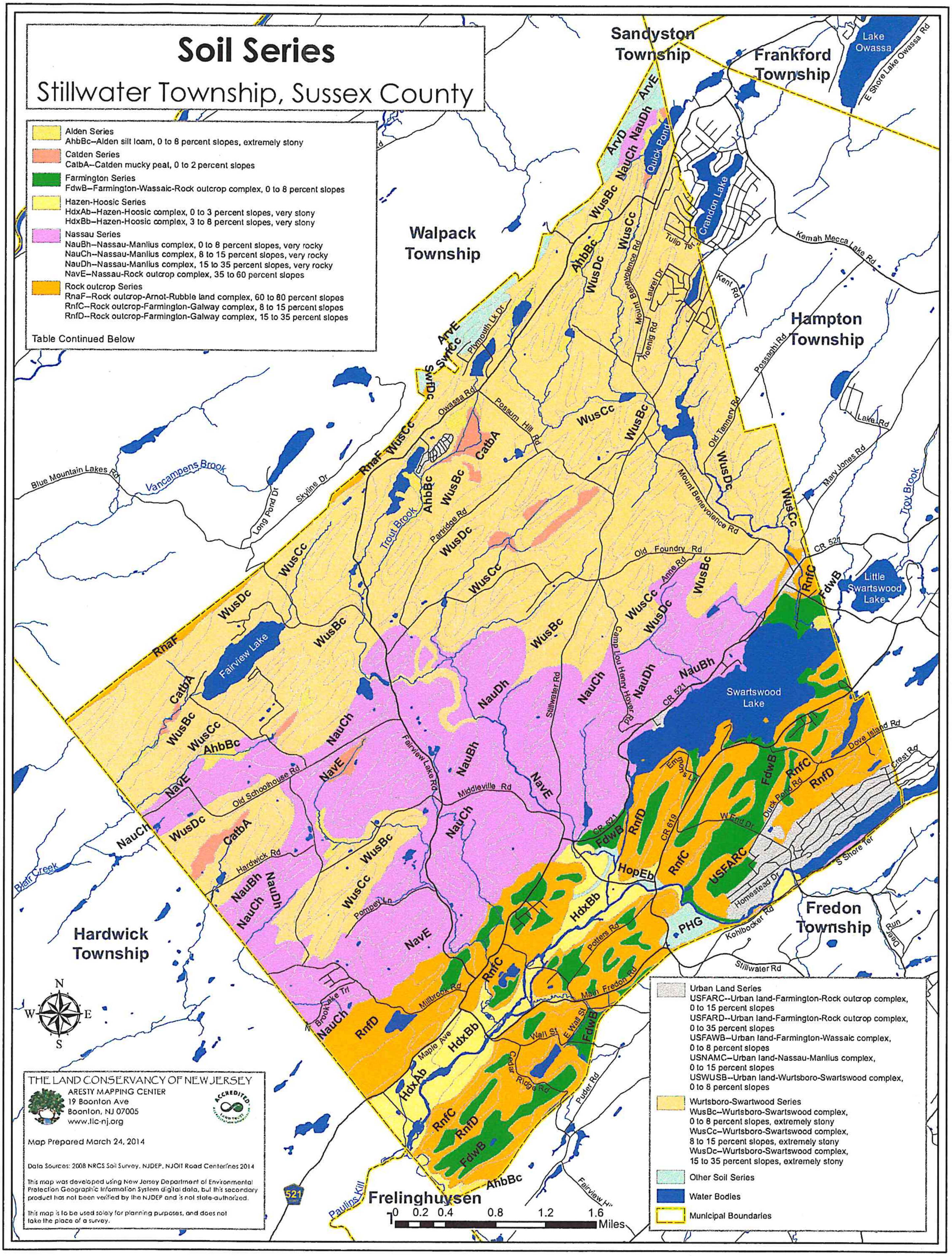
Soil Series
Stillwater Township, Sussex County
Alden Series
AhbBc–Alden silt loam, 0 to 8 percent slopes, extremely stony
Catden Series
CatbA–Catden mucky peat, 0 to 2 percent slopes
Farmington Series
FdwB–Farmington-Wassaic-Rock outcrop complex, 0 to 8 percent slopes
Hazen-Hoosic Series
HdxAb–Hazen-Hoosic complex, 0 to 3 percent slopes, very stony
HdxBb–Hazen-Hoosic complex, 3 to 8 percent slopes, very stony
Nassau Series
NauBh–Nassau-Manlius complex, 0 to 8 percent slopes, very rocky
NauCh–Nassau-Manlius complex, 8 to 15 percent slopes, very rocky
NauDh–Nassau-Manlius complex, 15 to 35 percent slopes, very rocky
NavE–Nassau-Rock outcrop complex, 35 to 60 percent slopes
Rock outcrop Series
RnaF–Rock outcrop-Arnot-Rubble land complex, 60 to 80 percent slopes
RnfC–Rock outcrop-Farmington-Galway complex, 8 to 15 percent slopes
RnfD–Rock outcrop-Farmington-Galway complex, 15 to 35 percent slopes
Table Continued Below
Urban Land Series
USFARC–Urban land-Farmington-Rock outcrop complex, 0 to 15 percent slopes
USFARD–Urban land-Farmington-Rock outcrop complex, 0 to 35 percent slopes
USFAWB–Urban land-Farmington-Wassaic complex, 0 to 8 percent slopes
USNAMC–Urban land-Nassau-Manlius complex, 0 to 15 percent slopes
USWUSB–Urban land-Wurtsboro-Swartswood complex, 0 to 8 percent slopes
Wurtsboro-Swartwood Series
WusBc–Wurtsboro-Swartswood complex, 0 to 8 percent slopes, extremely stony
WusCc–Wurtsboro-Swartswood complex, 8 to 15 percent slopes, extremely stony
WusDc–Wurtsboro-Swartswood complex, 15 to 35 percent slopes, extremely stony
Other Soil Series
Water Bodies
Municipal Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen
Lake Owassa
Quick Pond
Crandon Lake
Fairview Lake
Swartswood Lake
Little Swartswood Lake
Vancampens Brook
Trout Brook
Troy Brook
Blair Creek
Paulins Kill
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Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
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Map Prepared March 24, 2014
Data Sources: 2008 NRCS Soil Survey, NJDEP, NJOIT Road Centerlines 2014
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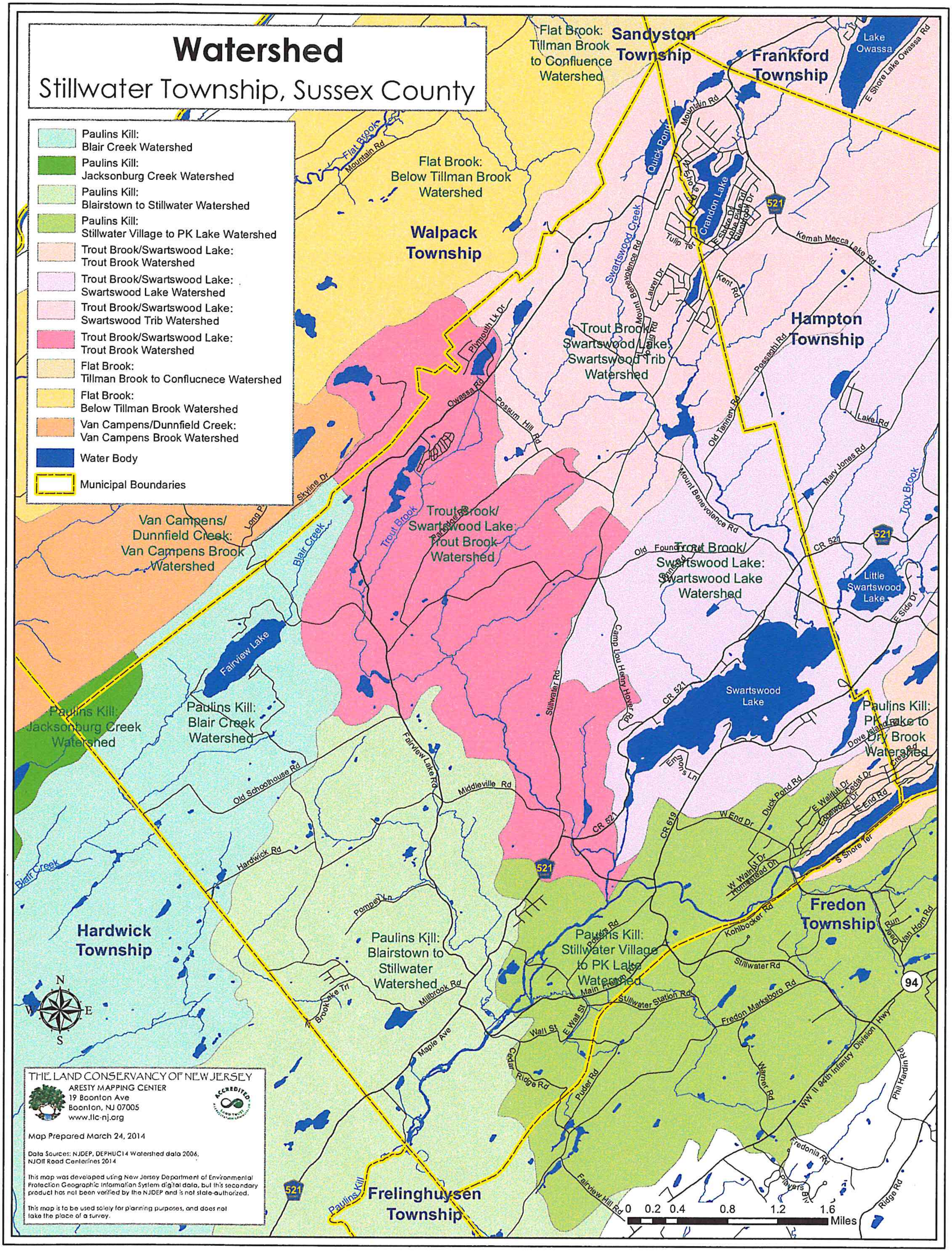
Watershed
Stillwater Township, Sussex County
Paulins Kill: Blair Creek Watershed
Paulins Kill: Jacksonburg Creek Watershed
Paulins Kill: Blairstown to Stillwater Watershed
Paulins Kill: Stillwater Village to PK Lake Watershed
Trout Brook/Swartswood Lake: Trout Brook Watershed
Trout Brook/Swartswood Lake: Swartswood Lake Watershed
Trout Brook/Swartswood Lake: Swartswood Trib Watershed
Trout Brook/Swartswood Lake: Trout Brook Watershed
Flat Brook: Tillman Brook to Conflucnece Watershed
Flat Brook: Below Tillman Brook Watershed
Van Campens/Dunnfield Creek: Van Campens Brook Watershed
Water Body
Municipal Boundaries
Flat Brook: Tillman Brook to Confluence Watershed
Sandyston Township
Frankford Township
Lake Owassa
Flat Brook: Below Tillman Brook Watershed
Walpack Township
Crandon Lake
Quick Pond
Swartswood Creek
Trout Brook/ Swartswood Lake/ Swartswood Trib Watershed
Hampton Township
Trout Brook/ Swartswood Lake: Trout Brook Watershed
Trout Brook
Trout Brook/ Swartswood Lake: Swartswood Lake Watershed
Little Swartswood Lake
Troy Brook
Van Campens/ Dunnfield Creek: Van Campens Brook Watershed
Blair Creek
Fairview Lake
Paulins Kill: Jacksonburg Creek Watershed
Paulins Kill: Blair Creek Watershed
Swartswood Lake
Paulins Kill: PK Lake to Dry Brook Watershed
Hardwick Township
Paulins Kill: Blairstown to Stillwater Watershed
Paulins Kill: Stillwater Village to PK Lake Watershed
Fredon Township
Frelinghuysen Township
Paulins Kill
521
94
N
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0 0.2 0.4 0.8 1.2 1.6 Miles
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared March 24, 2014
Data Sources: NJDEP, DEPHUC14 Watershed data 2006, NJOIT Road Centerlines 2014
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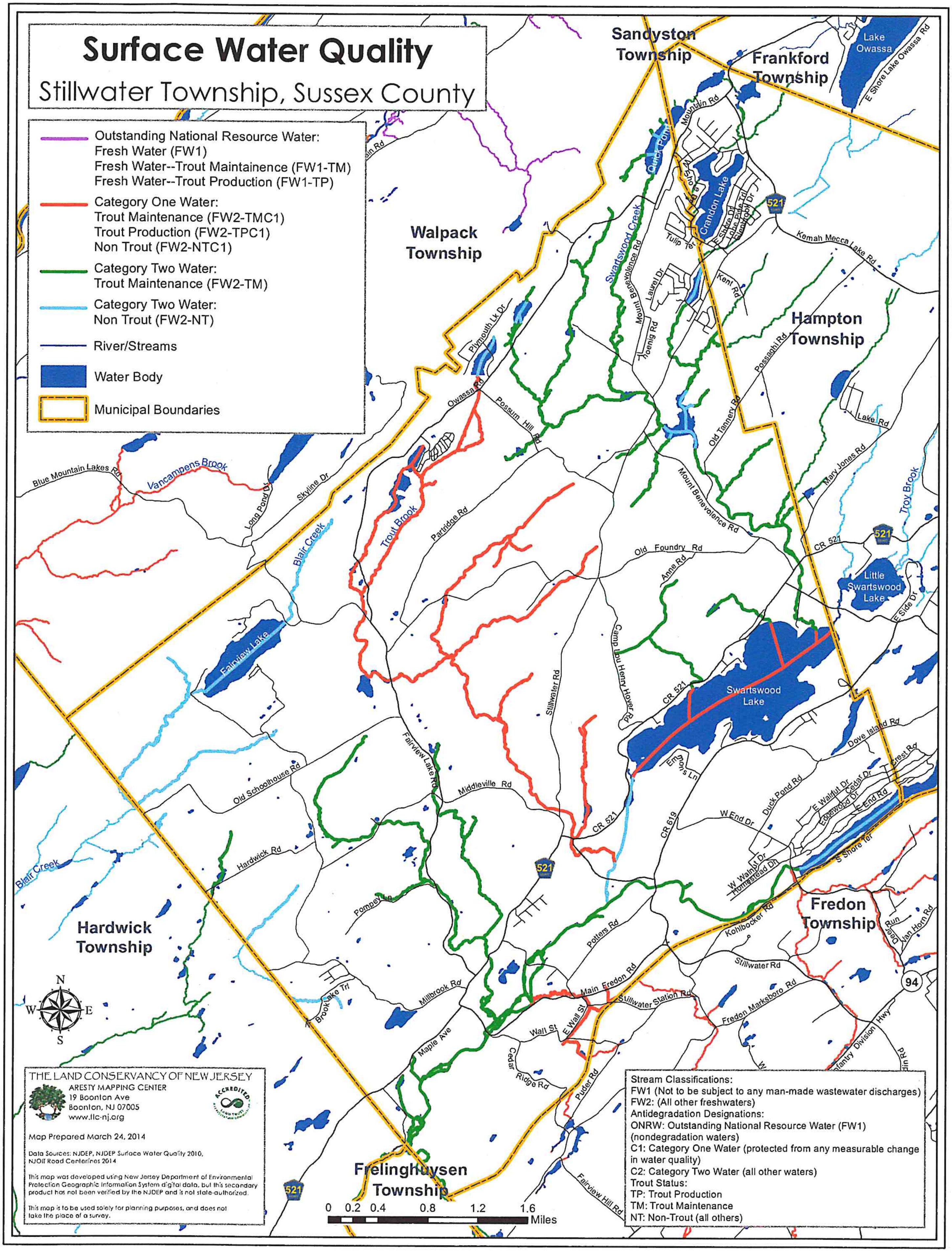
Surface Water Quality
Stillwater Township, Sussex County
Outstanding National Resource Water:
Fresh Water (FW1)
Fresh Water--Trout Maintainence (FW1-TM)
Fresh Water--Trout Production (FW1-TP)
Category One Water:
Trout Maintenance (FW2-TMC1)
Trout Production (FW2-TPC1)
Non Trout (FW2-NTC1)
Category Two Water:
Trout Maintenance (FW2-TM)
Category Two Water:
Non Trout (FW2-NT)
River/Streams
Water Body
Municipal Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Lake Owassa
Crandon Lake
Swartswood Lake
Little Swartswood Lake
Fairview Lake
Quick Pond
Swartswood Creek
Vancampens Brook
Blair Creek
Trout Brook
Troy Brook
Mountain Rd
Kemah Mecca Lake Rd
E Shore Lake Owassa Rd
Mount Benevolence Rd
Possum Hill Rd
Owassa Rd
Plymouth Lk Dr
Blue Mountain Lakes Rd
Long Pond Dr
Skyline Dr
Partridge Rd
Old Foundry Rd
Anne Rd
Camp Lou Henry Hoover Rd
Stillwater Rd
Old Tannery Rd
Possaghi Rd
Lake Rd
Mary Jones Rd
Dove Island Rd
Duck Pond Rd
W End Dr
E End Rd
S Shore Ter
Kohlbocker Rd
Potters Rd
Main Fredon Rd
Stillwater Station Rd
Fredon Marksboro Rd
Infantry Division Hwy
Van Horn Rd
Deer Run
Old Schoolhouse Rd
Hardwick Rd
Middleville Rd
Fairview Lake Rd
Pompey Ln
Millbrook Rd
Brook Lake Trl
Maple Ave
Wall St
E Wall St
Cedar Ridge Rd
Puder Rd
Fairview Hill Rd
CR 521
CR 619
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0 0.2 0.4 0.8 1.2 1.6 Miles
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ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared March 24, 2014
Data Sources: NJDEP, NJDEP Surface Water Quality 2010, NJOIT Road Centerlines 2014
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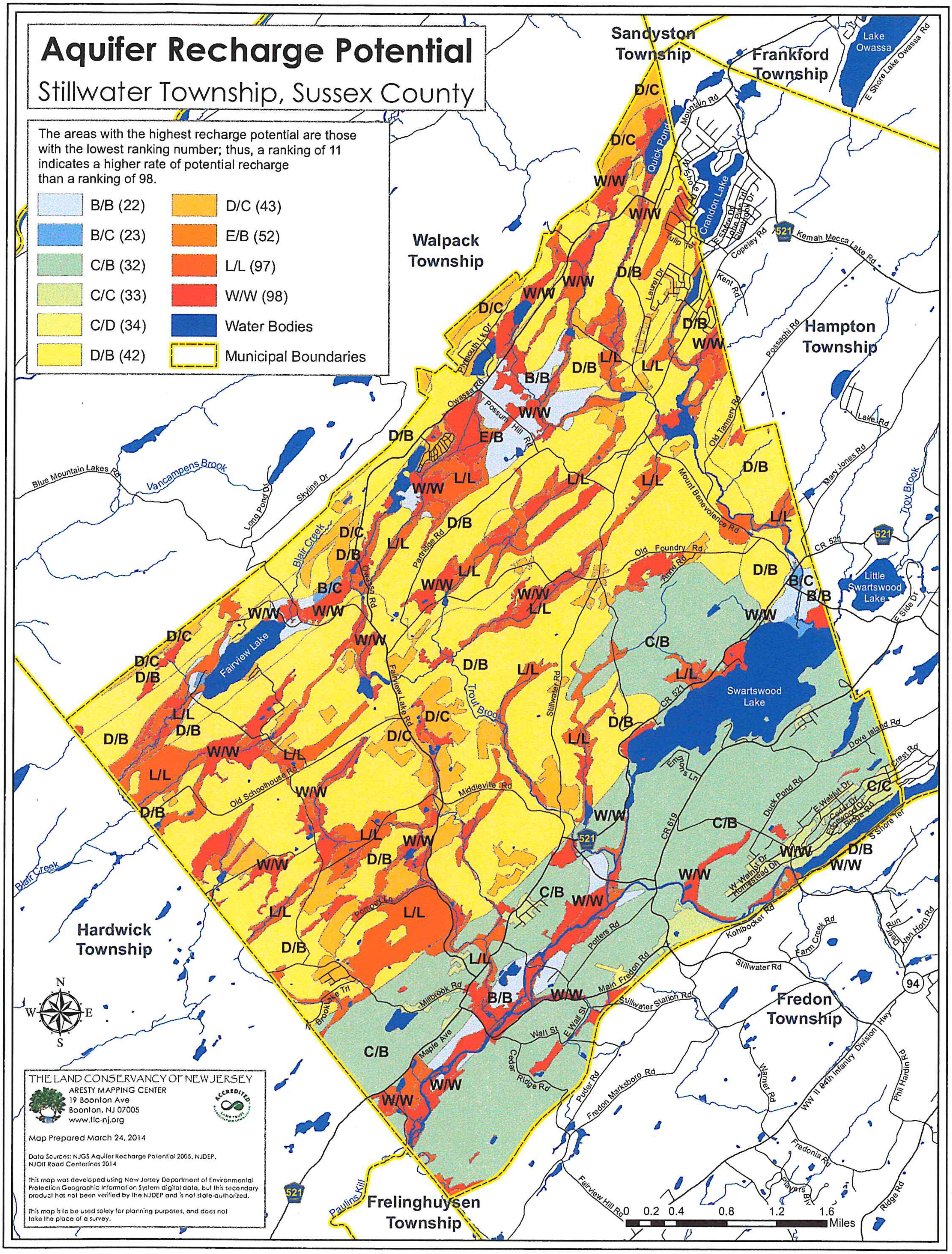
Stream Classifications:
FW1 (Not to be subject to any man-made wastewater discharges)
FW2: (All other freshwaters)
Antidegradation Designations:
ONRW: Outstanding National Resource Water (FW1)
(nondegradation waters)
C1: Category One Water (protected from any measurable change
in water quality)
C2: Category Two Water (all other waters)
Trout Status:
TP: Trout Production
TM: Trout Maintenance
NT: Non-Trout (all others)


Aquifer Recharge Potential
Stillwater Township, Sussex County
The areas with the highest recharge potential are those with the lowest ranking number; thus, a ranking of 11 indicates a higher rate of potential recharge than a ranking of 98.
B/B (22)
B/C (23)
C/B (32)
C/C (33)
C/D (34)
D/B (42)
D/C (43)
E/B (52)
L/L (97)
W/W (98)
Water Bodies
Municipal Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Lake Owassa
Crandon Lake
Fairview Lake
Swartswood Lake
Little Swartswood Lake
0 0.2 0.4 0.8 1.2 1.6 Miles
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Data Sources: NJGS Aquifer Recharge Potential 2005, NJDEP, NJOIT Road Centerlines 2014
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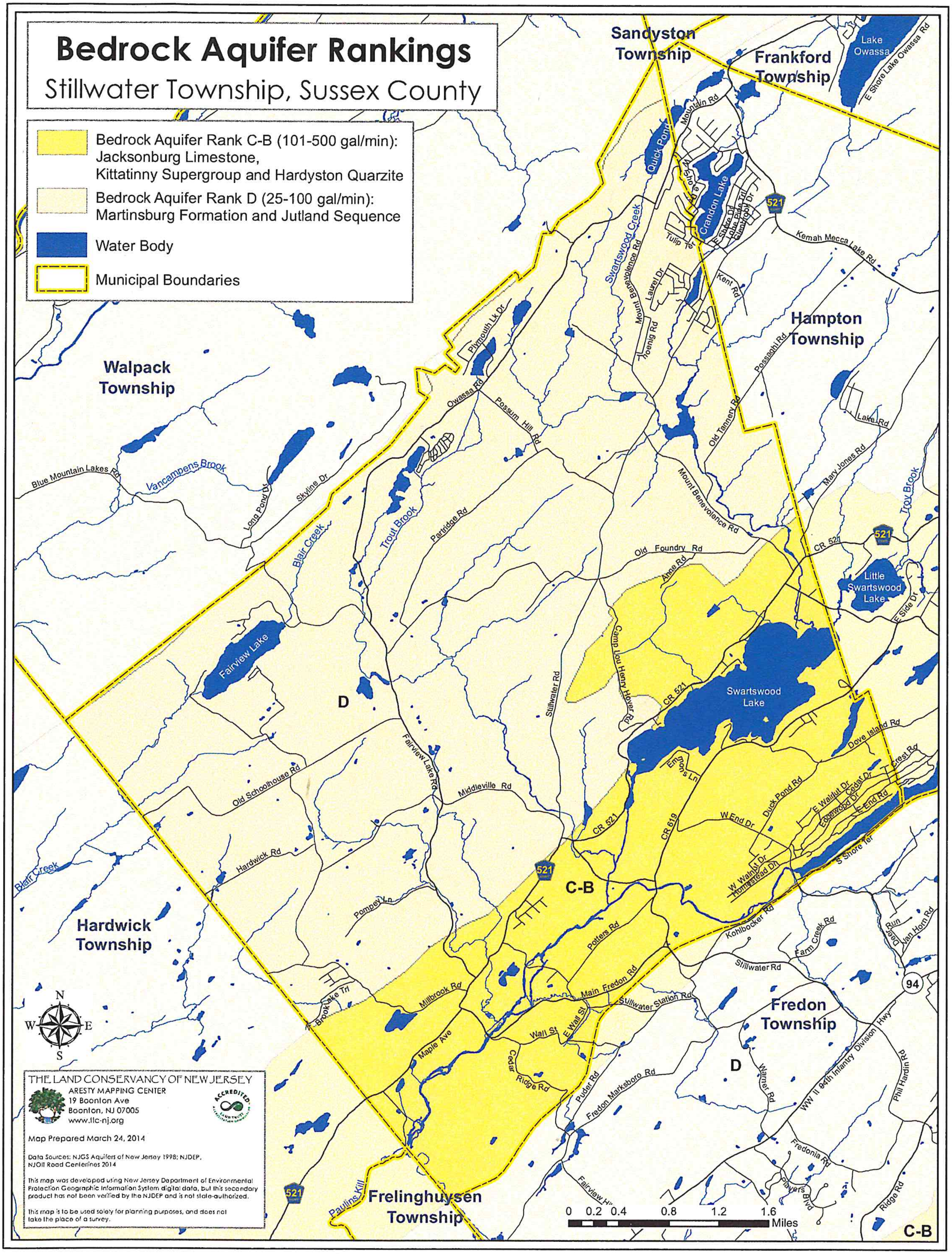
Bedrock Aquifer Rankings
Stillwater Township, Sussex County
Bedrock Aquifer Rank C-B (101-500 gal/min): Jacksonburg Limestone, Kittatinny Supergroup and Hardyston Quartzite
Bedrock Aquifer Rank D (25-100 gal/min): Martinsburg Formation and Jutland Sequence
Water Body
Municipal Boundaries
Sandyston Township
Frankford Township
Lake Owassa
E Shore Lake Owassa Rd
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Quick Pond
Crandon Lake
Swartswood Creek
Mountain Rd
Kemah Mecca Lake Rd
Tulip Te
Kent Rd
Laurel Dr
Mount Benevolence Rd
Hoenig Rd
Possaghi Rd
Old Tannery Rd
Lake Rd
Mary Jones Rd
Troy Brook
Plymouth Lk Dr
Owassa Rd
Possum Hill Rd
Blue Mountain Lakes Rd
Vancampens Brook
Long Pond Dr
Skyline Dr
Trout Brook
Blair Creek
Partridge Rd
Old Foundry Rd
Anne Rd
CR 521
Little Swartswood Lake
E Side Dr
Fairview Lake
Camp Lou Henry Hoover Rd
Stillwater Rd
Swartswood Lake
Dove Island Rd
Crest Rd
D
Fairview Lake Rd
Middleville Rd
Old Schoolhouse Rd
Emmons Ln
Duck Pond Rd
E Walnut Dr
Cedar Dr
Edgewood Dr
E End Rd
W End Dr
CR 619
S Shore Ter
W Walnut Dr
Homestead Dr
Hardwick Rd
C-B
Pompey Ln
Kohlbocker Rd
Farm Creek Rd
Van Horn Rd
Potters Rd
Stillwater Rd
Main Fredon Rd
Millbrook Rd
Brook Lake Trl
Stillwater Station Rd
Wall St
E Wall St
Maple Ave
Cedar Ridge Rd
Puder Rd
Fredon Marksboro Rd
Warner Rd
WW II 84th Infantry Division Hwy
Phil Hardin Rd
Fredonia Rd
Players Blvd
Fairview Hill Rd
Ridge Rd
Paulins Kill
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C-B
THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
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Data Sources: NJGS Aquifers of New Jersey 1998; NJDEP, NJOIT Road Centerlines 2014
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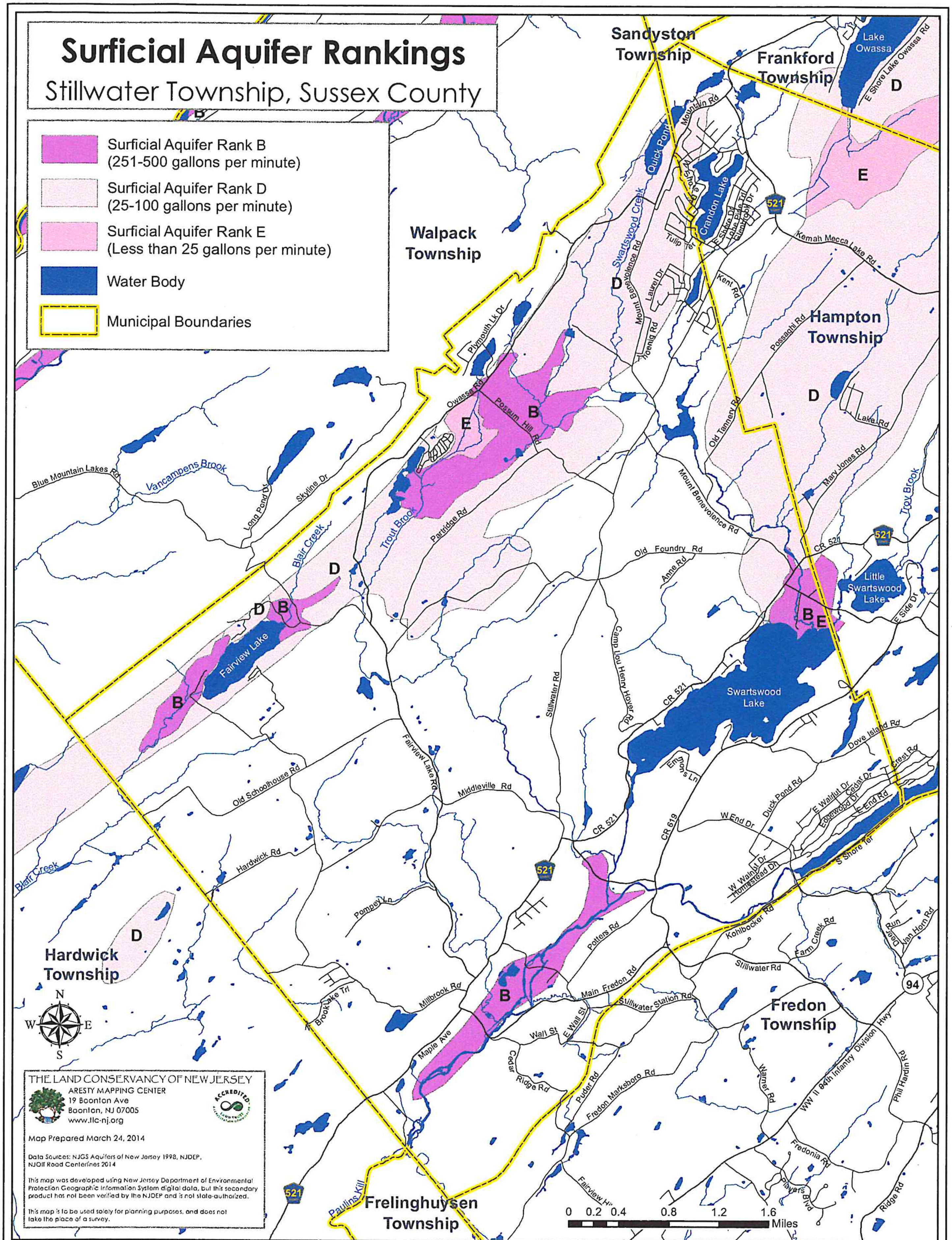
Surficial Aquifer Rankings
Stillwater Township, Sussex County
Surficial Aquifer Rank B
(251-500 gallons per minute)
Surficial Aquifer Rank D
(25-100 gallons per minute)
Surficial Aquifer Rank E
(Less than 25 gallons per minute)
Water Body
Municipal Boundaries
Sandyston Township
Frankford Township
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Lake Owassa
Crandon Lake
Quick Pond
Fairview Lake
Swartswood Lake
Little Swartswood Lake
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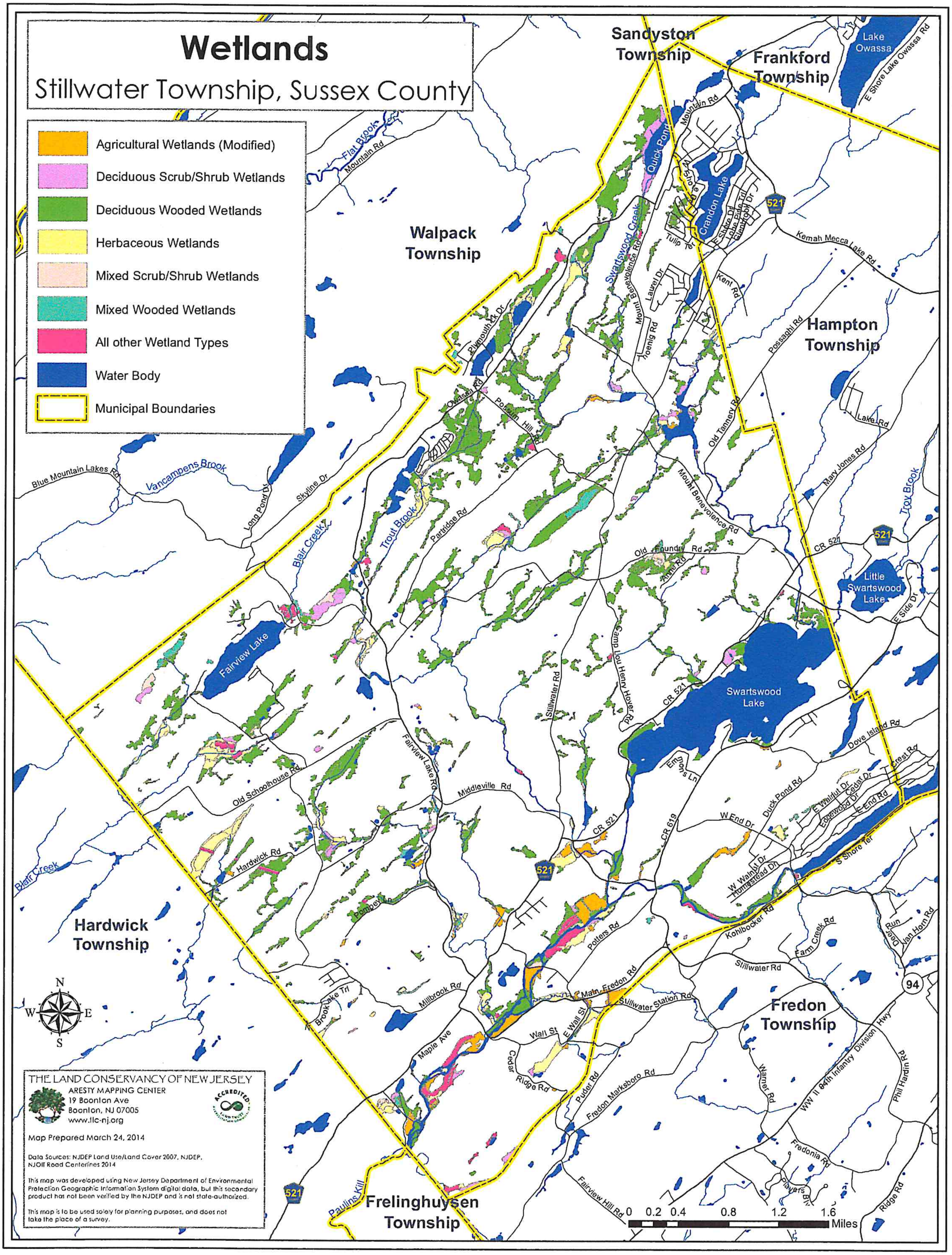
0 0.2 0.4 0.8 1.2 1.6
Miles


Wetlands
Stillwater Township, Sussex County
Agricultural Wetlands (Modified)
Deciduous Scrub/Shrub Wetlands
Deciduous Wooded Wetlands
Herbaceous Wetlands
Mixed Scrub/Shrub Wetlands
Mixed Wooded Wetlands
All other Wetland Types
Water Body
Municipal Boundaries
Sandyston Township
Frankford Township
Lake Owassa
E Shore Lake Owassa Rd
Walpack Township
Hampton Township
Hardwick Township
Fredon Township
Frelinghuysen Township
Crandon Lake
Quick Pond
Swartswood Creek
Fairview Lake
Swartswood Lake
Little Swartswood Lake
Blair Creek
Trout Brook
Vancampens Brook
Flat Brook
Troy Brook
Paulins Kill
Mountain Rd
Kemah Mecca Lake Rd
Mount Benevolence Rd
Possaghi Rd
Old Tannery Rd
Lake Rd
Mary Jones Rd
Blue Mountain Lakes Rd
Long Pond Dr
Skyline Dr
Partridge Rd
Possum Hill Rd
Plymouth Lk Dr
Old Foundry Rd
CR 521
CR 619
Camp Lou Henry Hoover Rd
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Fairview Lake Rd
Middleville Rd
Old Schoolhouse Rd
Hardwick Rd
Pompey Ln
Millbrook Rd
Brook Lake Trl
Maple Ave
Cedar Ridge Rd
Wall St
E Wall St
Main Fredon Rd
Stillwater Station Rd
Potters Rd
Kohlbocker Rd
Farm Creek Rd
Stillwater Rd
Puder Rd
Fredon Marksboro Rd
Fairview Hill Rd
Warner Rd
WW II 84th Infantry Division Hwy
Phil Hardin Rd
Fredonia Rd
Players Blvd
Ridge Rd
Dove Island Rd
E Side Dr
Duck Pond Rd
W End Dr
W Walnut Dr
Homestead Dr
S Shore Ter
Emmons Ln
Tulip Te
Laurel Dr
Kent Rd
Hoenig Rd
Van Horn Rd
Deer Run
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THE LAND CONSERVANCY OF NEW JERSEY
ARESTY MAPPING CENTER
19 Boonton Ave
Boonton, NJ 07005
www.tlc-nj.org
Map Prepared March 24, 2014
Data Sources: NJDEP Land Use/Land Cover 2007, NJDEP, NJOIT Road Centerlines 2014
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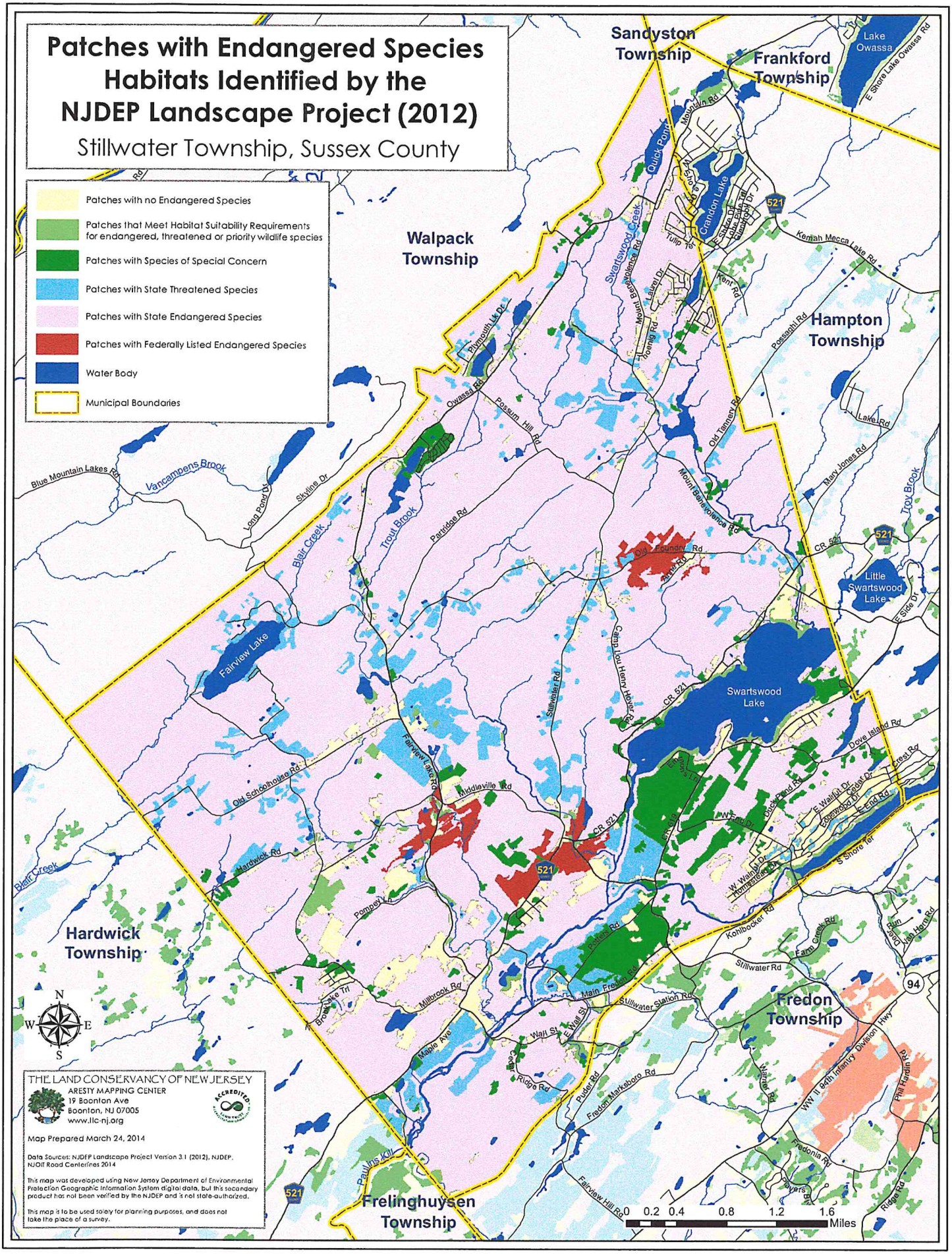
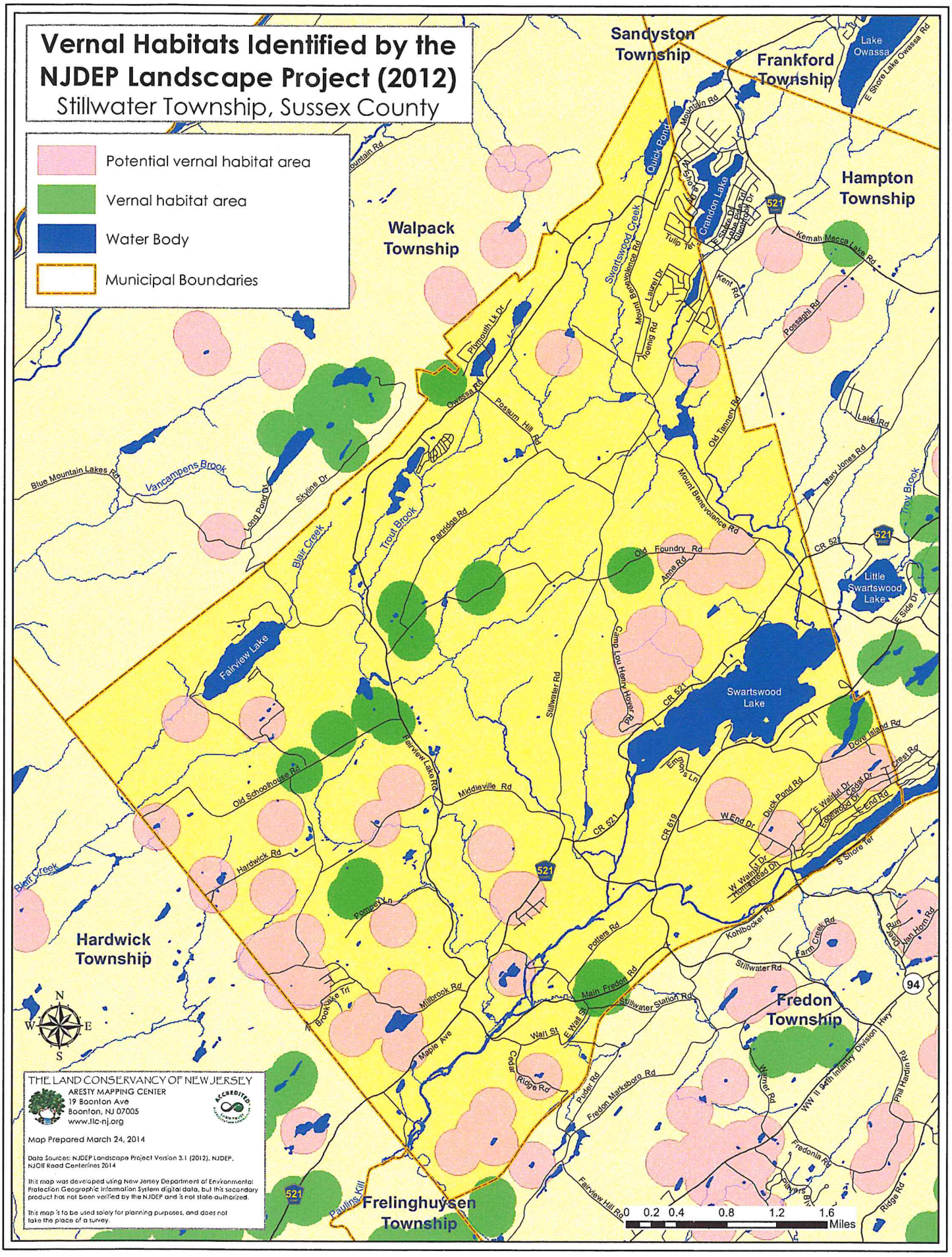
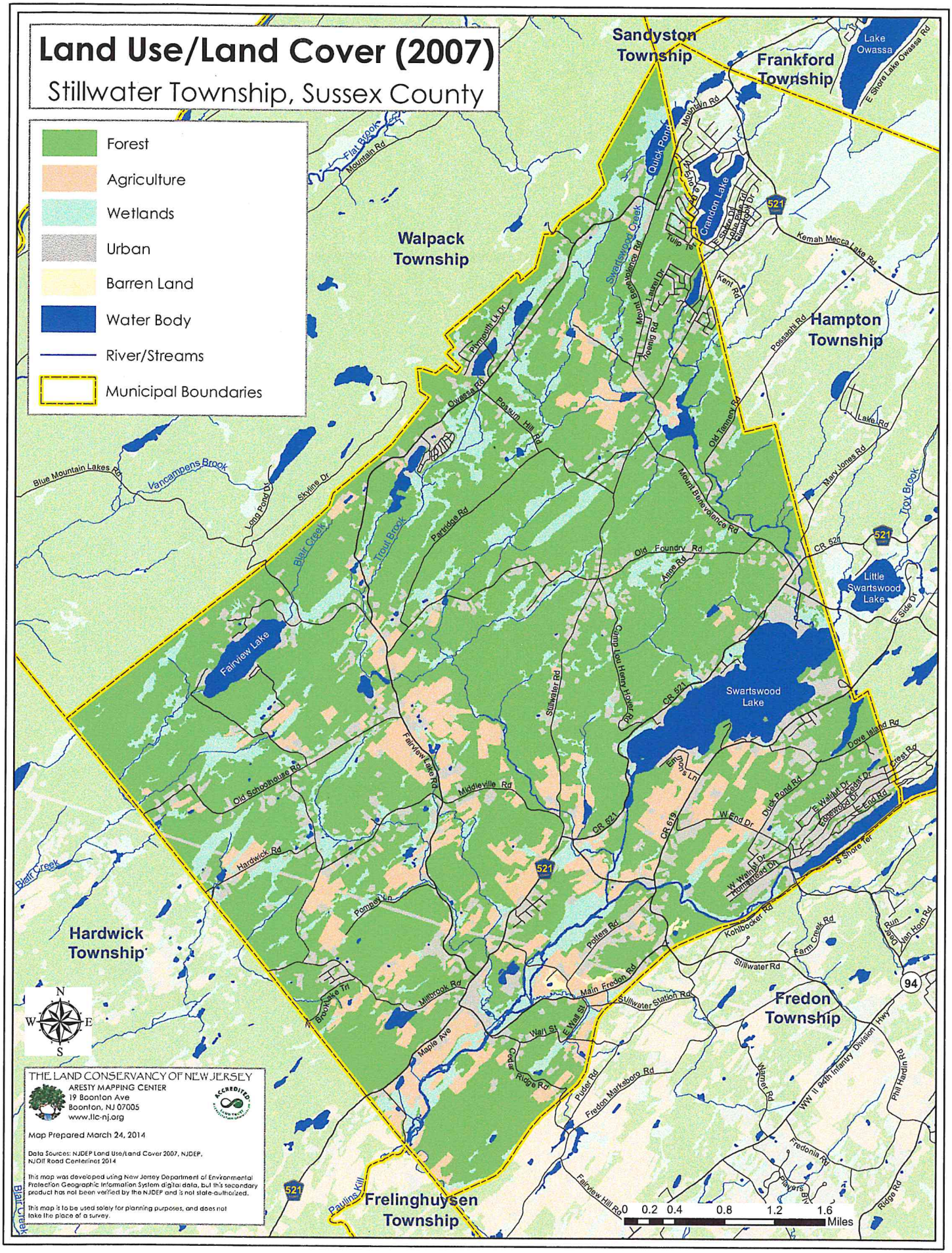
Map 13. Patches with Endangered Species Habitats Identified by the Landscape Project



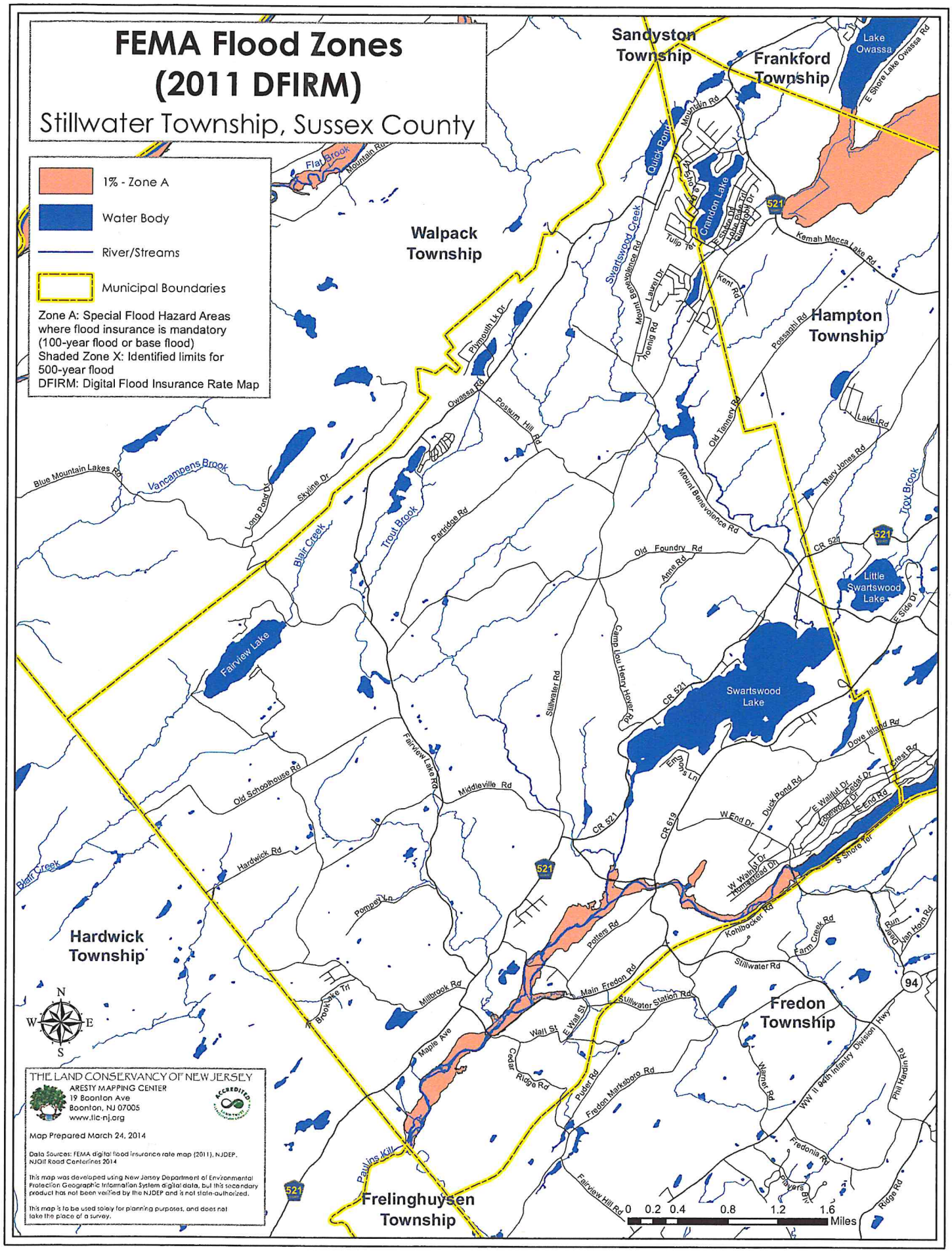
Map 14. Vernal Habitats Identified by the NJDEP Landscape Project



Map 15. Land Use/Land Cover



Map 16. FEMA Flood Zones



Map 17. Preserved Land, Non-Profit Camps, and Public Lands