

OPEN SPACE AND RECREATION PLAN UPDATE: AMENDMENT—WATER RESOURCES

COUNTY of WARREN



SEPTEMBER 27, 2018



**OPEN SPACE AND RECREATION PLAN UPDATE:
AMENDMENT – WATER RESOURCES**

for

County of Warren

Prepared September 27, 2018 by:

The Land Conservancy of New Jersey

An accredited land trust

19 Boonton Avenue

Boonton, NJ 07005



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

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

OPEN SPACE AND RECREATION PLAN UPDATE: AMENDMENT – WATER RESOURCES

for

County of Warren

Produced by:

The Land Conservancy of New Jersey

David Epstein, President

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

Kenneth Fung, GIS Manager

Bobby DeMarco, Andrea Dunchus, Christine Leonhardt, Andrew Wainwright – Planning Interns

Project Consultants:

Daniel J. Van Abs, Ph.D.

School of Environmental & Biological Sciences, Rutgers, The State University of New Jersey

Laura Tessieri, Associate Director

North Jersey Resource Conservation & Development Council (RC&D)

For further information, please contact:



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG



Warren County Department of Planning
Wayne Dumont, Jr. Administration Building
165 County Route 519 South
Belvidere, NJ 07823-1949
PH: (908) 475-6532

Warren County Department of Land Preservation
500 Mt. Pisgah Avenue, P.O. Box 179
Oxford, NJ 07863
PH: (908) 453-3252

www.co.warren.nj.us

ACKNOWLEDGEMENTS

The Land Conservancy of New Jersey wishes to acknowledge the following individuals and organizations for their help in providing information, guidance, and materials for the *Water Resources Amendment to the Warren County Open Space and Recreation Plan Update*. Their contributions have been instrumental in the creation of the report.

Board of Chosen Freeholders:

Edward J. Smith, Freeholder Director
Jason J. Sarnoski, Freeholder Deputy Director
Richard D. Gardner, Freeholder

Warren County Department of Land Preservation:

Corey Tierney, Administrator

Warren County Planning Department:

David K. Dech, Planning Director
Albert Krouse, Senior Planner (GIS)

The following individuals provided updated endangered species data for Warren County:

Elizabeth Ciuzio Freiday, Partner for Fish and Wildlife, United States Fish and Wildlife Service

Kris Schantz and Brian Zarate, Endangered & Nongame Species Program
New Jersey Department of Environmental Protection, Division of Fish and Wildlife

Kelly Triece, Conserve Wildlife Foundation of New Jersey

The following individuals assisted with the preparation and coordination of the field days:

Craig Metzgar, Amy S. Greene Environmental Consultants, Inc.

Jane Bullis, Merrill Creek Reservoir

Alan Hunt, Musconetcong Watershed Association

Kyle Richter, North Jersey RC&D and Musconetcong Watershed Association

Don Donnelly and John Parke, New Jersey Audubon

Cole Baldino, Trout Unlimited

This project was supported through the Open Space Institute's *Delaware River Watershed Protection Fund* which is made possible with a lead grant from the William Penn Foundation.

The *Delaware River Watershed Protection Program* seeks to ensure abundant, clean water within the 13,000 square mile drainage of the Delaware River.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	2
PROGRAM HISTORY AND GOALS	3
Program History	3
Goals of the Open Space Program	4
PRESERVED AND PUBLIC LANDS	5
WATER RESOURCE MODEL	9
Modeling for Water Resource Protection in Warren County.....	9
Data and Methodology	9
How are Water Resource Priorities Determined?	10
Protecting Water Resources	11
Fact Sheets and Water Resource Maps.....	12
PRESERVATION PRIORITIES	13
How are the Water Resource Priorities Mapped?	13
Priorities for Preservation – Results.....	14
Modeling Consistency.....	31
LAND STEWARDSHIP	36
Land Management: Warren County.....	36
The Use of Stewardship Criteria.....	37
LAND STEWARDSHIP MAPS.....	40
Case Studies: Land Stewardship Projects in Warren County	41
CASE STUDIES.....	43
APPENDIX.....	44
REFERENCES	45

COVER PHOTOGRAPH:

The Murphy Farm on Lanning Road, Frelinghuysen Township. Preserved in 2018, this picturesque 204 acre farm is located in the valley of the Kittatinny Mountain.

The information and maps presented in this report are intended for guidance in decision making and cannot substitute for on-site evaluation. The maps for the Water Resources Amendment to the Warren County Open Space and Recreation Plan Update were developed using NJDEP Geographic Information System digital data and the best available scientific data.

EXECUTIVE SUMMARY

Warren County has a rich and diverse open space and farmland preservation program. Home to some of the most productive soils in the region, the County has invested in its farmland program preserving over 24,000 acres of agricultural land. Of the land in Warren County that is not in agricultural production, most is covered by forests, wetlands, and winding rivers. The County's natural resources are concentrated along the Highlands and Kittatinny Ridgelines, and provide a fitting backdrop to the large farm belts within the Musconetcong, Delaware, and Pequest River Valleys. Historic villages dot the landscape and their homes, churches and barns are integrated into the County's bucolic setting. The rural setting of Warren County – with its balance of natural areas, farm belts, and small towns – has benefitted from the County's Open Space Trust Fund. Protecting the rural charm and agricultural integrity of the County has been a priority for residents, local officials, and the Board of Chosen Freeholders.

As noted in the *2018 Open Space and Recreation Plan Update*, Warren County's introduction to open space planning began in 1974 with the first open space element to the Warren County *Master Plan*. The Plan and its updates have guided the County's open space program, and have provided a record of the lands preserved in the County, and of how the County's Trust Fund has been allocated. In January of 2018, the Planning Department, in partnership with the Open Space Subcommittee of the Planning Board, completed a comprehensive update to the *Open Space Plan*. Detailed mapping of the County and documentation of local priorities for open space are the backbone of the 2018 Plan Update. The *Water Resources Amendment* to the *Open Space and Recreation Plan Update* supplements this report highlighting the County's water resources and their importance to its infrastructure and future resiliency. The *Amendment* supports the *2018 Plan*, providing a comprehensive study of the water resources, identifying properties of strategic value for preservation, and recommending best management practices for public and private lands to ensure the long-term sustainability of the County's water resources.

Since 1994, Warren County has preserved over 24,418 acres of farmland and 2,219 acres of open space. The County has participated in 142 historical and open space preservation projects with local non-profit organizations and municipalities. The *Water Resources Amendment* identifies opportunities to preserve land for protection of the water supply. Effective land stewardship and strategic acquisition rely upon a well-planned program. The *Amendment* integrates computer modeling with scientific and environmental analysis of the landscape's resources. An assessment of preserved lands in Warren County, including recommendations for stewardship of these lands, is included.

With funding support from the William Penn Foundation, the *Water Resources Amendment* identifies those land areas which score highly for water quality and quantity protection using a computer model based on Warren County's geology, geography, and natural resource base. The results of this model will assist the Board of Recreation Commissioners, Municipal and Charitable Conservancy Trust Fund Committee, local municipalities, and non-profit land trust and watershed organizations in prioritizing lands for acquisition and preservation.

INTRODUCTION

The *Water Resources Amendment* provides a strategic look at Warren County’s natural resources with an emphasis on protecting lands of water quality value for residents and business which call Warren County their home. The use of the County Open Space Trust Fund is integral to the success of the land preservation program, and leveraging the local funding with state, regional, and private dollars will expand the ability of Warren County to preserve, protect, and steward its public lands for water resource protection.

Inherent to the analysis is a detailed study of the hydrology, water quality, and unique habitat that water-dependent lands afford in Warren County. The best available scientific data, along with existing on-the-ground surveying, supports the conclusions and recommendations in this report.

The *Water Resources Amendment* is organized as follows:

- Program history and goals for open space preservation in Warren County
- Lands preserved in Warren County

These two preliminary sections are adapted from the *2018 Update to the Warren County Open Space and Recreation Plan*, adopted by the Planning Board in June of 2018.

Following this, the *Amendment* presents the methodology and analysis for the water resources model developed for Warren County. The results for the model are discussed, accompanied by detailed mapping.

Integral to the identification and preservation of the land is its management and stewardship practices. These practices work to improve the water quality functioning and ensure the resiliency of the natural lands to support the water resources upon which the county relies. A series of sites visits were conducted to properties throughout the County which highlight different best management practices either recommended or underway. Maps and representative photographs are included to provide a look at what can be done in Warren County to steward our public lands sustainably and strategically.

This report details the metrics, data, and mapping of the water resource areas studied in Warren County. The *Amendment* concludes with the priority lands for preservation, as identified by the water resource model developed for Warren County. These are identified on a parcel basis and are ranked by their proximity to already preserved lands. This table, accompanied by maps, provides the tools by which the Administration and Staff, Municipal and Charitable Conservancy Trust Fund Committee (MCCT), Board of Chosen Freeholders, and local officials can target their efforts to protect lands in Warren County – focusing on those properties that support the water resources integral to the County, and expand existing public open spaces.

PROGRAM HISTORY AND GOALS

Program History

Warren County's Open Space Trust Fund was established by the Board of Chosen Freeholders following the approval of the election ballot question in November 1993:

- 1993: **2 cents** – Voters approved a rate not to exceed two cents (\$0.02) per \$100 of total county equalized real property valuation.
- 1994: Trust Fund was implemented by the Freeholders in October 1994.
- 1995: Trust Fund began collecting funds.
- 1996: The Freeholders agreed to set aside 25% of the Fund to support municipal open space preservation projects.
- 1998: Voters approved adding maintenance as an eligible expenditure from the Open Space Trust Fund.
- 1999: **4 cents** – Voters approved increasing the amount collected from two cents to four cents (\$0.04), and historic preservation was approved as an additional eligible expense.
- 2002: **6 cents** – In response to the rapidly growing open space and farmland preservation program, the Freeholders created the Department of Land Preservation in 2002 to manage the program. That same year, voters increased the amount collected an additional two cents to six cents (\$0.06).

With the increase in the available funds, in 2002 the Freeholders agreed to distribute funding for farmland projects, local municipal/non-profit projects, and county initiatives. The percent allocation between programs remains unchanged:

- 55% towards farmland preservation (County Agriculture Development Board, CADB)
- 25% for municipal and non-profit projects (Municipal and Charitable Conservancy Trust Fund Committee, MCCT)
- 20% towards County open space projects (Board of Recreation Commissions, BORC)

Beginning in 2013, the Board of Chosen Freeholders began lowering the tax levy:

- 2013: From 6 cents to **4.5 cents**. This reduced the amount collected from \$7.2 million in 2012 to \$5.0 million in 2013.
- 2015: Decreased by an additional half cent to **4.0 cents** with \$4.78 million collected in 2014 and \$4.28 million in 2015.¹
- 2017: Continued at **4.0 cents** with \$4,303,139 collected in 2016 and \$4,299,898 in 2017.²
- 2018: The Open Space Tax has been reduced in fiscal year 2018 to **3.0 cents** per \$100. It is projected to collect \$3,267,000.³

Warren County has preserved **26,637 acres** using funds from the County Open Space Trust Fund. They have leveraged these funds with grants from outside sources including the New Jersey Department of Environmental Protection (NJDEP) Green Acres program, and the State Agriculture Development Committee (SADC).

- Open Space and Historical Preservation Projects: **2,219 acres** of open space have been protected as parkland, and **142** historical and open space preservation projects have been completed in partnership with non-profit organizations and municipalities since 1997 in each of the 22 municipalities in Warren County.⁴
- Farmland: **24,418 acres** of farmland (**275 farms**) have been preserved.

Goals of the Open Space Program

Warren County began its open space program with the completion of the *Open Space Plan* in 1974. It was updated in 1980 and again in 1981. Following the 1993 ballot question authorizing the Open Space Trust Fund and implementation of the Open Space Trust Fund in 1995, the County produced a new *Open Space Plan* in 1999. Ten years later, the County's *2008 Open Space and Recreation Plan* identified Tier I and Tier II properties for acquisition:

- Tier I properties: Higher priority projects in which the County would pursue acquisition. These include the Morris Canal Greenway Trail, Ridge and Valley Trail, Warren Railroad Trail, Lehigh Hudson/Pequest Valley Trail, Warren-Highlands Trail, and those properties which interconnect the trail systems.
- Tier II properties: The County will consider these sites when an owner offers a property for sale and it is consistent with the County's *Open Space Plan*. These include the railroad corridors, Delaware River Greenway Trail, Musconetong River Greenway Trail, and the Liberty Water Gap Trail.⁵

The *2018 Update* reviewed the goals included in the *1999* and *2008 Open Space Plans*. It reaffirmed the following goals for the County's open space program:⁶

1. Land bank as much land as possible for future use or conservation.
2. Acquire properties or easements where necessary along established and proposed trails, specifically the Highlands/Warren Trail, abandoned railroad rights-of-way, and the Morris Canal, to create greenways as a high priority.
3. Acquire properties or easements where necessary along streams and rivers to establish greenways and linear parks.
4. Acquire environmentally sensitive sites.
5. Acquire cultural, historical, and archeological open space sites.
6. Act as a facilitator in the coordination of land purchases among all levels of government and non-profit agencies.
7. When possible, develop a modest, passive recreation system that allows activities like walking, hiking, sightseeing, bird watching, and more.
8. Where appropriate, give consideration to providing opportunities for traditional uses, such as hunting and fishing.
9. Interconnect various open space reserves.
10. Interagency coordination.
11. Consideration should be given to accessing trails through urban areas through acquisition and easements.

PRESERVED AND PUBLIC LANDS

Note: This section of the Water Resources Amendment is from the 2018 Open Space and Recreation Plan Update dated January 23, 2018 (Chapter IV Inventory of Land Areas).

Warren County is 365 square miles, or 233,600 acres. A quarter of Warren County is identified as open space, totaling **59,524 acres** or **25%** of its land base.⁷ Additionally, there are **24,418 acres** of permanently preserved farmland in Warren County. In total, there are **83,942 acres** of open space and farmland in Warren County, or **36%** of its land base.

Warren County can be divided into three distinct regions for planning purposes: the Northern, Central, and Southern Regions:

- Northern Region – Blairstown, Frelinghuysen, Hardwick, Hope, and Knowlton Townships.
- Central Region – Allamuchy Township, Towns of Belvidere and Hackettstown, Independence, Liberty, Mansfield and Oxford Townships, Washington Borough and Township, and White Township.
- Southern Region – Alpha Borough, Franklin, Greenwich, Harmony, and Lopatcong Townships, Towns of Phillipsburg and Pohatcong Township.

Preserved Open Space

Federal (9,588 acres)

The Delaware Water Gap National Recreation Area is the only federal land reserve in Warren County, consisting of 9,588 acres entirely in the northern region of the county. The area is home to a portion of the Appalachian Trail and offers visitors hiking, bicycling, boating, rock climbing, camping, and fishing. The Delaware Water Gap National Recreation Area covers more than 67,000 acres in New Jersey and Pennsylvania.

State (30,580 acres)

The State of New Jersey owns 30,580 acres of open space in Warren County. This includes land within the NJDEP Wildlife Management Areas (WMA), State Parks and Forests. The State has added the most land areas in the central region at Jenny Jump State Forest, Stephens State Forest, the Pequest River WMA and the Rockport WMA.

The New Jersey Wildlife Management Areas system is administered by the NJDEP Division of Fish and Wildlife's Bureau of Land Management to protect fish and wildlife habitat, as well as provide recreational and educational opportunities for New Jersey residents and visitors. Wildlife Management Areas total 11,400 acres of Warren County in the following sites:

- Alpha Grasslands Preserve, Pohatcong Township, 128 acres
- Beaver Brook WMA, White and Knowlton Townships, 606 acres
- Belvidere Boat access, Town of Belvidere, 7.02 acres
- Buckhorn Creek WMA, White and Washington Townships, 711 acres
- Columbia Lake WMA, Knowlton Township, 1,260 acres
- Hackettstown State Fish Hatchery, Town of Hackettstown, 235 acres

- Harmony Access Points (Delaware River), Harmony Township, 28 acres
- Honey Run WMA, Hope Township, 79 acres
- Hummers Beach Access (Delaware River), Lopatcong Township, 3.20 acres
- Knowlton access (car top only), Knowlton Township, 12 acres
- Musconetcong River WMA in Mansfield, Washington Township, Franklin and Pohatcong Townships in Warren County, and areas in Hunterdon and Morris Counties, 1,558 acres
- Pequest WMA (east and west), Liberty, Mansfield and White Townships, 4,609 acres
- Pohatcong Creek WMA (north and south), Pohatcong Township, 129 acres
- Rockport WMA, Mansfield Township, 1,161 acres
- Ratzman access, White Township, 7.42 acres
- White Lake WMA, Hardwick Township, 865 acres. The County of Warren owns 395 acres of the WMA in Hardwick Township.

The New Jersey Park and Forest system is administered by the NJDEP Division of Parks and Forestry, which provides for the operation, management, and protection for state parks, forests, and historic sites across the state. In Warren County, they are responsible for 19,180 acres:

- Allamuchy Mountain State Park accounts for a total of 8,711 acres of open space in Warren, Sussex and Morris Counties. 3,390 acres are located in Allamuchy Township.
- Stephens State Park contains 327 acres in Hackettstown and extends into Morris County. The total size of the park is 805 acres.
- Jenny Jump State Forest totals 4,343 acres in the Townships of Frelinghuysen, Independence, Hope, Liberty, and White.
- Worthington State Forest is in Hardwick, Blairstown and Knowlton Townships. The forest covers 6,584 acres and is within the Delaware Water Gap National Recreation Area.
- Paulinskill Valley Trail traverses the Townships of Knowlton, Hardwick, Frelinghuysen, and Blairstown, and continues into Sussex County for a total of 27 miles.
- Limestone Ridge Marsh is 389 acres and is managed by NJ Natural Lands Trust.

Warren County (2,054 acres)

Warren County owns 2,054 acres of open space in Warren County. Major land areas owned by the County of Warren include portions of White Lake WMA and the Warren-Highlands Trail, and the White Lake Natural Resource Area, Marble Hill, and Oxford Mountain. The county also owns properties which are part of the Morris Canal Greenway, including Port Murray Preserve, Bread Lock Park, and Florence Kuipers Memorial Park.^a

Municipal (6,443 acres)

Municipally-owned open space in Warren County consists of 6,443 acres of parks, playgrounds, playing fields, and picnic areas throughout the county. Additionally, many of the recreational programs are operating in conjunction with the local Board of Education using their fields and facilities, totaling 380 acres. Almost every municipality in the County has at least one municipally-owned park.

^a See the *Land Management: Warren County* section of this report for a more detailed description of the County lands.

Preserved Farmland

There are 24,418 acres of privately owned farmland (275 farms) which have been permanently preserved through the county and state farmland preservation program.

Other Public Properties

Semi-Public and Non-Profit Land (7,407 acres)

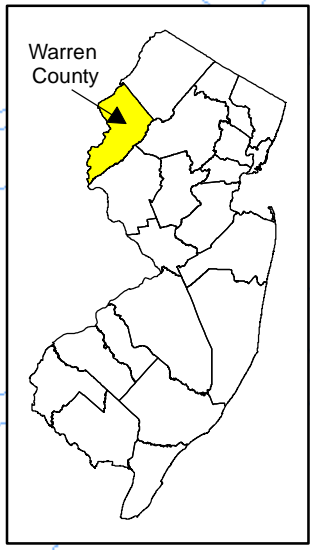
These open space areas are owned by private entities or non-profit organizations but are made available for public use. They consist of 7,407 acres in Warren County. Notable sites include the Merrill Creek Reservoir and Environmental Resource Center, Ridge and Valley Conservancy's Limestone Forest Preserve, and Johnsonburg Swamp Preserve owned and managed by The Nature Conservancy.

Private Open Space

Private open space consists of sites that either charge a fee to visitors, or only allow members of the owning organization to access the land. Private open space makes up 3,131 acres in Warren County. Notable sites include Northern New Jersey Council – Boy Scouts of America Camp NoBeBosCo, Yards Creek Scout Reservation owned by the Central New Jersey Council – Boy Scouts of America, and the Princeton Blairstown Center, which is an affiliate of Princeton University.

Appendix A and Preserved, Public and Private Open Space Map illustrate the open spaces in each municipality in Warren County.

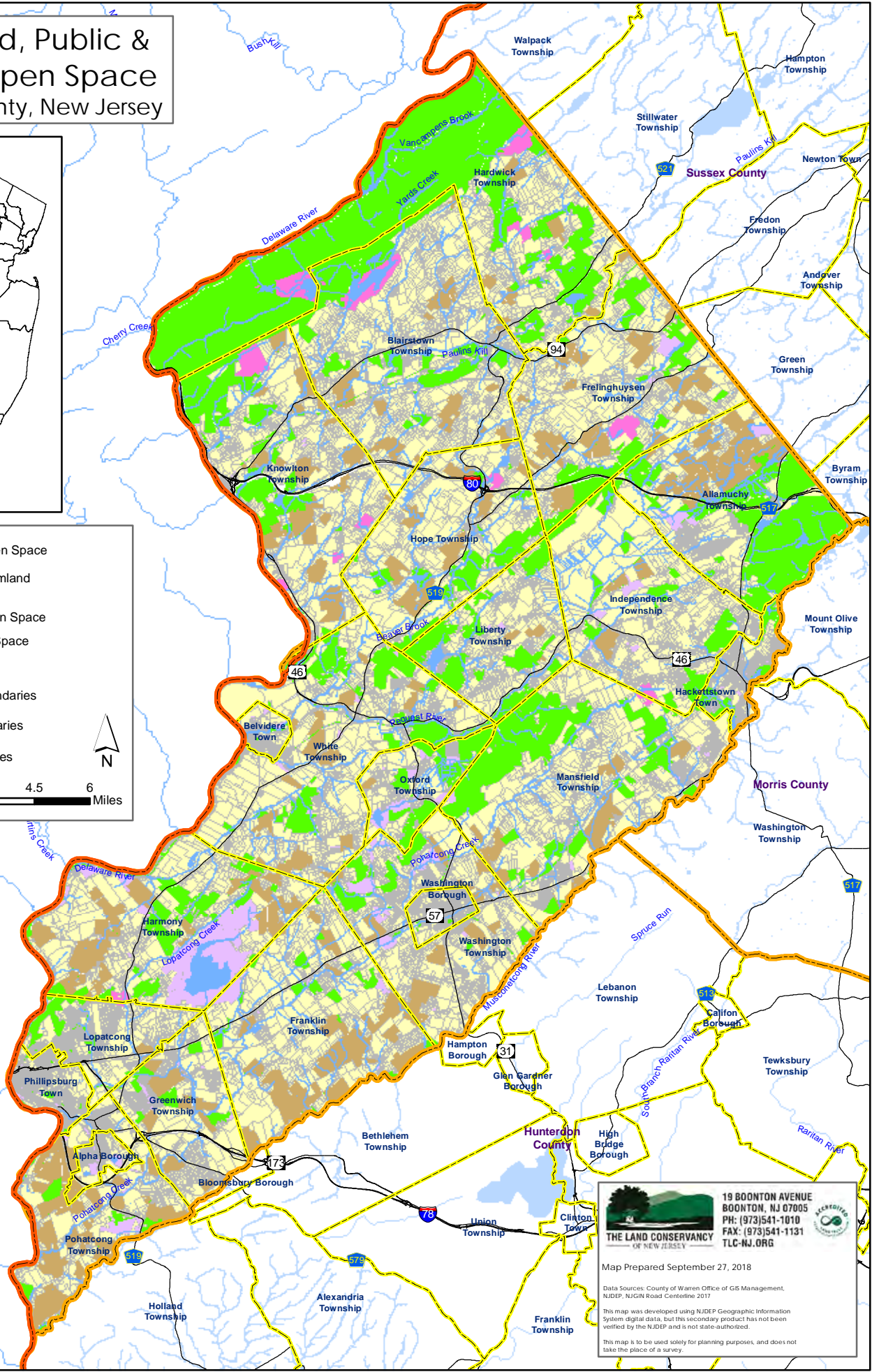
Preserved, Public & Private Open Space Warren County, New Jersey



- Preserved Open Space
- Preserved Farmland
- Semi-Public & Non Profit Open Space
- Private Open Space
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries

0 0.75 1.5 3 4.5 6 Miles

N



**19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG**

**THE LAND CONSERVANCY
OF NEW JERSEY**

Map Prepared September 27, 2018

Data Sources: County of Warren Office of GIS Management, NJDEP, NJGIN Road Centeline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

WATER RESOURCE MODEL

Evaluation and selection of conservation projects is based on the identification and selection of criteria specific to the geography and demographics of the region where it is located. A computer model was developed and compared with existing Warren County selection criteria, including in the *2018 Open Space and Recreation Plan Update* and the recently released Conservation Blueprint for New Jersey.

Modeling for Water Resource Protection in Warren County

Warren County is located within the Highlands and the Valley and Ridge physiographic provinces, and entirely within the Delaware River watershed. The Highlands region is underlain by granite and metamorphic rocks. Its characteristic geologic structures and weathering affect the occurrence of groundwater in these rocks. The County relies heavily on groundwater supplies for its drinking water and agricultural operations. The Valley and Ridge physiographic province is underlain by sedimentary rock, where outcrops are abundant. The surface is rugged and dotted with rocky knolls and ridges, sinkholes, and streamless valleys.⁸

The goal of the *Water Resources Amendment* is to identify those lands of highest priority to protect the quantity and quality of water resources in Warren County. The digital mapping provides an up-to-date technical and detailed approach to the identification of the water resources and development of specific criteria for the designation of priority watershed lands located within the County. The results of the computer mapping will assist the County in the following:

- Determine areas where preservation may be most effective.
- Target resources for preservation and stewardship of these areas.
- Prioritize lands for protection.

Data and Methodology

Using current digital mapping and technology tools, and built upon scientifically based water quality measures and water-based priorities, strategic parcels are identified for land protection. The mapping analysis offers the County the ability to analyze the properties based on unique water quality and/or water resource attributes. In determining how to best target prime areas for protection of the resources that affect water quality and water supply, hydrology, stream and aquifer quality, and aquatic ecosystems functions are mapped and analyzed. Based on the results of this mapping, an overall composite map identifies the areas of highest priority for preservation.

Existing primary source data were used to integrate conservation and restoration with water quality and open space preservation. GIS data used were developed by the New Jersey Department of Environmental Protection (NJDEP), Open Space Institute, The Academy of Natural Sciences of Drexel University's Stream Reach Assessment Tool, and The Nature Conservancy's Active Rivers Area.^b Geologic strata, land use cover, and vegetative cover were incorporated to identify field assessment sites and opportunities for permanent land protection. Tax assessment data (2017), the

^b The analysis for the *Water Resources Amendment* is independent of the *New Jersey Highlands Regional Master Plan (RMP)*. Data from the RMP was used for the development of the Net Water Availability Map (Map 1) only.

NJDEP 2012 digital orthophotography for land use/land cover data, and information from Warren County regarding public land holdings were mapped. ArcGIS 10.6 mapping software was used to develop the model. The data was converted to a web-based platform using the ESRI GIS mapping forum for County staff.

How are water resource priorities determined?

In determining how to best target prime areas for protection of the resources that affect water quality and water supply, the following were studied:

1. Hydrology
2. Stream and Aquifer Quality
3. Aquatic Ecosystems Functions

Hydrology is the science of water movement, including its relationship with the environment. The hydrologic cycle is a continuous process by which water is purified by evaporation and transported back to the earth's surface. Water may flow to rivers, or into the soil where it may percolate through the soil to groundwater reservoirs (aquifers) to be stored, or it may flow to wells or springs, or back to streams by seepage. People tap the water cycle for their own uses. Water is used for a variety of activities such as for households, businesses and industries; for irrigation of farms and parklands; and for production of electric power. After use, returned water is lower in quality, which often poses a problem for downstream users.⁹

To quantify the data for each of the water resource factors (hydrology, stream and aquifer quality, and ecosystem functions) a set of characteristics was identified. Where needed, metrics were developed to define a standard of measurement to determine how the characteristic would be quantified for mapping.

Hydrology:

- Stressed watersheds and net water availability (*Map 1*)
- Prime recharge areas that provide flow to surface waters and wells (*Map 2*)
- Forest cover, including wooded wetlands (*Map 3*)
- Wetlands (*Map 4*)
- Flood hazard or flood prone areas (*Map 5*)

Stream and Aquifer Quality:

- Forest cover (*Map 3*)
- Riparian areas (*Map 6*)
- Soluble carbonate rocks – limestone and dolomite (*Map 7*)
- Public community water supply wells (*Map 8*)
- Surface water quality using SRAT, the Stream Reach Assessment Tool (*Map 9*)

Aquatic Ecosystem Functions:

- Undeveloped riparian areas of headwater streams (*Map 10*)
- Unique and unusual aquatic habitats (*Map 11*)
- Riparian habitats for threatened and endangered species (*Map 12*)
- Wetland habitats for threatened and endangered species (*Map 13*)

Protecting Water Resources

Maps 1 through 13 illustrate characteristics used to identify targets for protection of the water resources in Warren County. Each map targets a defining characteristic important to water quality and/or quantity. These are defined in greater detail on the accompanying *Fact Sheets*.

Map 1 identifies stressed watersheds in Warren County based on net water availability; 43% of the County (20 of its 41 sub-watersheds) is identified as stressed if pumped at volumes authorized under existing permits.

Map 2 illustrates prime recharge areas that support surface waters and wells. These account for 31% of the County.

Map 3 identifies forest cover (including wooded wetlands) which makes up 53% of the County.

Map 4 shows where Warren County's wetlands are located and that they make up 9% of the County.

Map 5 identifies flood hazard or flood prone areas, which make up 12% of the County.

Map 6 identifies riparian areas in Warren County, which make up 21% of the County.

Map 7 identifies soluble carbonate rocks to illustrate areas that are at a higher risk of water contamination. These areas make up 42% of the County.

Map 8 shows where public community water supply wells are located, as well as time buffer zones (known as wellhead protection areas) for 2, 5, and 12 year travel times to the well. These zones make up 10% of Warren County.

Map 9 identifies surface water quality in Warren County using the Stream Reach Assessment Tool known as SRAT. 42% of the County scores high for the APCAW, or the Ability to Produce Clean and Abundant Water (score of 20-29).

Map 10 identifies undeveloped riparian areas of headwater streams in Warren County, totaling 13%.

Map 11 identifies unique and unusual aquatic habitats. The different categories are potential and existing vernal habitat, high elevation natural and artificial water bodies, and a 300 foot buffer around those high elevation water bodies. High elevation natural water bodies comprise of 0.5% of the county; high elevation artificial water bodies account for 1% of the county; and potential and existing vernal habitat and buffers account for 12% of the county.

Map 12 shows the riparian habitats for threatened and endangered species, which is 3% of the County.

Map 13 shows wetland habitats for threatened and endangered species, which is 8.5% of the County.



Warren County: Stressed Watersheds (Map 1)



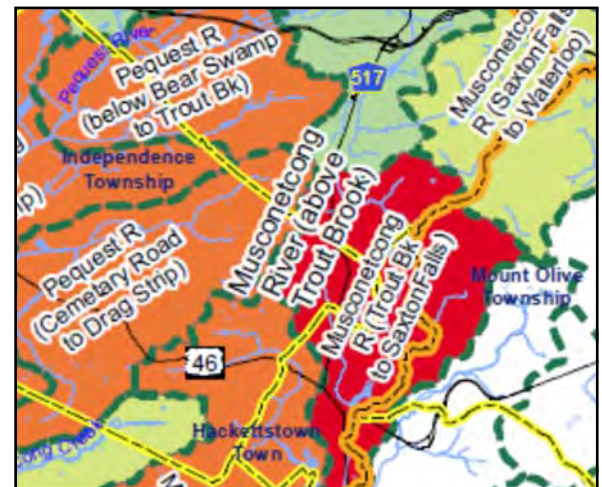
Purpose

Stressed watersheds exhibit a higher demand for water than natural water supply can provide. This is based on surface water and groundwater withdrawal (net water availability). In Warren County, this approach illustrates that 20 of the County's 41 subwatersheds are currently stressed if pumped at volumes authorized under existing permits.

Data Source and Methodology

Stressed watersheds are defined as subwatersheds (HUC 14) within the Highlands Region, or watersheds (HUC 11) outside the Highlands Region, where current demands exceed 85% of Water Availability. Net Water Availability within the Highlands Region is based on the Highlands Regional Master Plan. Net Water Availability for watersheds outside the Highlands Region is based on 25% of Low Flow Margin setting per the DGS14-1 Computer Workbook Investigating Water Availability in New Jersey on a Watershed Management Area Basis, minus withdrawals from groundwater and surface water (other than reservoir-supported), following the protocol of the NJ Statewide Water Supply Plan. Target areas are the best recharge areas (those which provide 70% of total recharge) within the stressed watersheds.

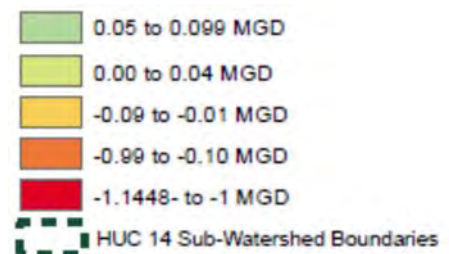
Stressed Watersheds	
Subwatershed	Acres
Musconetcong River (Trout Brook to Saxton Falls)	4,943
Bear Brook (Sussex/Warren County)	2,971
Delawanna Creek (including Upper Delaware River)	1,518
Furnace Brook	4,939
Honey Run	4,300
Lopatcong Creek (above Route 57)	4,964
Lopatcong Creek (below Route 57) including Upper Delaware River	7,718
Musconetcong River (to Route 31)	3,266
Musconetcong River (below Warren Glen)	4,789
Musconetcong River (Hances Brook through Trout Brook)	9,285
Musconetcong River (Route 31 to Washington)	4,975
Musconetcong River (Warren Glen to I-78)	4,331
Pequest River (below Bear Swamp to Trout Bk)	4,034
Pequest River (Cemetery Road to Drag Strip)	4,891
Pequest River (Drag Strip--below Bear Swamp)	6,079
Pequest River (Furnace Brook to Cemetery Road)	5,270
Pohatcong Creek (Brass Castle Creek to Route 31)	7,999
Pohatcong Creek (below Springtown) including Upper Delaware River	3,753
Pophandusing Brook	3,599
Upper Delaware River tributaries (Route 22 to Buckhorn Creek)	5,013
Total:	98,636



Net Water Availability:

(Million Gallons Per Day, MGD)

*Less than 0 indicates a stressed watershed



Map 1: Stressed Watersheds (Net Water Availability) Warren County, New Jersey

Net Water Availability (HUC 11): NJ State Water Supply Plan (2017)

0.3924 to 3.33 MGD

Net Water Availability (HUC 14): Highlands Regional Master Plan (2008)

0.05 to 0.099 MGD

0.00 to 0.04 MGD

-0.09 to -0.01 MGD

-0.99 to -0.10 MGD

-1.1448 to -1 MGD

HUC 14 Sub-Watershed Boundaries

Water Body

Municipal Boundaries

County Boundaries

0 0.75 1.5 3 4.5 6 Miles



Pennsylvania

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department,
NJ Highlands Council, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information
System digital data, but this secondary product has not been
verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not
take the place of a survey.



Prime Groundwater Recharge Areas (Map 2)



Definitions

Groundwater recharge is the process by which water moves through soil to form saturated zones.

A **watershed** is an area of land that channels rainfall and snowmelt to a single surface water body such as a river or stream.

HUC14 subwatersheds are the watersheds contributing to small streams, as delineated by the United States Geological Survey (USGS) and modified by the New Jersey Department of Environmental Protection (NJDEP). Groups of related HUC14 subwatersheds form larger HUC11 watersheds and the 20 Watershed Management Areas.

Acreage

Warren County has **71,501 acres** of prime groundwater recharge areas. They account for **31%** of Warren County.

Purpose

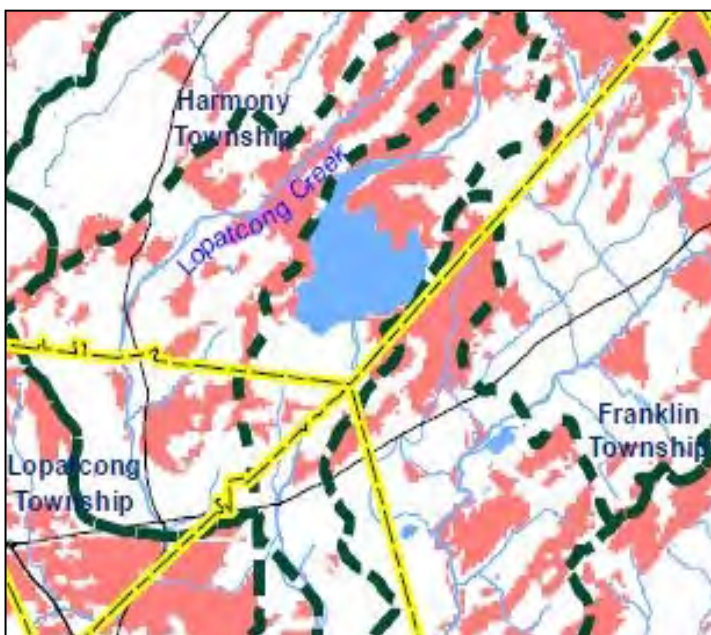
Prime groundwater recharge areas provide 40% or more of the total recharge volume for each HUC14 subwatershed. Communities rely on groundwater for everyday needs. As demand for water increases, more water is drawn from the ground, but if the water table is not replenished, regional water flows are disrupted.

Data Source and Methodology

Data Source: NJDEP HUC14 Watershed data (2014) and New Jersey Geological Survey (NJGS) Groundwater Recharge data (2004).

Warren County is included in two Watershed Management Areas: Upper Delaware (WMA1) and Wallkill (WMA2).

Prime groundwater recharge areas provide water to wells and surface waters. They are critical to supplying the base flow for trout streams that are important to Warren County's tourist/recreational economy and ecological health.



Prime groundwater recharge areas surrounding Lopatcong Creek and the Merrill Creek Reservoir.

- Prime Recharge Areas (40% of Total HUC 14 Recharge)
- HUC 14 Sub-Watershed Boundaries
- Water Body

Map 2. Prime Recharge Areas Warren County, New Jersey

Prime Recharge Areas
(40% of Total HUC 14 Recharge)

HUC 14 Sub-Watershed Boundaries

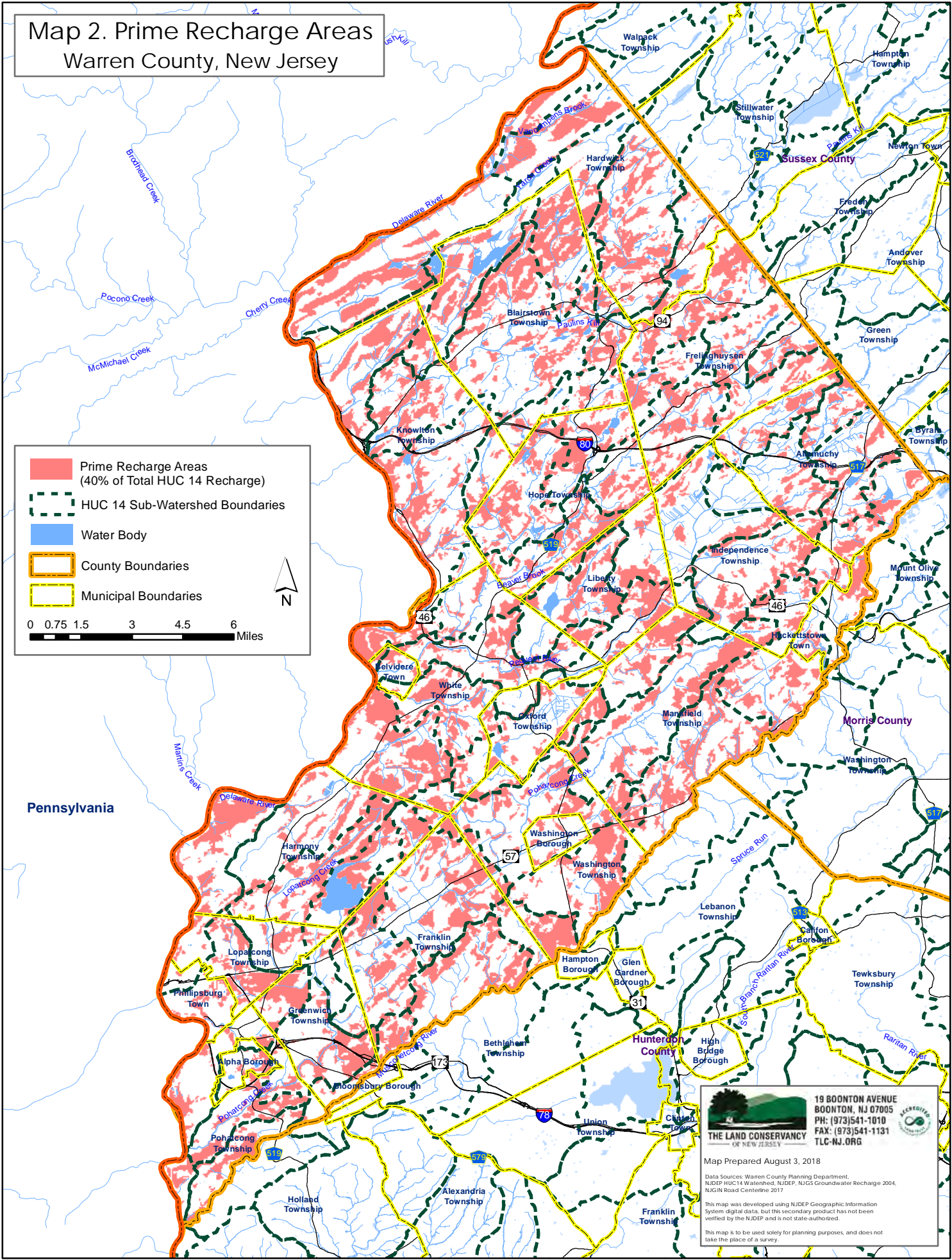
Water Body

County Boundaries


Municipal Boundaries

N

0 0.75 1.5 3 4.5 6 Miles




Pennsylvania



THE LAND CONSERVANCY
OF NEW JERSEY

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG



Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP HUC 14 Watershed, NJDEP, NJGS Groundwater Recharge 2004, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Forest Cover (Map 3)



Purpose

Forest cover supports higher groundwater recharge rates, more even stream flow, better water quality, and reduced runoff.

Data Source and Methodology

This map was created using NJDEP Land Use/Land Cover Data (2012) and the Anderson Land Use Classification System. The 20 forest classifications identified in Warren County have been condensed into five groups for mapping and analysis.



Acreages

Forest covers 122,855 acres (53%) of Warren's total land area.

Definitions

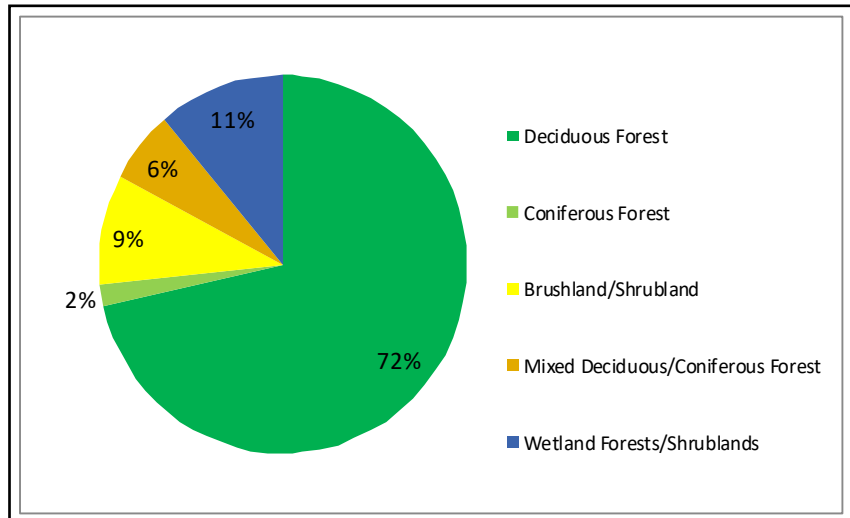
Deciduous Forest: Area covered predominately with trees that shed their leaves at the end of the growing season. (72% of Warren County)

Coniferous Forest: Trees that are needle or scale-leaved and cone-bearing. (2%)

Brushland/Shrubland: Vegetation that is less than 20 feet tall. (9%)

Mixed Deciduous/Coniferous Forest: Forested areas in which neither deciduous or coniferous trees represent 75% or more of the forested area. (6%)

Wetland Forests/Shrublands: Wetland areas that have forest cover and shrubland. (11%)



Highlights: Forest Cover

- Delaware Water Gap National Recreation Area and Worthington State Forest
- Kittatinny Ridge Valley and Paulins Kills watershed
- Pequest River watershed, Beaver Brook watershed, and Jenny Jump State Forest
- Scotts Mountain Ridge and Merrill Creek Reservoir
- Pohatcong Ridge and watershed
- Allamuchy Mountain State Park

Map 3: Forest Cover


Warren County, New Jersey

Forest Cover
 (Includes Wooded Wetlands)

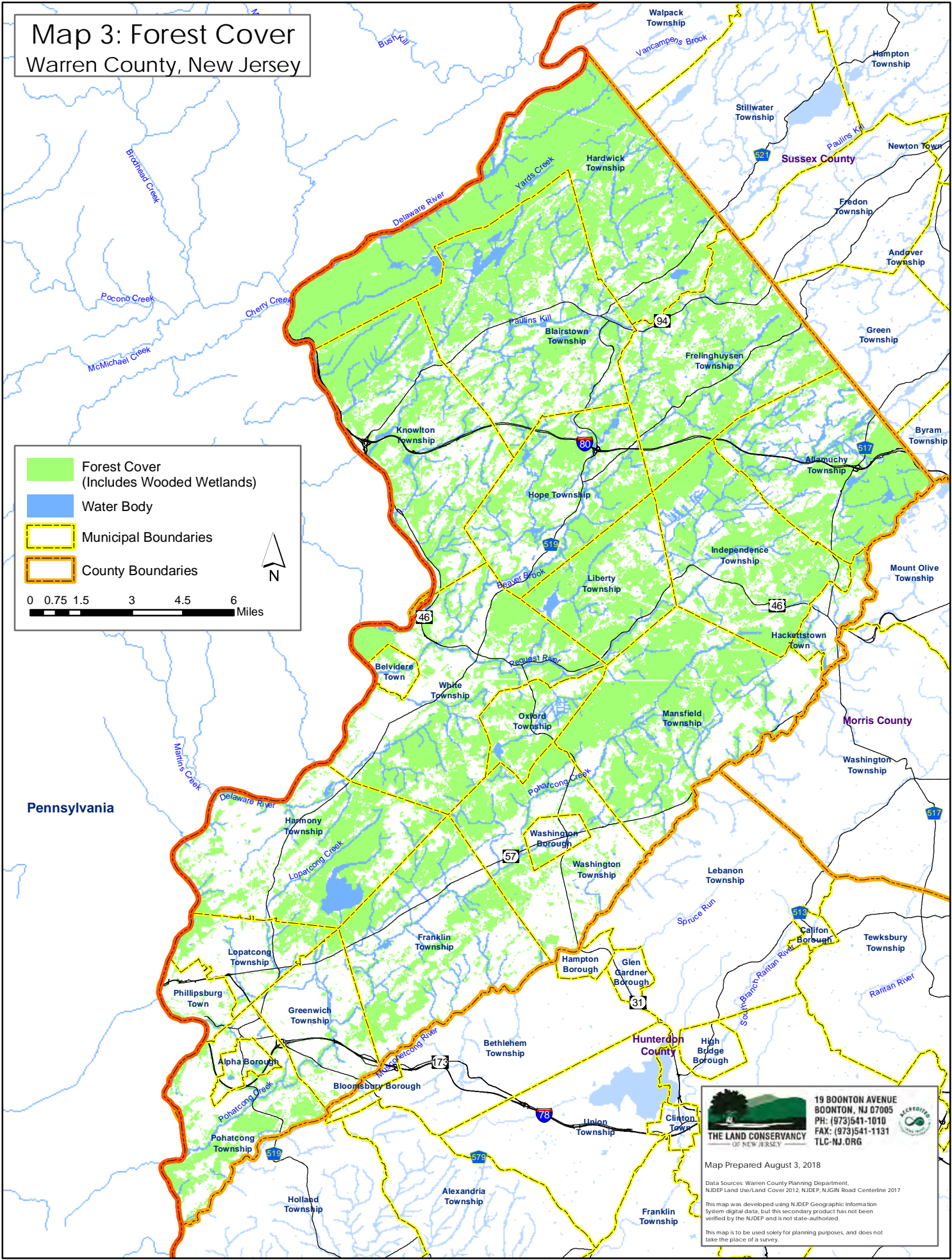
Water Body

Municipal Boundaries

County Boundaries


 N

0 0.75 1.5 3 4.5 6 Miles





19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018
Data Sources: Warren County Planning Department, NJDEP Land Use/Land Cover 2012, NJDEP, NJGN Road Centerline 2017
This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Wetlands (Map 4)



Purpose

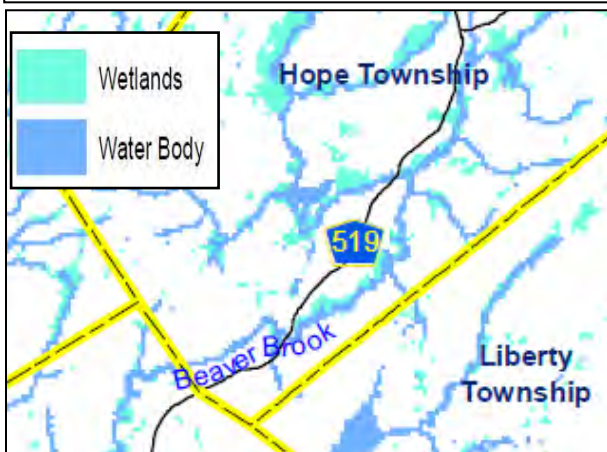
Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Municipalities with Low Concentration of Wetlands

Belvidere Town	Delaware River, Pequest River
Phillipsburg Town	Delaware River
Alpha Borough	Branch of Delaware
Pohatcong Township	Branch of Delaware, Musconetcong River
Lopatcong Township	Lopatcong Creek

Municipalities with High Concentration of Wetlands

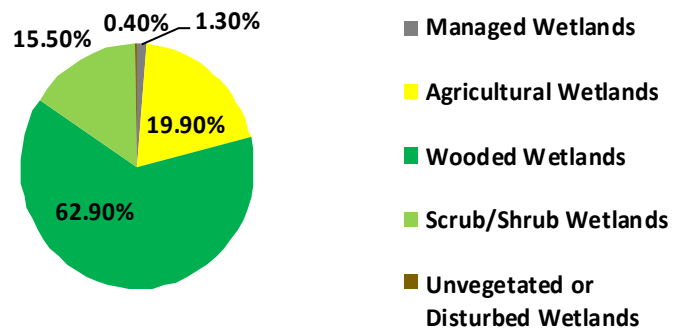
Greenwich Township	Lopatcong Creek, Merrill Creek, Pohatcong Creek
Independence Township	Barkers Mill Brook, Bowers Brook, Pequest River
Allamuchy Township	Bear Creek, Independence Creek, Pequest River, Trout Brook
Oxford Township	Furnace Brook, Furnace Lake, Pohatcong Creek, Tunnel Brook



Distribution of Wetlands

Wetlands cover approximately 21,451 acres, or 9% of all Warren County. The percentages below show how much each type of wetland comprises Warren County's total acres of wetlands.

- **Managed Wetlands:** Wetlands areas that are near development and are maintained by public or private owners (273 acres or 1% of total wetlands).
- **Agricultural Wetlands:** Wetland areas which have been or are currently being used for agriculture (4,263 acres or 20%).
- **Wooded Wetlands:** Wetland areas with a high concentration of trees, both deciduous and coniferous (13,491 acres or 63%).
- **Scrub/Shrub Wetlands:** Wetland areas covered with vegetation that is less than 20 feet in height (3,324 acres or 15.5%).
- **Unvegetated or Disturbed Wetlands:** Wetlands that have been disturbed or interfered with, or wetlands that have no vegetation (98 acres or 0.4%).



Data Source and Methodology

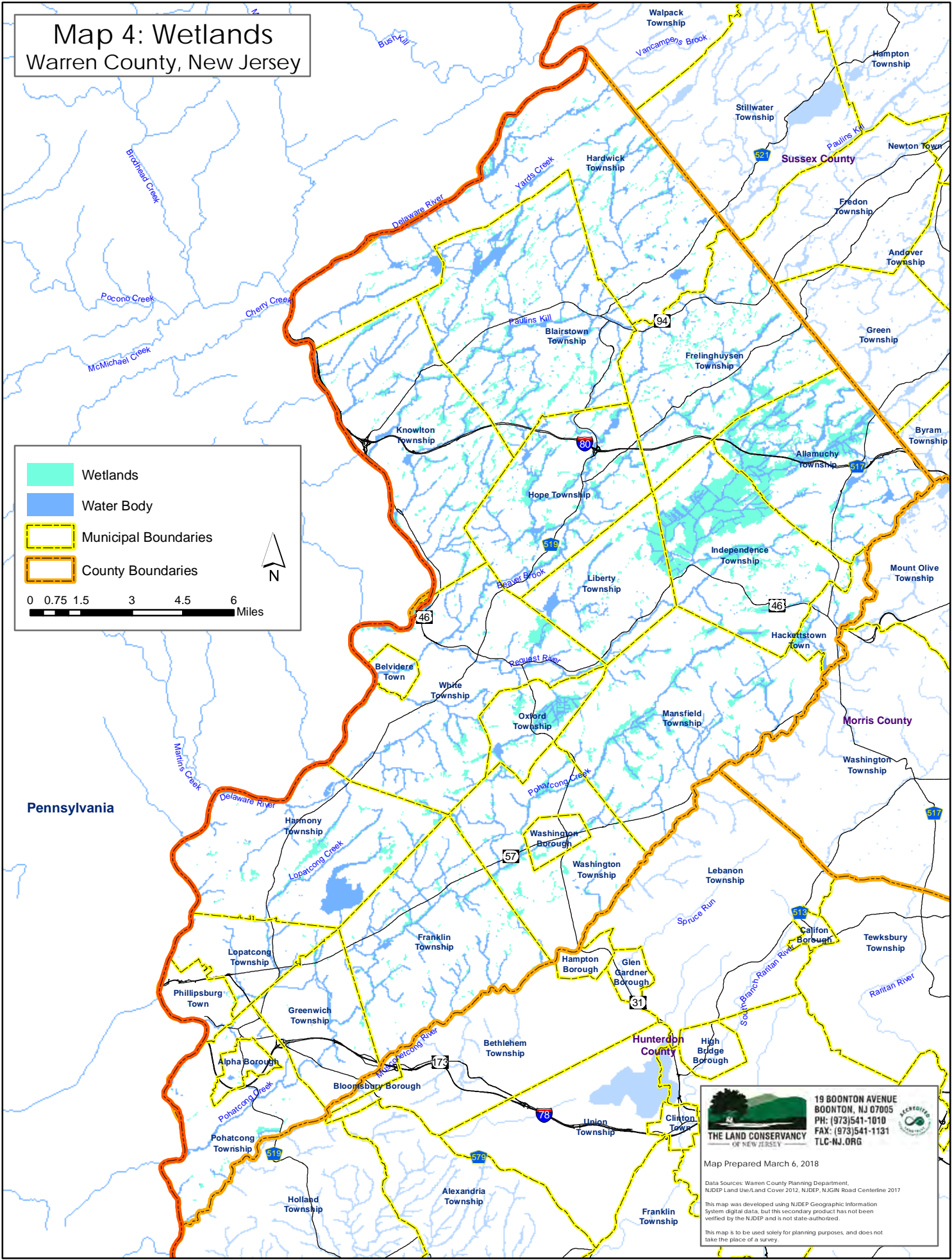
This map was created using NJDEP Land Use/Land Cover (LU/LC) data (2012). The NJDEP developed this dataset using the *Land Use and Land Cover Classification System for Use with Remote Sensor Data*, U. S. Geological Survey Professional Paper 964, 1976; by J.R. Anderson. The data compilation used computer interactive photo interpretation techniques and limited on-site field surveys. The 18 wetlands classifications in Warren County were condensed into six groups for simplification.

Map 4: Wetlands

Warren County, New Jersey

Wetlands
 Water Body
 Municipal Boundaries
 County Boundaries

0 0.75 1.5 3 4.5 6 Miles



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared March 6, 2018

Data Sources: Warren County Planning Department, NJDEP Land Use/Land Cover 2012, NJDEP, NJGIN Road Centerline 2017
This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
This map is to be used solely for planning purposes, and does not take the place of a survey.

Purpose

Floodplains provide key functions in the hydrologic cycle. They store and gradually release flood waters, reducing the severity of flooding in other areas and providing for pollutant reduction.

Restricting development in floodplains preserves their ability to contain floodwaters, reduce erosion, and support wildlife. Development within floodplains risks reducing their capacity to hold stormwater.

Data Source and Methodology

Data Source: Federal Emergency Management Agency (FEMA) Digital Flood Insurance Rate Map (DFIRM), updated on September 29, 2011, and NJDEP's data on flood prone areas. The data includes three flood hazard area identifications that illustrate the severity and likelihood of flooding in Warren County. The USGS maps flood prone areas and FEMA evaluates and maps Special Flood Hazard Areas (SFHAs) and other flood zones, creating the official Flood Rate Insurance Mapping (FIRM) that can be used in participating communities to determine flood insurance rates. SFHA are areas that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year, also referred to as the base flood or 100-year flood.

Pequest River Valley

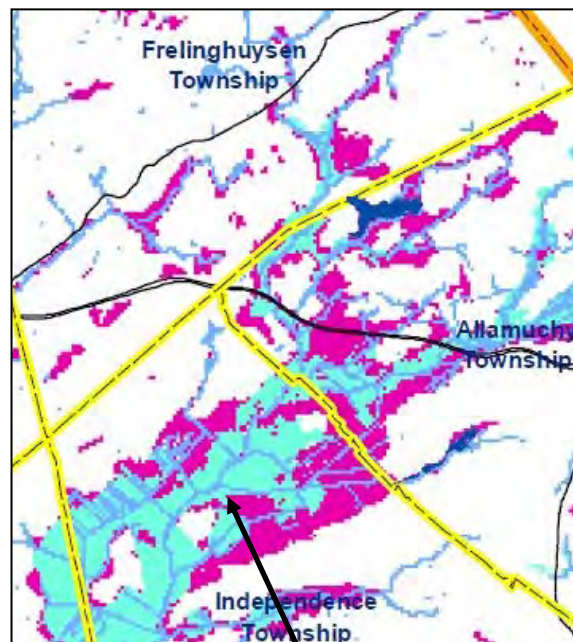
- **Pequest River** and **Great Meadows** are large wetlands below the Jenny Jump Mountain Ridge.
- **Pequest River:** 35 mile long tributary of the Delaware River with a drainage area of 162 square miles.
- **Water bodies:** Pequest River and tributaries — Bear Creek and Independence Creek.

Acreages

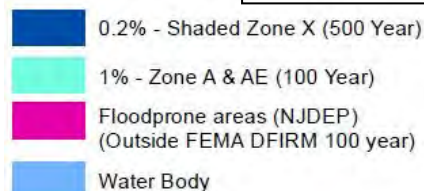
Approximately 26,970 acres (12%) of Warren's total land area is floodprone.

Definitions

- **FEMA 1% - Zone A & AE (100 Year Flood):** An area having a 1% chance of being flooded in any given year. (57% of floodprone areas in the County)
- **FEMA 0.2% - Shaded Zone X (500 Year Flood):** Areas between the limits of the base flood (1%) and the 0.2% annual chance of a flood. (5% of floodprone areas in the County)
- **Floodprone Areas:** Areas identified by the NJDEP outside FEMA's 100-year floodplain areas that are prone to flooding. (38% of floodprone areas in the County).









Pequest River and tributaries



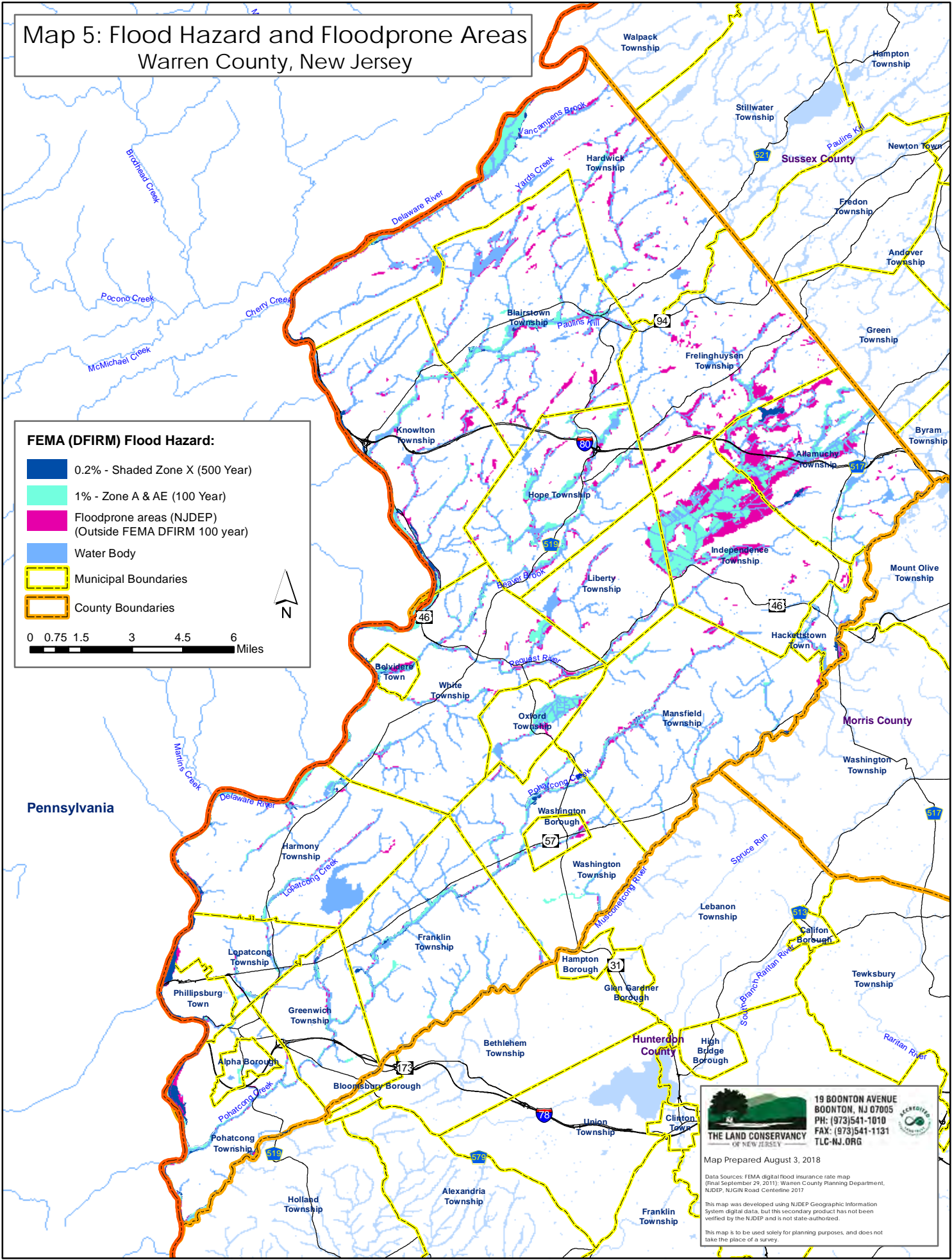
Map 5: Flood Hazard and Floodprone Areas Warren County, New Jersey


FEMA (DFIRM) Flood Hazard:

-  0.2% - Shaded Zone X (500 Year)
-  1% - Zone A & AE (100 Year)
-  Floodprone areas (NJDEP)
(Outside FEMA DFIRM 100 year)
-  Water Body
-  Municipal Boundaries
-  County Boundaries



0 0.75 1.5 3 4.5 6 Miles





19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: FEMA digital flood insurance rate map (final September 29, 2013); Warren County Planning Department, NJDEP; NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.



Riparian Areas (Map 6)



Purpose

A riparian area is the buffering area between land and rivers and streams. Riparian areas buffer stream banks, improve water quality, filter sediment, and increase groundwater recharge rates.

Riparian areas also provide critical habitats for wildlife, including a variety of threatened and endangered species.

Data Source

NJDEP Land Use/Land Cover Data (2012) and NRCS SURGO. The riparian areas dataset is composed of several different land types including: wetlands, wetland transition areas, streams, floodprone areas, wildlife passage corridors, and hydric/alluvial/high water table soils.

Lopatcong Creek and Pohatcong Creek

The Lopatcong and Pohatcong Creeks parallel each other within Harmony and Franklin Township respectively. Their alluvial soils and riparian habitats support diverse wildlife, plant life, and recreational/agricultural activities in the County.

Acreage

Riparian areas cover 49,993 acres (21%) of Warren's total land area.

Definitions

Wetlands: Land in which water covers the soil part of the time or permanently.

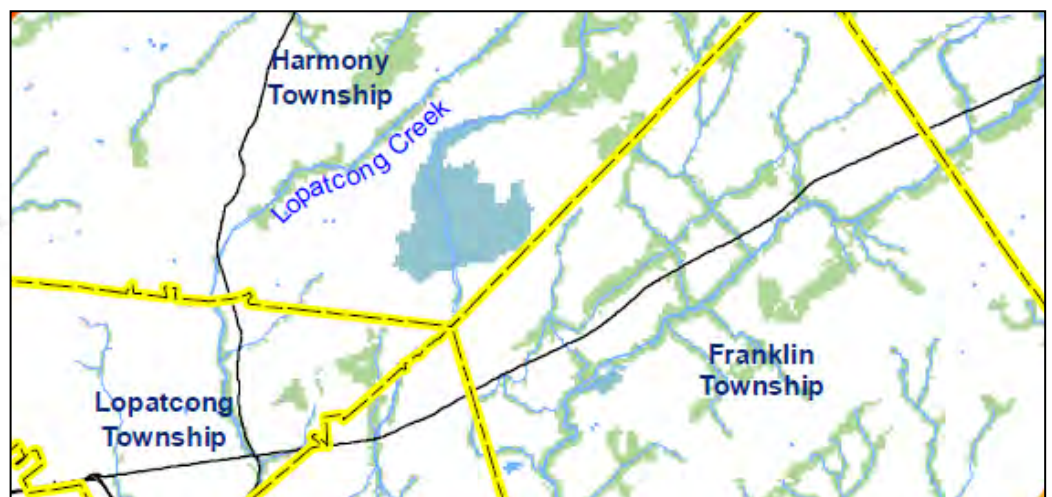
Wetland Transition Areas: Area of dry land adjacent to a freshwater wetland. Size of the transition area is dictated by State regulations, and depends on the resource value of the wetland. Wetlands of exceptional resource value have a 150 foot transition zone; wetlands of intermediate resource value have a 50 foot transition area.

Wildlife Passage Corridors: Areas that connect wildlife habitat populations which are separated by human activities or structures.

Steep Slopes: Slopes that are greater than 15% grades and adjacent to waterways.

Hydric soils: soils that are saturated seasonally or permanently, resulting in anaerobic conditions (no oxygen).

Alluvial Soils: Loose soil type that has been eroded by water and deposited on dry land through flooding or slowing of streams.

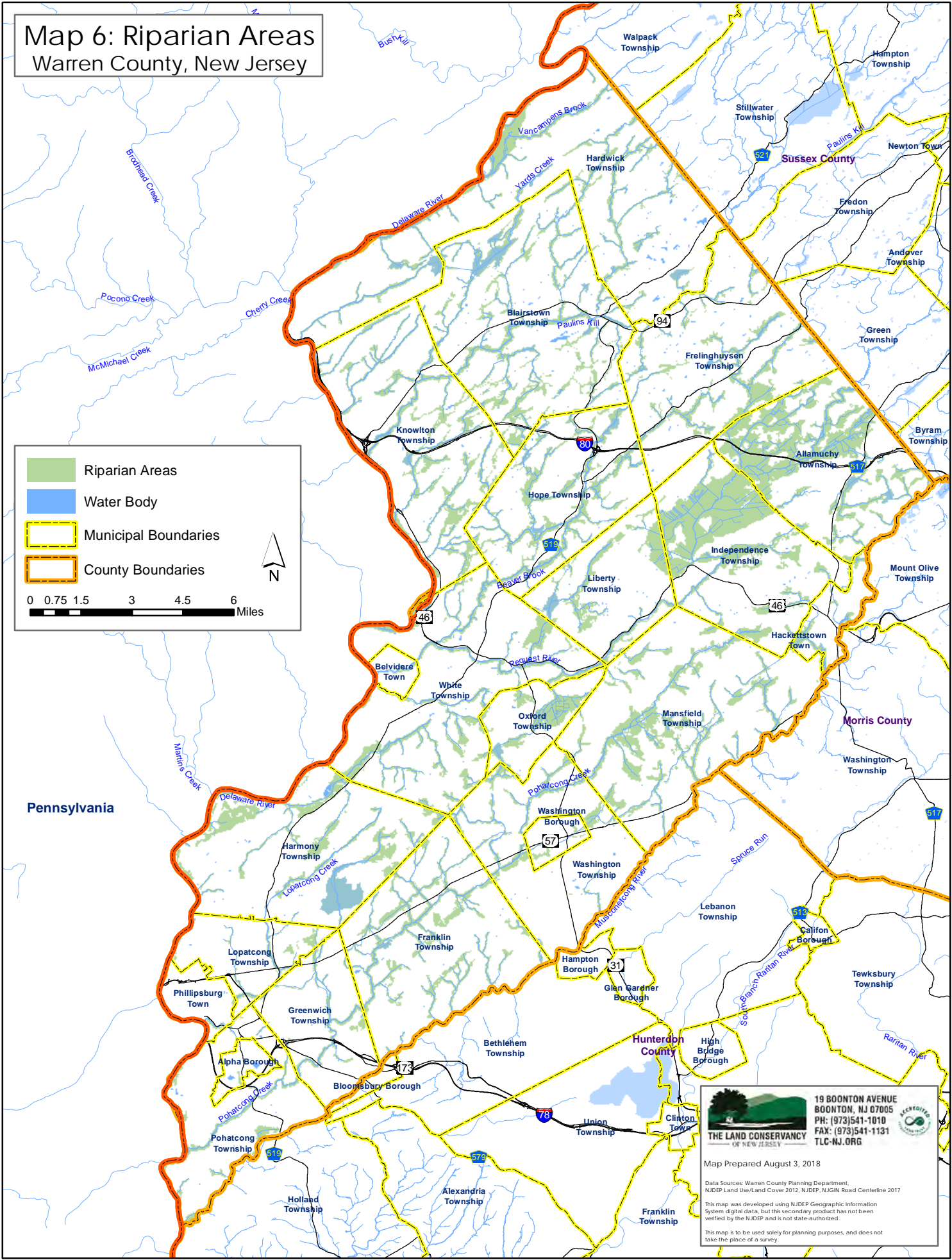


Map 6: Riparian Areas

Warren County, New Jersey

Riparian Areas
 Water Body
 Municipal Boundaries
 County Boundaries

0 0.75 1.5 3 4.5 6 Miles



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department,
 NJDEP Land Use/Land Cover 2012, NJDEP, NJGIN Road Centerline 2017
 This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
 This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Carbonate Rock (Map 7)



Purpose

Areas with actively dissolving carbonate bedrock often produce sinkholes and underground caves. This puts groundwater at a greater risk of contamination, since the hollowed bedrock provides little space for soil filtration.

Acres

97,971 acres (42%) of Warren County's total land area is underlain by carbonate rock.

Data Source and Methodology

Data Source: NJGS Bedrock Geology (2007). The data used in this map includes several lithological, or physical, characteristics of rock types observed in areas in Warren County. The rock types are shown for surficial carbonate rock, including limestone and dolomite.

Definitions

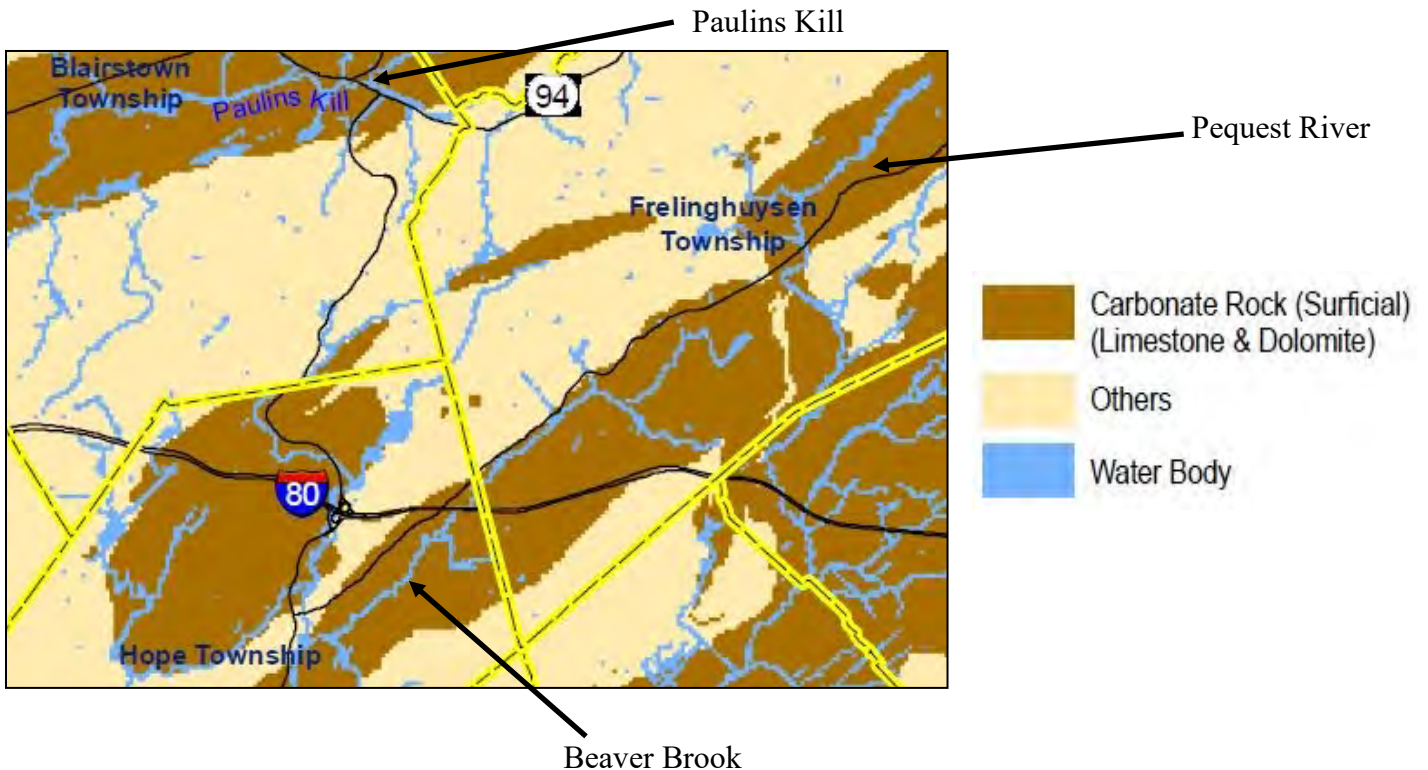
Surficial Limestone and Dolomite: Sedimentary rocks composed of carbonate minerals that can be dissolved by groundwater, increasing the risk of local water supply contamination. The dissolution of carbonate rocks is called Karst topography, which results in underground water conduits and caverns.

Sink holes: Holes in the ground that are caused by the dissolution of underground carbonate rock by groundwater, and the creation of underground caverns. When the underground cavern becomes so large or the weight on the surface layer too great, the ground layer collapses. Building on carbonate rock is very risky.

Other rock types: Rocks that do not typically cause water contamination and are generally insoluble, including granite and gneiss.

Watersheds with Carbonate Rock

- Buckhorn Creek
- Pohatcong Creek
- Paulins Kill
- Pequest River
- Middle Musconetcong
- Beaver Brook



Map 7: Carbonate Rock (Surficial) Warren County, New Jersey


Carbonate Rock (Surficial)
(Limestone & Dolomite)

Others

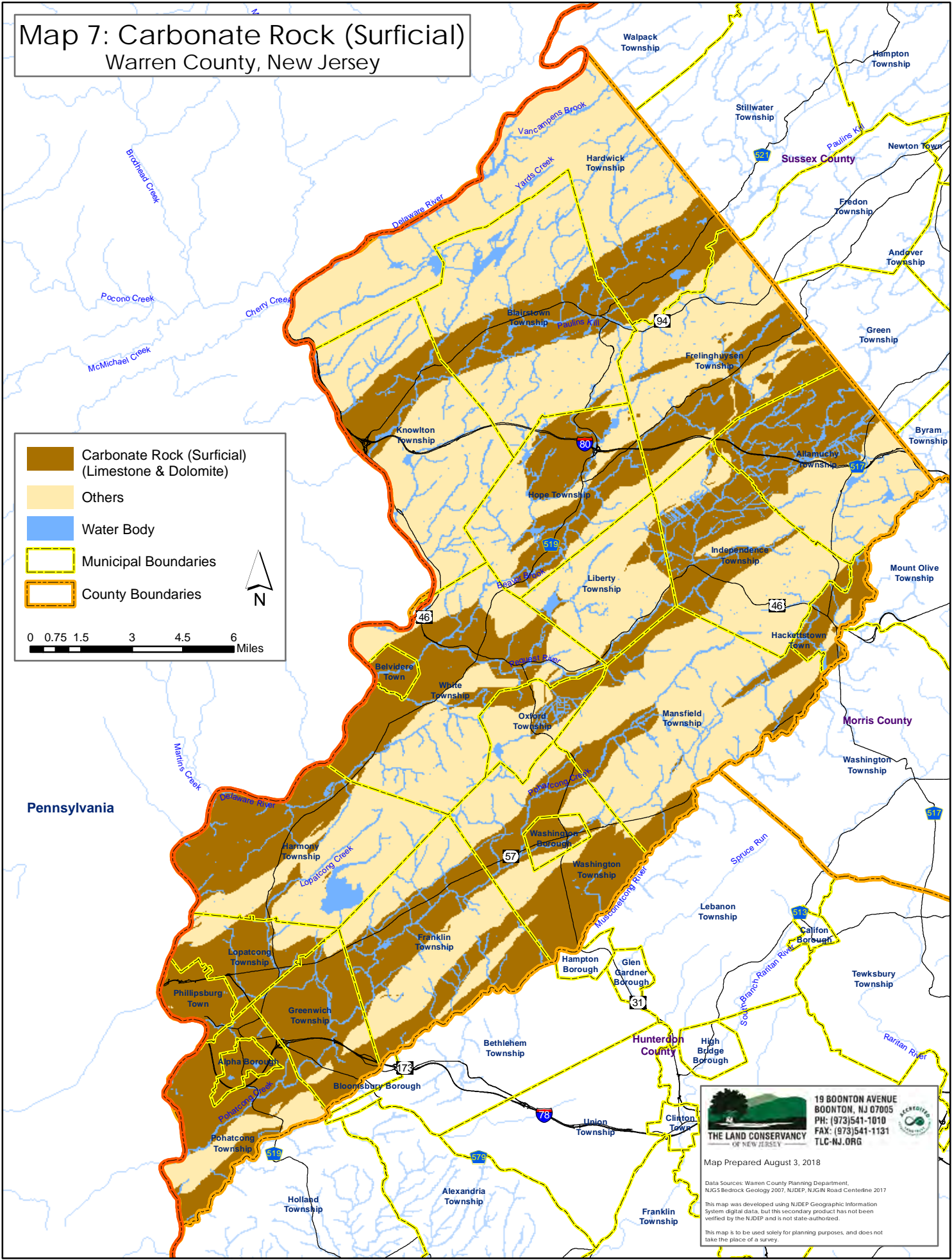
Water Body


Municipal Boundaries

County Boundaries


 N

0 0.75 1.5 3 4.5 6 Miles




 19 BOONTON AVENUE
 BOONTON, NJ 07005
 PH: (973)541-1010
 FAX: (973)541-1131
 TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department,
 NJGS Bedrock Geology 2007, NJDEP, NJGIN Road Centerline 2017
 This map was developed using NJDEP Geographic Information
 System digital data, but this secondary product has not been
 verified by the NJDEP and is not state-authorized.
 This map is to be used solely for planning purposes, and does not
 take the place of a survey.



Warren County: Wellhead Protection Areas (Map 8)



Purpose

Wellhead protection areas are above and below-ground areas of land which are monitored to prevent contamination to wells supplying public water. Wellhead protection areas provide the bulk of water to wells within a 12-year time period.

Acreages

- Wellhead protection areas make up approximately **22,539 acres (10%)** of Warren's total land area.
- There are **56** public water supply wells in Warren

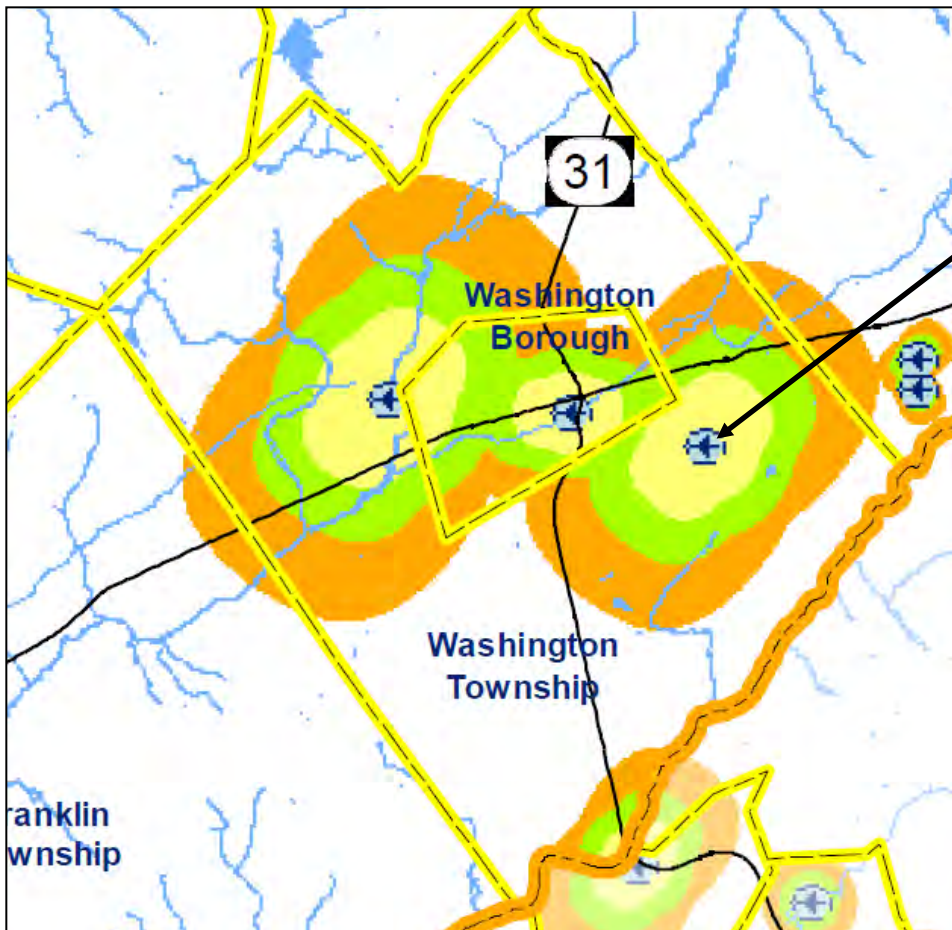
Data Source and Methodology

Data: NJDEP, New Jersey Geographic Information Network (NJGIN), and NJGS Well Head Protection for Public Community Water Supply Wells (2011). Wellhead protection areas are divided into three periods of time of travel: 2 years, 5 years, and 12 years.

Definitions

Times of travel (TOT): Based on the need to assess relative risk of well contamination. Establishing these delineations allows for identification and targeting of pollution sources that pose an imminent threat to the quality of a well and the water supply.








- 2-year TOT:** Area in which contaminants travel to a well within a 2-year period.
- 5-year TOT:** 5-year period of travel.
- 12-year TOT:** Area in which contaminants travel to a well within a 12-year period.


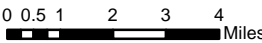


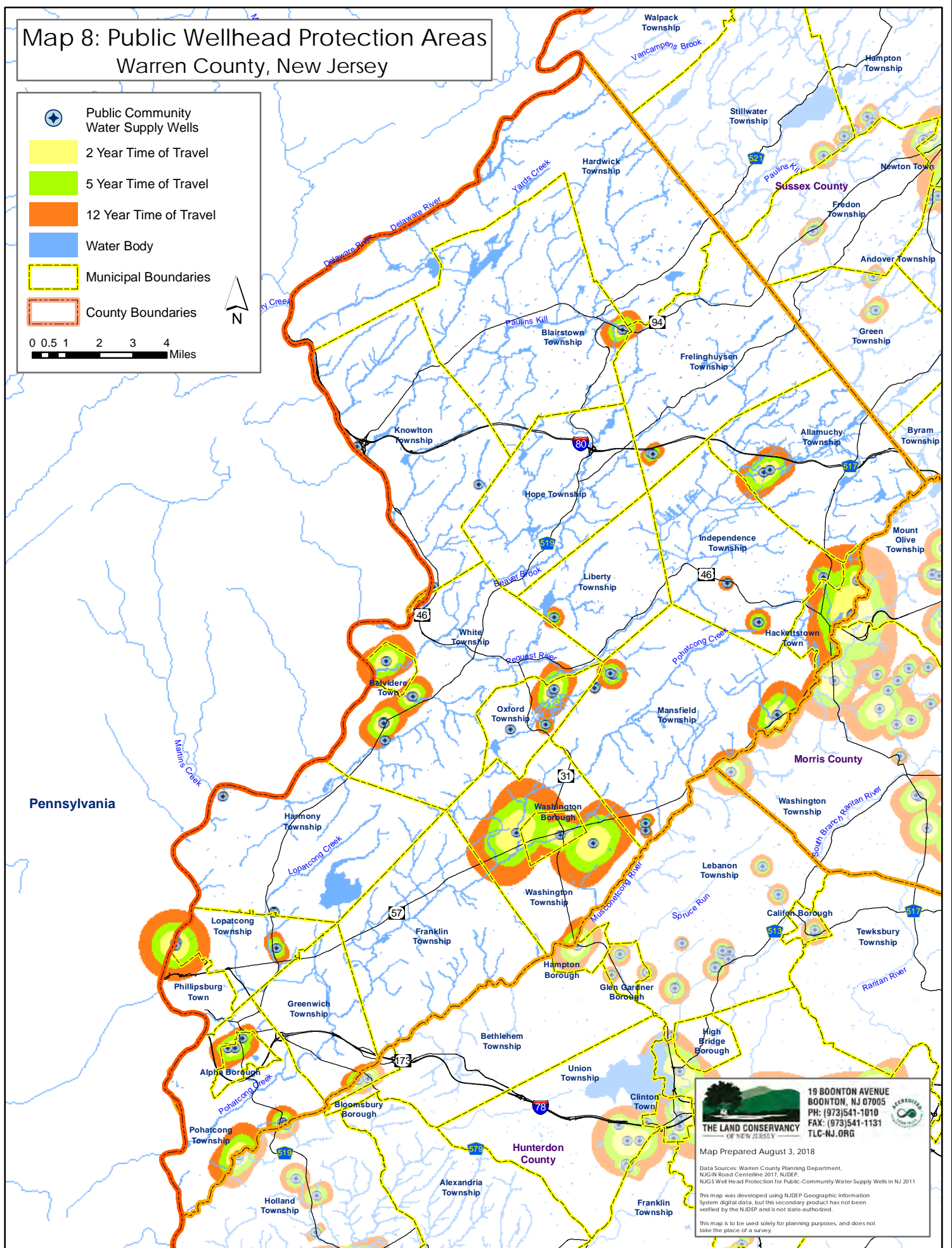
Public Community Water Supply Well




Map 8: Public Wellhead Protection Areas Warren County, New Jersey

 Public Community Water Supply Wells
 2 Year Time of Travel
 5 Year Time of Travel
 12 Year Time of Travel
 Water Body
 Municipal Boundaries
 County Boundaries

 N
 0 0.5 1 2 3 4 Miles




19 BOONTON AVENUE
 BOONTON, NJ 07005
 PH: (973)541-1010
 FAX: (973)541-1131
 TLC-NJ.ORG

Map Prepared August 3, 2018
 Data Sources: Warren County Planning Department, NJGIN Road Centlines 2011, NJDEP, NJGS Well Head Protection for Public-Community Water-Supply Wells in NJ 2011
 This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
 This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Surface Water Quality (Map 9)



Purpose

Reducing surface water contamination from chemical and physical pollutants protects the health of the public water supply and the local ecosystem.

Definitions

Surface Water: Water that collects on the surface of the earth in the form of rivers, streams and lakes, wetlands, and oceans (opposite of groundwater).

Sources of Contamination: Waste and stormwater runoff, industrial waste discharge, and runoff associated with fertilized lawns and farmland.

Data Source and Methodology

NJDEP, NJGIN, and Delaware River Watershed Initiative (DRWI) Stream Reach Assessment Tool (SRAT). The SRAT combines several datasets and factors to assess water quality using mean annual pollutant load, in-stream concentration of pollutants, and location and relative impact of point source pollution. SRAT includes an evaluation of the waterway's landscape features within a stream catchment that influence its Ability to Produce Clean and Abundant Water (APCAW). Its scoring is based upon the concentration of forests, wetlands, riparian natural cover, potential for erosion, groundwater recharge, stream order, and base flow.

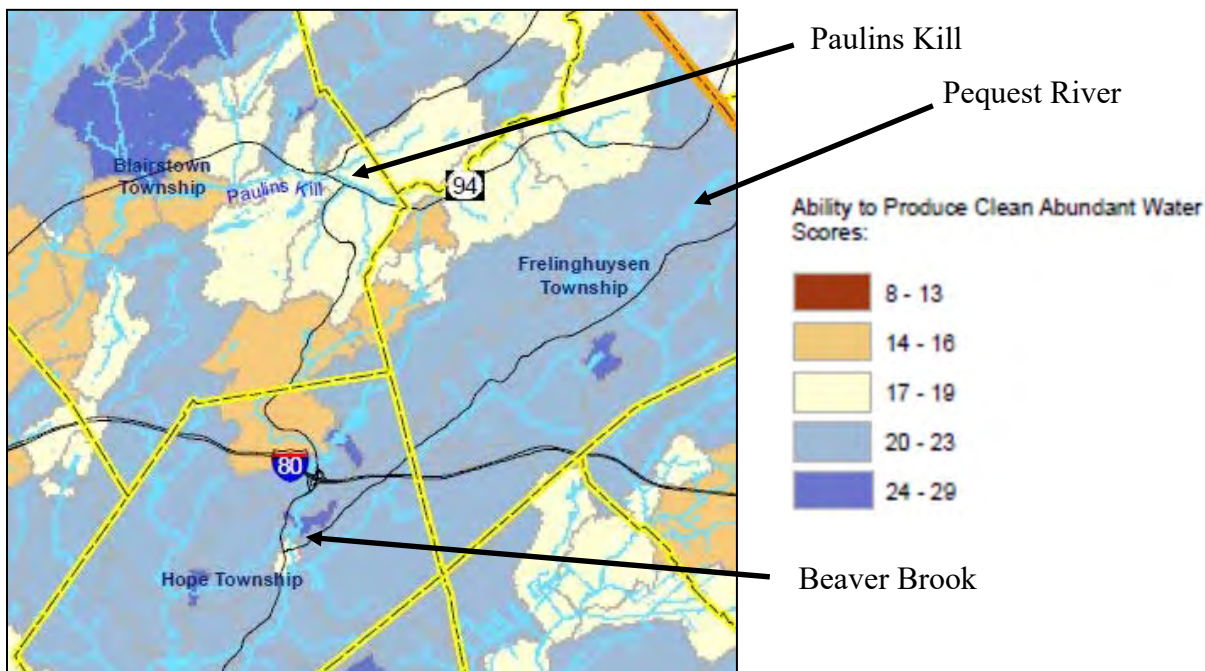
Ability to Produce Clean and Abundant Water (APCAW): This is determined by an evaluation of the landscape features in a stream reach catchment that influence its' ability to produce clean and abundant water. An areas' APCA W does not include an analysis of existing groundwater contamination areas.

Surface Water and APCA W

- ◆ **8-13:** 10,254.25 acres (4% of the County)
- ◆ **14-16:** 78,192.69 acres (26% of the County)
- ◆ **17-19:** 81,897.99 acres (28 % of the County)

Highest scores:

- ◆ **20-23:** 88,632.49 acres (30% of the County)
- ◆ **24-29:** 36,438.73 acres (12% of the County)




Map 9: Surface Water Quality Protection (SRAT: Ability to Produce Clean Abundant Water) Warren County, New Jersey

Ability to Produce Clean Abundant Water Scores:

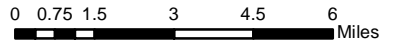
- 8 - 13
- 14 - 16
- 17 - 19
- 20 - 23
- 24 - 29
- Water Body

Municipal Boundaries

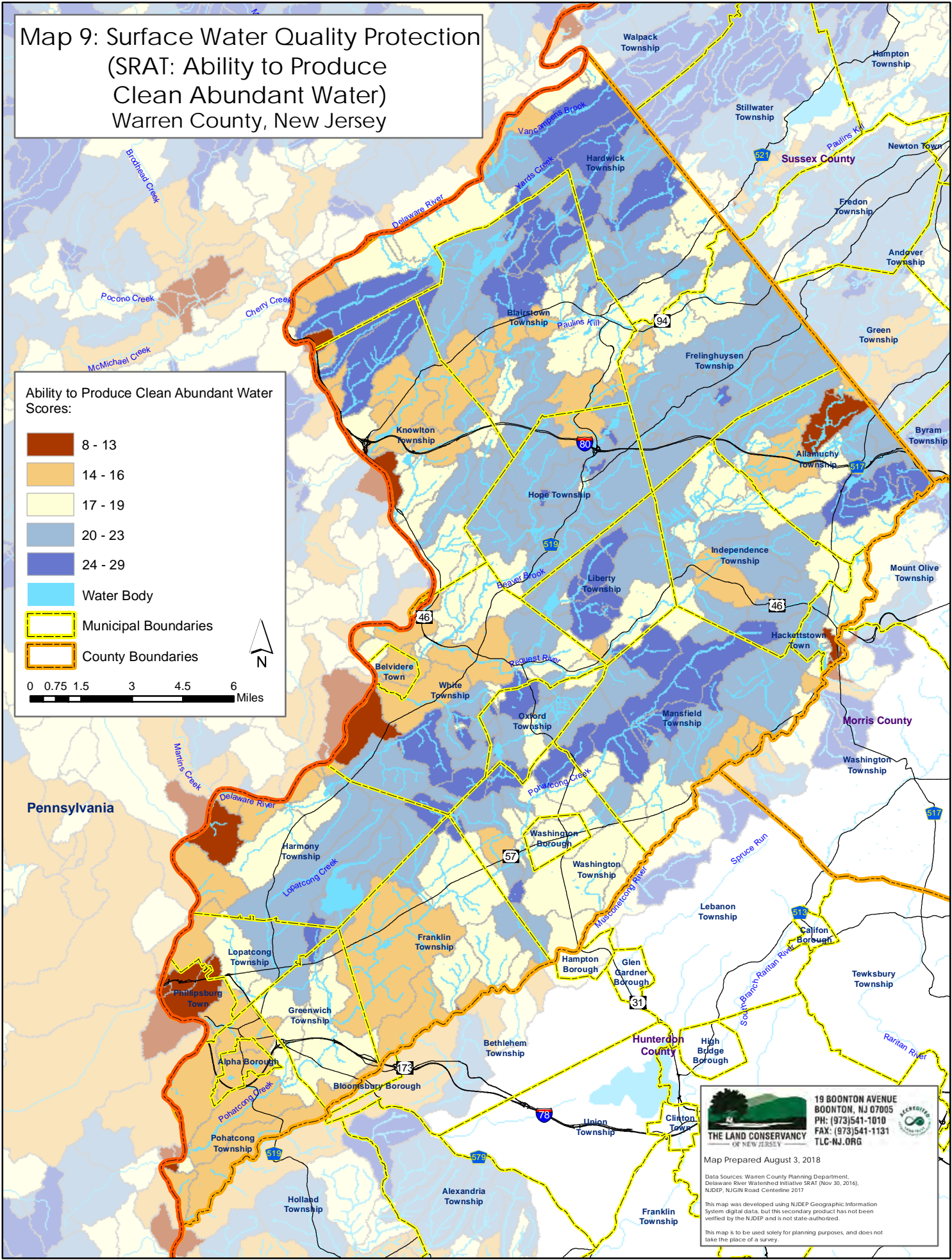
County Boundaries



N



0 0.75 1.5 3 4.5 6 Miles





THE LAND CONSERVANCY
OF NEW JERSEY

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, Delaware River Watershed Initiative SRAT (Nov 30, 2016), NJDEP, NJGIN Road Centeline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Headwaters and Riparian Areas (Map 10)



Purpose

Identifying headwaters and riparian areas helps protect ecosystems, water quality, and downstream flows. Headwaters are comprised mainly of overland water, making them highly vulnerable to non-point source pollution.

Data Source and Methodology

This map was created using data from the NJDEP Land Use/Land Cover 2012, and the Delaware River Watershed Initiative (DRWI) Stream Reach Assessment Tool (SRAT). Stream catchment areas are assigned “first order” or “second order” using the Strahler ordering system and are designated as headwaters. The headwater areas are overlaid with the Riparian Areas (Map 6) and known undeveloped areas. Undeveloped headwater riparian areas are identified using the Anderson Classification System., which uses photo interpretation, field surveys, and digital orthophotography to create the LC/LU (2012) layer.

Definitions

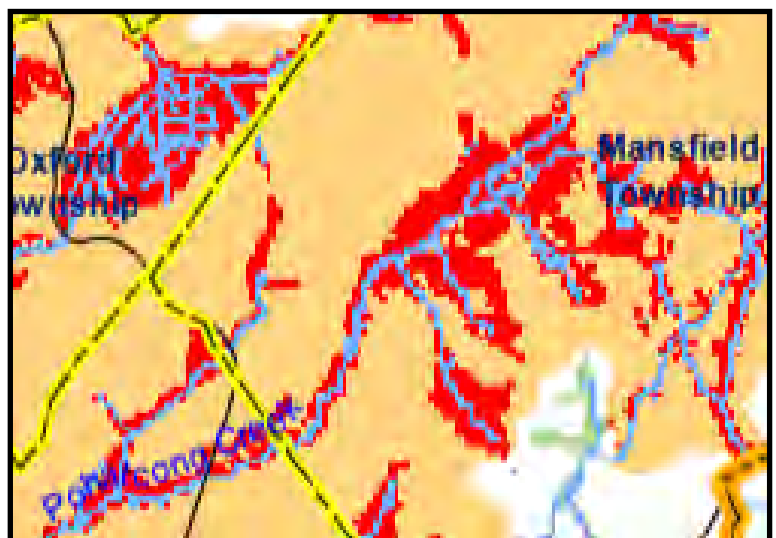
- **Headwaters:** Tributary of a stream or river that is close to or forming part of its source.
- **Riparian Areas:** Wetlands, wetland transition areas, floodprone areas, wildlife passage corridors, and alluvial soils (fertile soils deposited by water flowing over floodplains).
- **Stream Catchment Areas:** An area of land where water from a stream or storm collects.
- **Strahler Method:** Tributaries at the source of a river are referred to as first order stream. The stream order increases as streams of the same order intersect.
- **Non-point Source Pollution:** Pollution that comes from many different sources, usually as a result of precipitation, seepage, and stormwater runoff. This can include fertilizer, pesticides, oil, toxic chemicals, sediment, and salt.
- **Undeveloped Lands:** Developed urban and barren lands were filtered from the NJDEP Land Use Land Cover data (2012) to identify undeveloped riparian areas.

Acreeage

Headwaters and riparian areas make up **30,545 acres (13%)** of Warren County’s total land area.


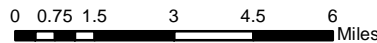


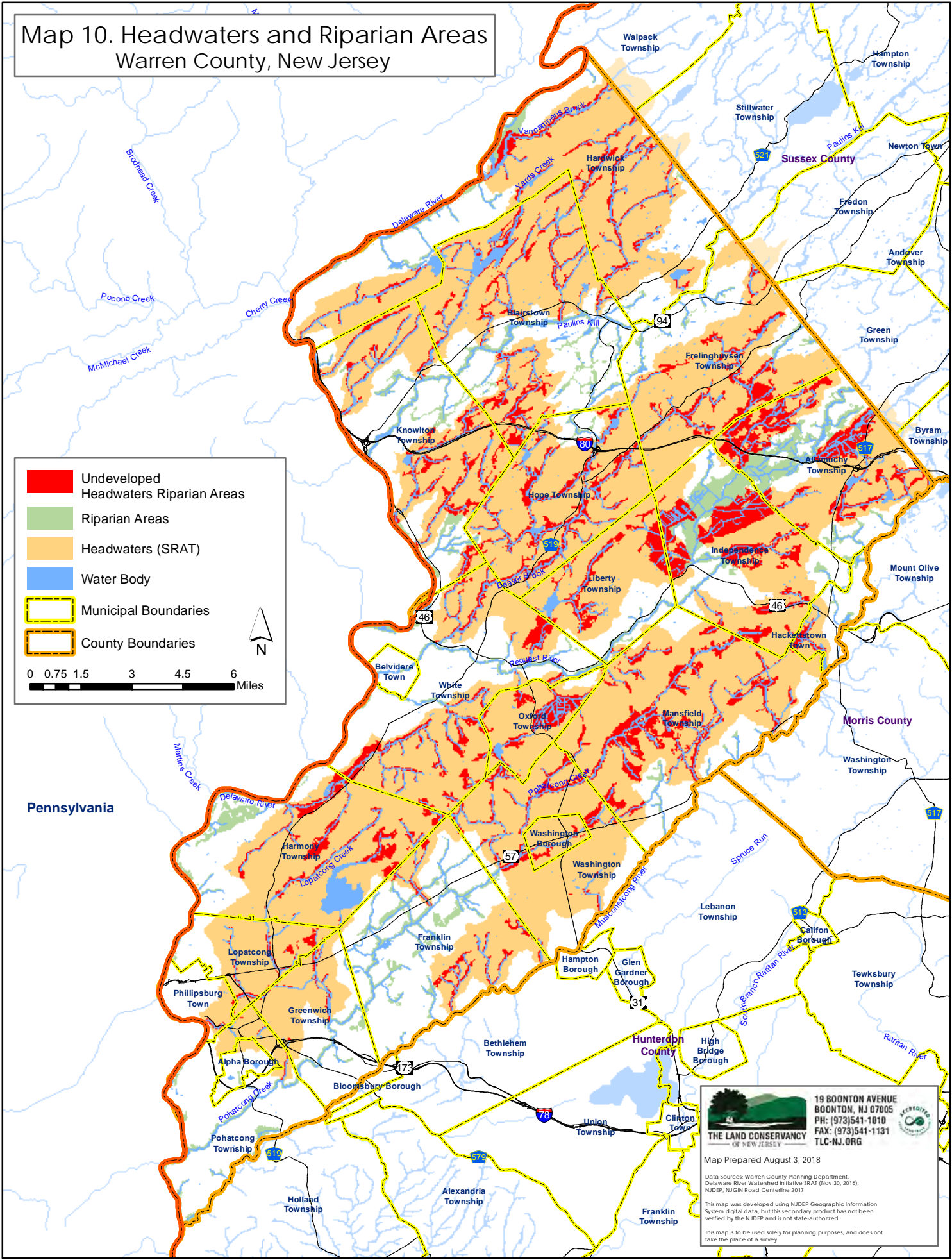
Pohatcong Creek, a tributary to the Delaware River from Hackettstown to Pohatcong Township.



Map 10. Headwaters and Riparian Areas Warren County, New Jersey

Undeveloped Headwaters Riparian Areas
 Riparian Areas
 Headwaters (SRAT)
 Water Body
 Municipal Boundaries
 County Boundaries




19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018
 Data Sources: Warren County Planning Department, Delaware River Watershed Initiative SRAT (Nov 30, 2016), NJDEP, NJGIN Road Centerline 2017
 This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
 This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Unique Aquatic Habitats (Map 11)



Purpose

Identifying unique and aquatic habitats helps to protect vulnerable habitats and threatened and endangered species, especially those that depend on surface water in higher elevations.

Habitats include natural water bodies, artificial water bodies, and vernal pools. Vernal pools are seasonal wetlands that form from rainfall and snowmelt with no connection to flowing surface waters.

Many of these elevated water bodies are vulnerable to contamination because of small watersheds, low soil levels, and higher precipitation rates. Identifying these vulnerable habitats and water bodies informs the development of water management strategies.

Acreage

- **High Elevation Natural Water Bodies:** Natural lakes located at an elevation of 600 feet or higher, with an open water dependent habitat (127 acres, or less than 0.5% of the County).
- **High Elevation Artificial Water Bodies:** Artificial lakes located at an elevation of 600 feet or higher, with an open water dependent habitat (1,578 acres, or 1%).
- **Vernal Pools and Buffers:** Confined wetland areas that hold water for at least two months of the year and have no fish populations (NJDEP, Division of Fish & Wildlife) (28,483 acres, or 12%, including potential vernal pools). The buffers provide critical habitat for threatened and endangered species.

Highlights

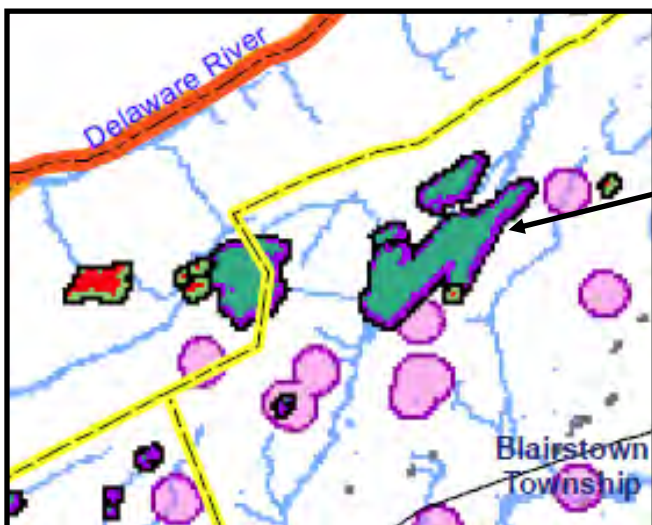
Warren County has a large concentration of vernal pools and potential vernal pools in the northeastern corner of the County.

High-elevation artificial lakes include:

- Merrill Creek Reservoir
- Lower Yards Creek Reservoir
- Upper Yards Creek Reservoir

Data Source and Methodology

This map was created using data from the NJDEP's Landscape Project Version 3.3 (2017), and the USGS elevation model. Potential vernal habitats are areas identified by Rutgers University Center for Remote Sensing and Spatial Analysis (CRSSA) 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.



Yards Creek Reservoir

Natural Water Bodies

- 600 feet elevation or above
- 600 feet elevation or above With 300 feet buffer

Artificial Water Bodies with Open Water Dependent Habitat

- 600 feet elevation or above
- 600 feet elevation or above With 300 feet buffer

Other Water Bodies

- Artificial & Natural Lakes
- Potential vernal habitat area
- Vernal habitat area

Map 11: Unique and Unusual Aquatic Habitats

Warren County, New Jersey

Natural Water Bodies

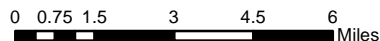
- 600 feet elevation or above
- 600 feet elevation or above
With 300 feet buffer

Artificial Water Bodies with Open Water Dependent Habitat


- 600 feet elevation or above
- 600 feet elevation or above
With 300 feet buffer

Other Water Bodies

- Artificial & Natural Lakes
- Potential vernal habitat area
- Vernal habitat area
- Municipal Boundaries
- County Boundaries



Pennsylvania



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJ Division of Fish & Wildlife, Landscape Project Version 3.3 2017, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Riparian Habitats for Threatened & Endangered Species (Map 12)



Purpose

Identifying riparian habitats with threatened and endangered species helps protect vulnerable habitats and threatened and endangered species, especially those that depend on surface water in higher elevations.

Locating these vulnerable habitats and water bodies informs the development of water management strategies.

These areas are high priority preservation areas and are critical habitats for at-risk species that are either entirely or highly dependent on these areas for food, water, reproduction, and shelter.

Acreages

Riparian areas with threatened or endangered species constitute **6,850 acres, or 3%** of Warren County.

Analysis

In Worthington State Forest and along the Delaware Water Gap, riparian areas support habitat Bog Turtles and Small Whorled Pogonia, an endangered species of orchid. The Bog Turtle is one of New Jersey's most important reptiles. It is one of the smallest turtle species found in North America and it faces threats from loss of habitat and illegal trading. New Jersey recently declared the Bog Turtle the state reptile.

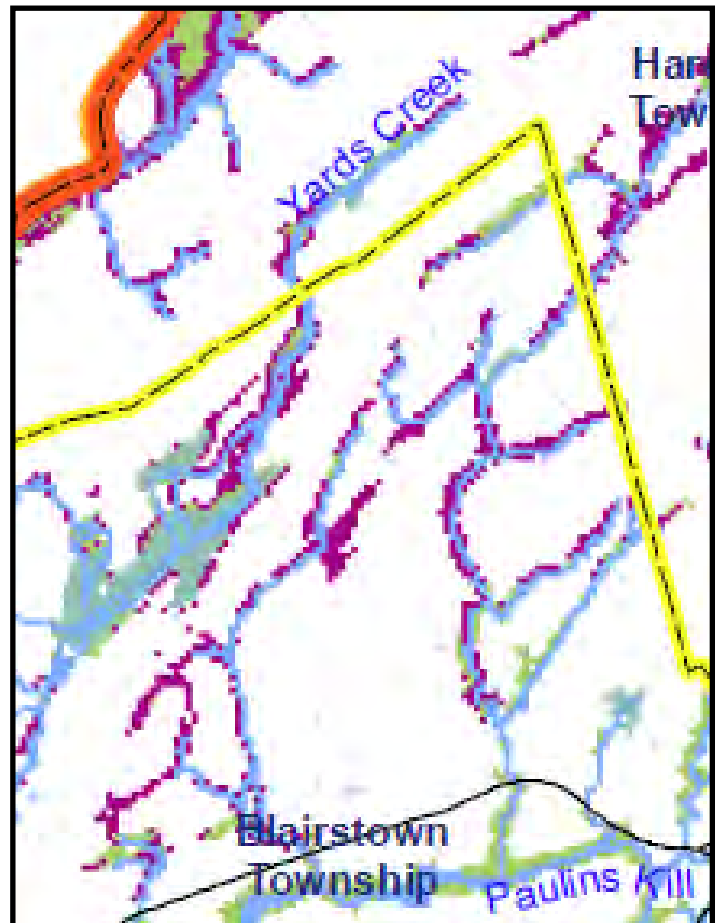


Bog Turtle

Source: <http://www.endangered.org/animal/bog-turtle/>

Data Source and Methodology

This map was created using data from the NJDEP's Landscape Project Version 3.3 (2017) and NJDEP Division of Fish & Wildlife Endangered & Nongame Species Program. Riparian areas includes wetlands, wetland transition areas, streams, floodprone areas, wildlife passage corridors, and hydric/alluvial/high water table soils (NJDEP Land Use/Land Cover 2012).



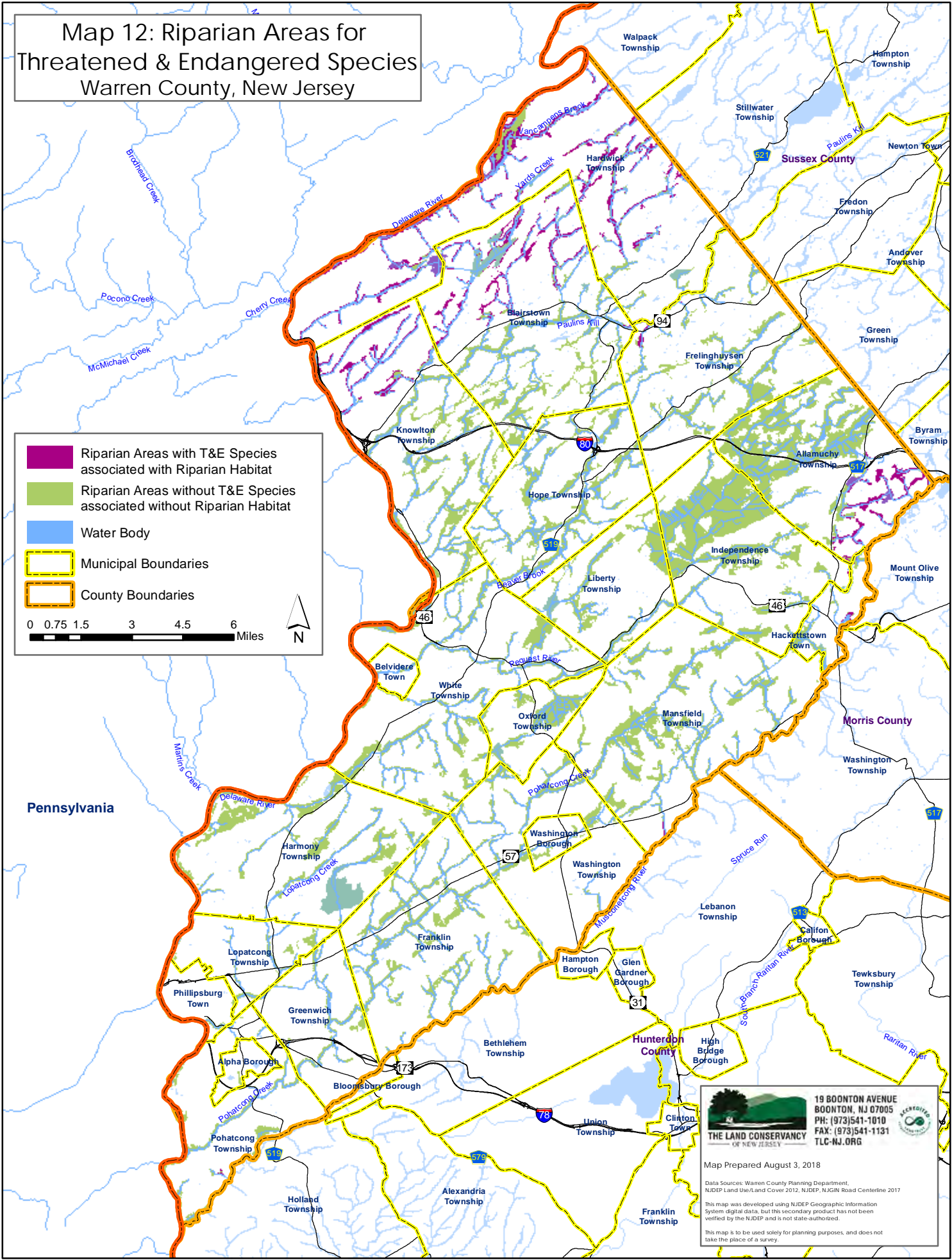
- Riparian Areas with T&E Species associated with Riparian Habitat
- Riparian Areas without T&E Species associated with Riparian Habitat

Map 12: Riparian Areas for Threatened & Endangered Species Warren County, New Jersey

- Riparian Areas with T&E Species associated with Riparian Habitat
- Riparian Areas without T&E Species associated without Riparian Habitat
- Water Body
- Municipal Boundaries
- County Boundaries

0 0.75 1.5 3 4.5 6 Miles

N



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP Land Use/Land Cover 2012, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.



Warren County: Wetland Habitats for Threatened & Endangered Species (Map 13)



Purpose

Identifying wetland habitats with threatened or endangered species helps protect vulnerable habitats and species, especially those that depend on surface water.

These wetlands are important aquatic and transitional ecosystems that provide critical habitat for at-risk species that are either

Data Source and Methodology

This map was created using data from the NJDEP's Landscape Project Version 3.3 (2017) and NJDEP Division of Fish & Wildlife Endangered & Nongame Species Program.

Wetlands data was provided by the NJDEP Land Use/Land Cover Data (2012). The data used in this map includes a variety of ecological environments identified in NJDEP's Anderson Classification System.

Acreage



Wetland habitats associated with threatened and endangered species constitute 19,736 acres (8.5% of the County).

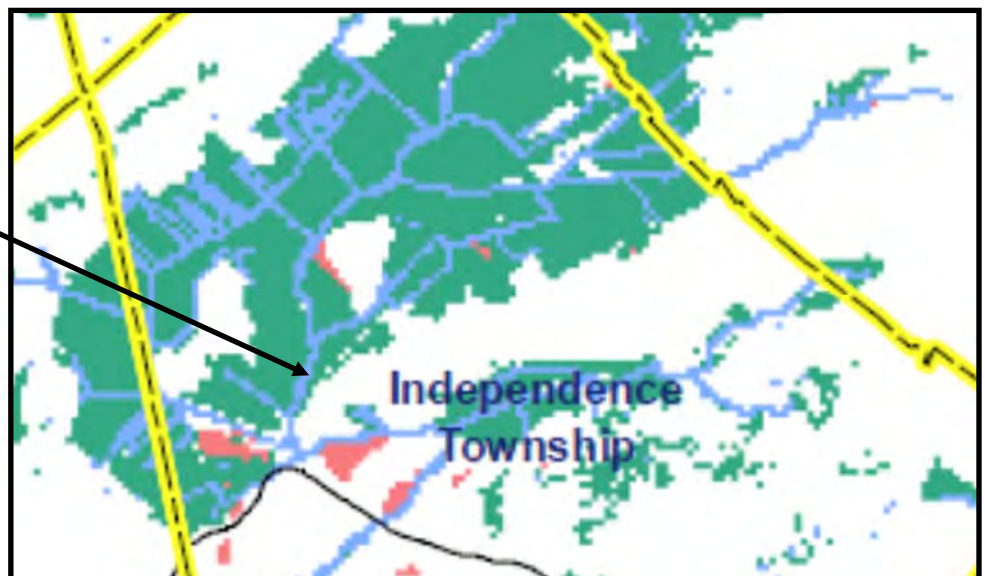
Analysis

A large concentration of Warren County's wetland habitats for threatened and endangered species is located in the northeast region of the county, below Jenny Jump State Forest, near the Pequest River valley. This area is made up of deciduous wooded wetlands, agricultural wetlands, herbaceous wetlands, and shrub wetlands. Bog Turtles are one example of endangered species that live in this region.

Another large concentration of wetland habitat for threatened or endangered species lies southwest of the Pequest Wildlife Management Area. There is also a significant Bog Turtle population in this region of Warren County.

Pequest River

-  Wetlands associated with T&E species habitat
-  Wetlands not associated with T&E species habitat

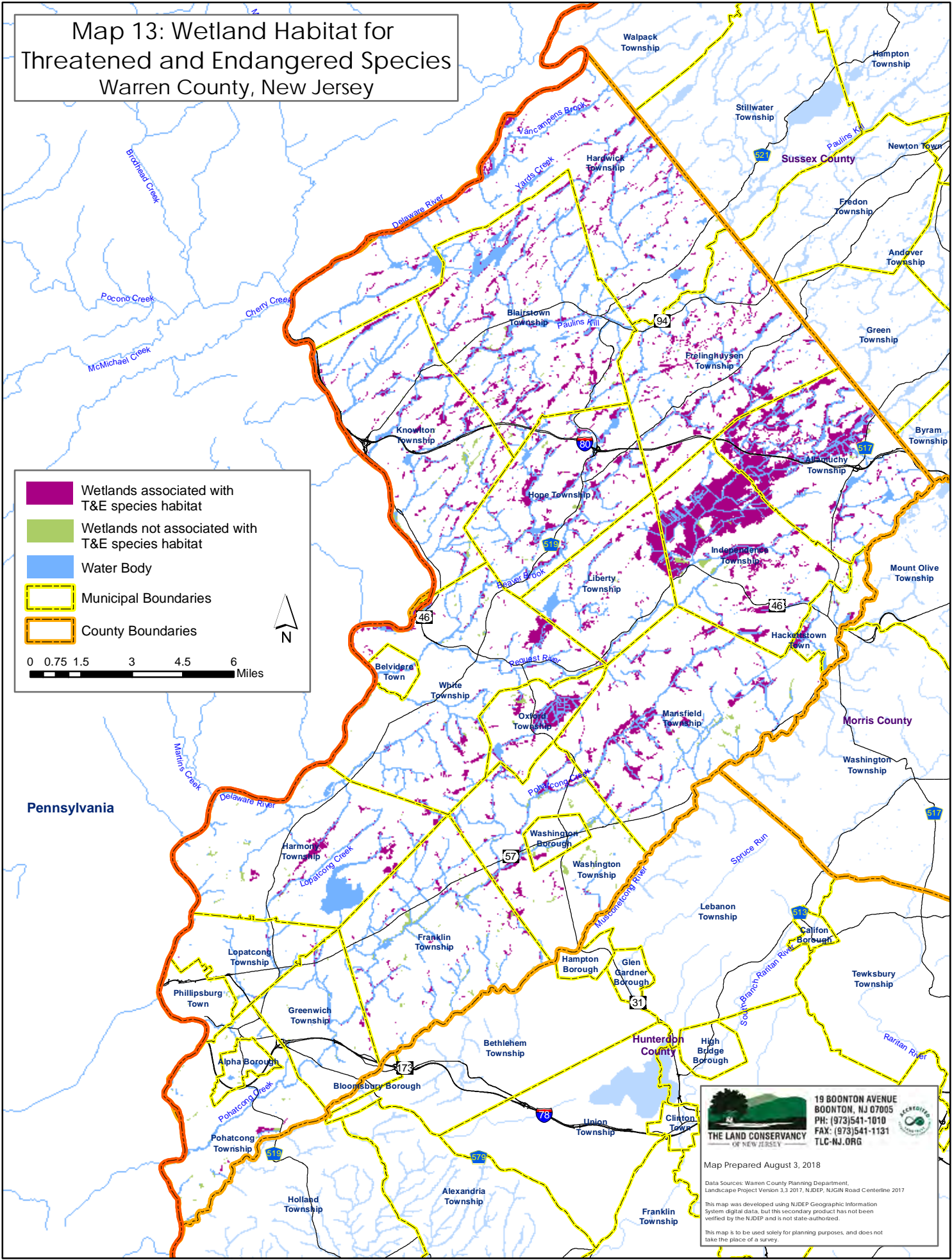


Map 13: Wetland Habitat for Threatened and Endangered Species Warren County, New Jersey

- Wetlands associated with T&E species habitat
- Wetlands not associated with T&E species habitat
- Water Body
- Municipal Boundaries
- County Boundaries

0 0.75 1.5 3 4.5 6 Miles

N



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, Landscape Project Version 3.3 2017, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

PRESERVATION PRIORITIES

How are the water resource priorities mapped?

Step 1 – Creating the Composite Maps: Once the maps were drawn and verified, they were overlain to determine priorities for preservation. Each of the characteristics were given an equal weight. The resulting composite maps display those polygons where a site can have a score from 1, where only one characteristic is present, to 4 or 5, where all the characteristics are present. This type of scoring approach is based on “presence/absence.” Consideration was given to use of more detailed scoring systems, where each characteristic could have a range of scores, or weighted so that one characteristic had a higher score than another. However, these more complicated systems involve significant judgement calls and often are harder to understand than the approach selected for this watershed analysis.

For example, if a specific area of the County as defined by a GIS polygon is identified as meeting the criteria for three of five characteristics, the polygon would be given a color associated with a score of three. (*Map I-A, Map II-A, Map III-A*)

Step 2 – Creating the Higher to Lower Priority Maps: Based on the assumption that 10% is the threshold for “high priority” polygons, the mapping was simplified to aggregate the detailed scores into two groups to show higher and lower priority areas by, for example, plotting areas that have 1 to 2 characteristics as lower priority and areas that have 3 to 5 characteristics as higher priority. (*Map I-B, Map II-B, Map III-B*)

Step 3 – Creating the Water Resources Priority Maps: Once each of the individual factors was mapped (hydrology, stream and aquifer quality, aquatic ecosystem functions), a set of overall composite maps were created based on the following schematic:

- A. Those polygons in the County that have a score of 1 to 3, 4, 5, 6, 7, 8 to 9, or 10 to 12 are identified. Individually mapped, it shows the gradient at which priority areas are located in the County. (*Map IV-A*)
- B. Aggregating the 12 characteristics into higher (6-12), middle (4-5) and lower (1-3) priority categories, the polygons are ranked for all unpreserved lands in Warren County. For the first time, the mapping now excludes from the analysis all protected lands to give a picture of potential acquisitions. (*Map IV-B*)
- C. Looking only at the lands identified as high priority (scores 6 to 12), the properties are analyzed on a tax parcel basis, where the individual parcels were mapped according to how much of the parcel scores high. The mapping shows those high priority parcels that range from less than 10% containing water resource attributes, to those parcels having more than 90% of their area identified as having a water quality value. (*Map IV-C*)
- D. The final step identified those high priority parcels (where 25% or more of their area has a water resource value) that are greater than 1 acre in size, and located within 300 feet of public/preserved lands. These are the highest priority parcels, based on a water resource characteristic, for Warren County. (*Map IV-D*)

Priorities for Preservation – Results

The mapping of these individual datasets, and a look at how they correlate, leads to composite information about the areas of Warren County identified as high priority for protection of water resources. The expectation is that an area of land with high scores will provide a greater level of water resource benefits than areas with lower scores. Ultimately, these maps and datasets, including the tax data information, will help Warren County stakeholders to identify properties that could most benefit the County’s water quality and supply through preservation efforts.

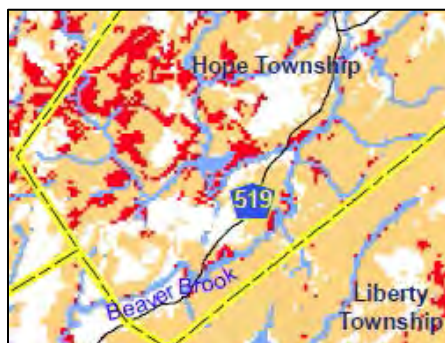
Results – Hydrology

Hydrology was measured by mapping net water availability, prime recharge areas, forest cover, wetlands, and flood hazard areas in Warren County. (Maps 1, 2, 3, 4 and 5) Overall, 74% of Warren County’s land base has a hydrologic value. Nearly half of these lands present at least one of these attributes, and only 82 acres (or 0.04% of the County) includes all five hydrologic characteristics.

Hydrology (Map I-A)			
Scores	Acres	% Hydrology	% County
5	82.47	0.05%	0.04%
4	1,231.44	0.71%	0.53%
3	25,815.51	14.95%	11.12%
2	64,624.09	37.41%	27.85%
1	80,980.09	46.88%	34.90%
Total:	172,733.59	100.00%	74.43%

Of those lands with hydrologic features, the vast majority have only one or two of the five possible features. Using 10% as the pivot point at which priority lands are identified, those lands which have either 3, 4, or 5 of these attributes rank higher for protection and encompass 27,129 acres of land.

Hydrology: High Priority (Map I-B)			
Scores	Acres	% Hydrology	% County
3-5	27,129.42	15.71%	11.69%
1-2	145,604.17	84.29%	62.74%
Total:	172,733.59	100.00%	74.43%



- Higher Priority:
Score 3 to 5
- Lower Priority:
Score 1 & 2

In Hope Township, the lands surrounding Beaver Brook are higher priority lands, scoring between 3 and 5 for hydrology.

Map I-A: Hydrology

Warren County, New Jersey

Hydrology Composite

Scores	Acres	Percent	% County
5	82.47	0.05%	0.04%
4	1231.44	0.71%	0.53%
3	25815.51	14.95%	11.12%
2	64624.09	37.41%	27.85%
1	80980.09	46.88%	34.90%
	172733.59	100.00%	74.43%

High to Low Priority Scores:

- Score 5
- Score 4
- Score 3
- Score 2
- Score 1
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries



0 0.75 1.5 3 4.5 6 Miles

Pennsylvania

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP Land Use/Land Cover 2012, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

Map I-B: Hydrology

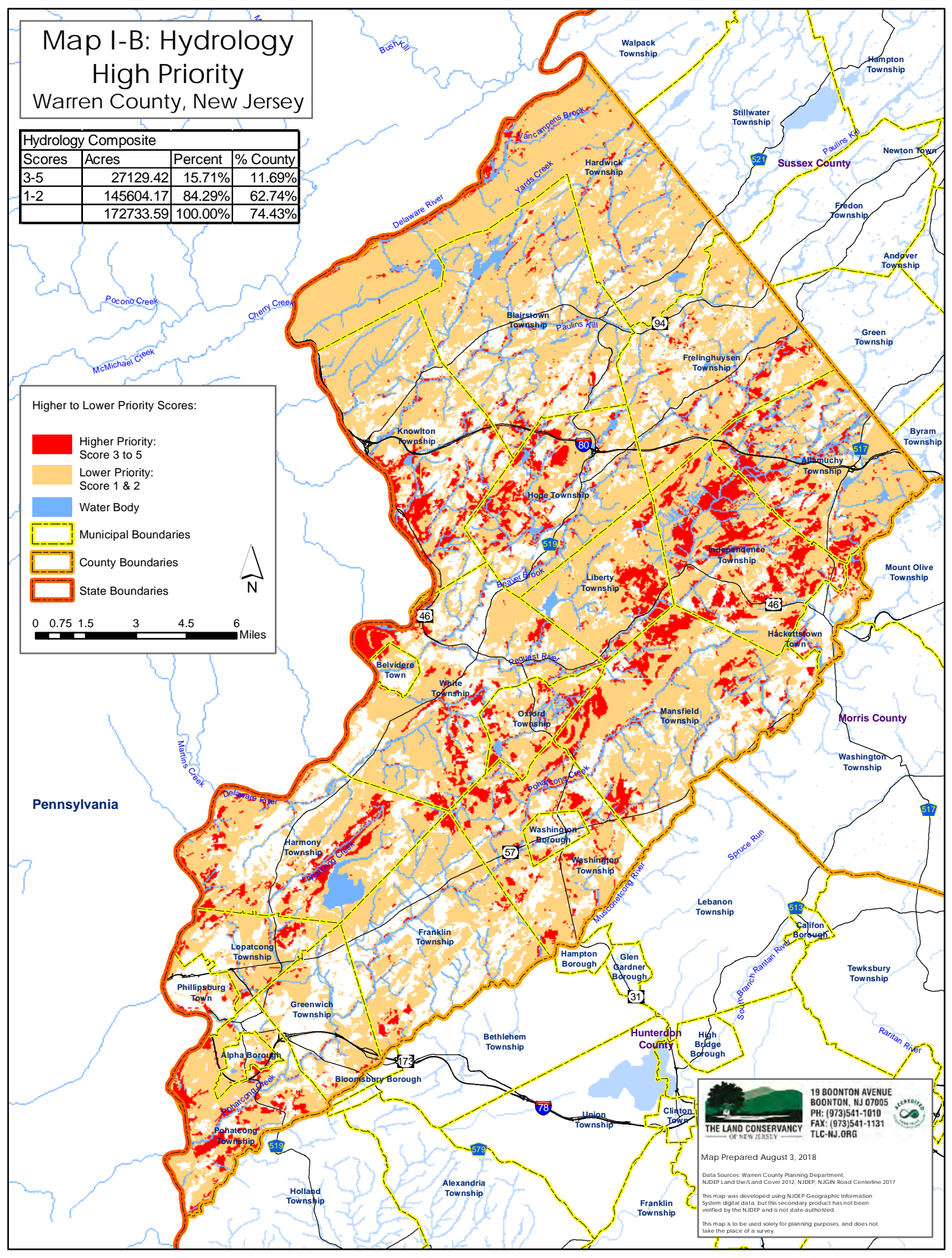
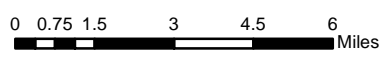
High Priority

Warren County, New Jersey

Hydrology Composite			
Scores	Acres	Percent	% County
3-5	27129.42	15.71%	11.69%
1-2	145604.17	84.29%	62.74%
	172733.59	100.00%	74.43%

Higher to Lower Priority Scores:

- Higher Priority: Score 3 to 5
- Lower Priority: Score 1 & 2
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP Land Use/Land Cover 2012, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

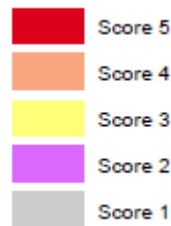
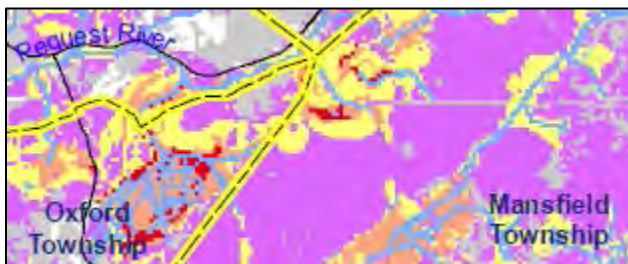
This map is to be used solely for planning purposes, and does not take the place of a survey.

Results – Stream and Aquifer Quality

Forest cover, riparian areas, soluble carbonate rocks, public community supply wells, and surface water quality (*Map 3, 6, 7, 8 and 9*) measure and illustrate lands which support stream and aquifer quality. Of those lands with stream and aquifer quality features, the vast majority have only one or two of the five possible features.

Stream and Aquifer Quality (<i>Map II-A</i>)			
Scores	Acres	% Quality	% County
5	419.07	0.19%	0.18%
4	7,575.21	3.43%	3.26%
3	35,367.13	16.04%	15.24%
2	93,327.25	42.32%	40.22%
1	83,862.86	38.02%	36.14%
Total:	220,551.52	100.00%	95.04%

Nearly all of Warren County’s land base (95%) exhibits attributes reflective of stream and aquifer quality. (*Map II-A*) Of this, only 419 acres of land (0.18% of the County) support all five water quality characteristics.



The riparian corridor of the Pequest River in Oxford and Mansfield Townships has areas of high priority, with all five water quality attributes present.

Close to 20% of Warren County (43,361 acres) has land which is identified as a high priority for stream and aquifer quality.

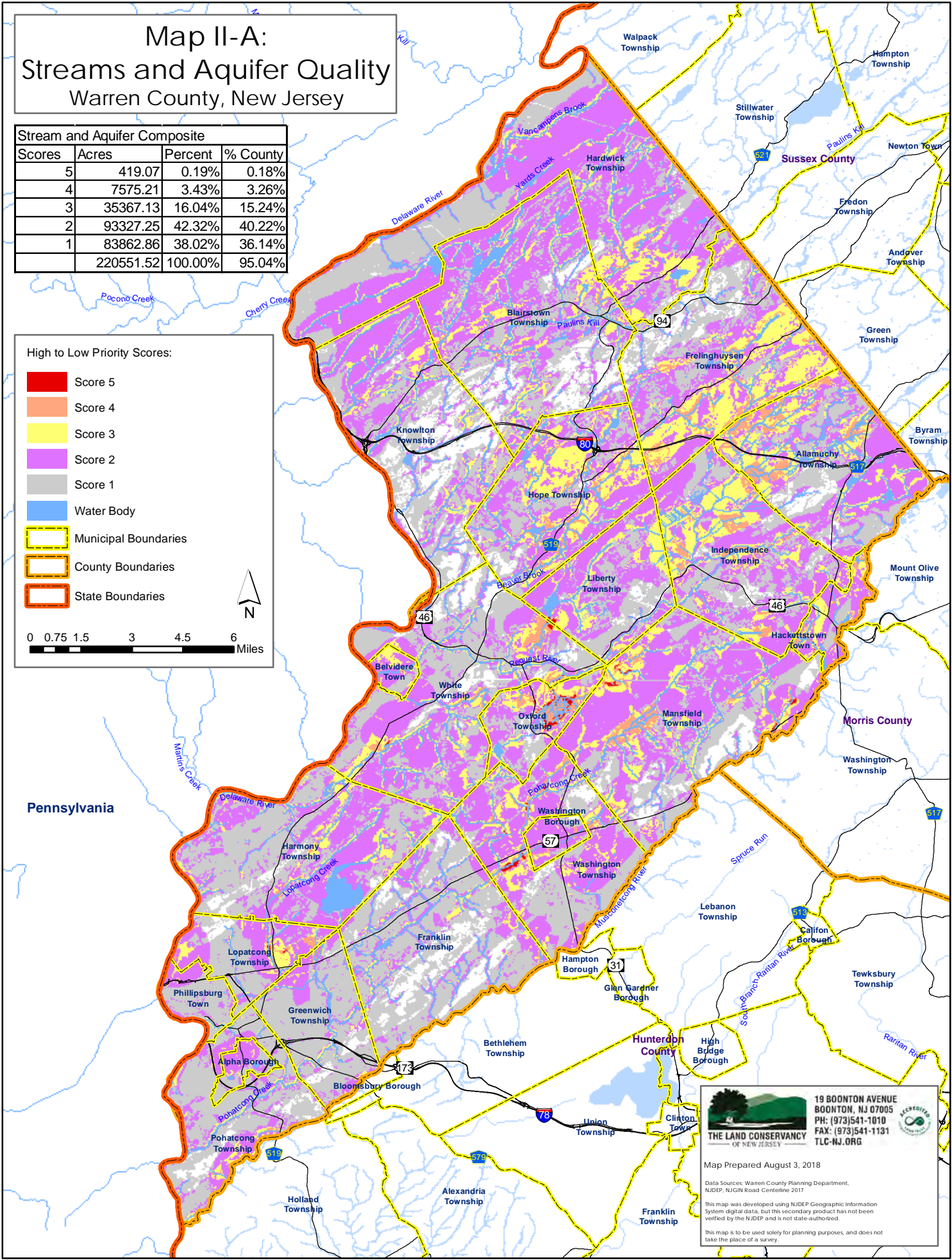
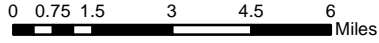
Stream and Aquifer Quality: High Priority (<i>Map II-B</i>)			
Scores	Acres	% Quality	% County
3-5	43,361.41	19.66%	18.69%
1-2	177,190.12	80.34%	76.35%
Total:	220,551.52	100.00%	95.04%

Map II-A: Streams and Aquifer Quality Warren County, New Jersey

Stream and Aquifer Composite			
Scores	Acres	Percent	% County
5	419.07	0.19%	0.18%
4	7575.21	3.43%	3.26%
3	35367.13	16.04%	15.24%
2	93327.25	42.32%	40.22%
1	83862.86	38.02%	36.14%
	220551.52	100.00%	95.04%

High to Low Priority Scores:

- Score 5
- Score 4
- Score 3
- Score 2
- Score 1
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries




19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018
 Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centerline 2017
 This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.
 This map is to be used solely for planning purposes, and does not take the place of a survey.

Map II-B: Streams and Aquifer Quality High Priority Warren County, New Jersey

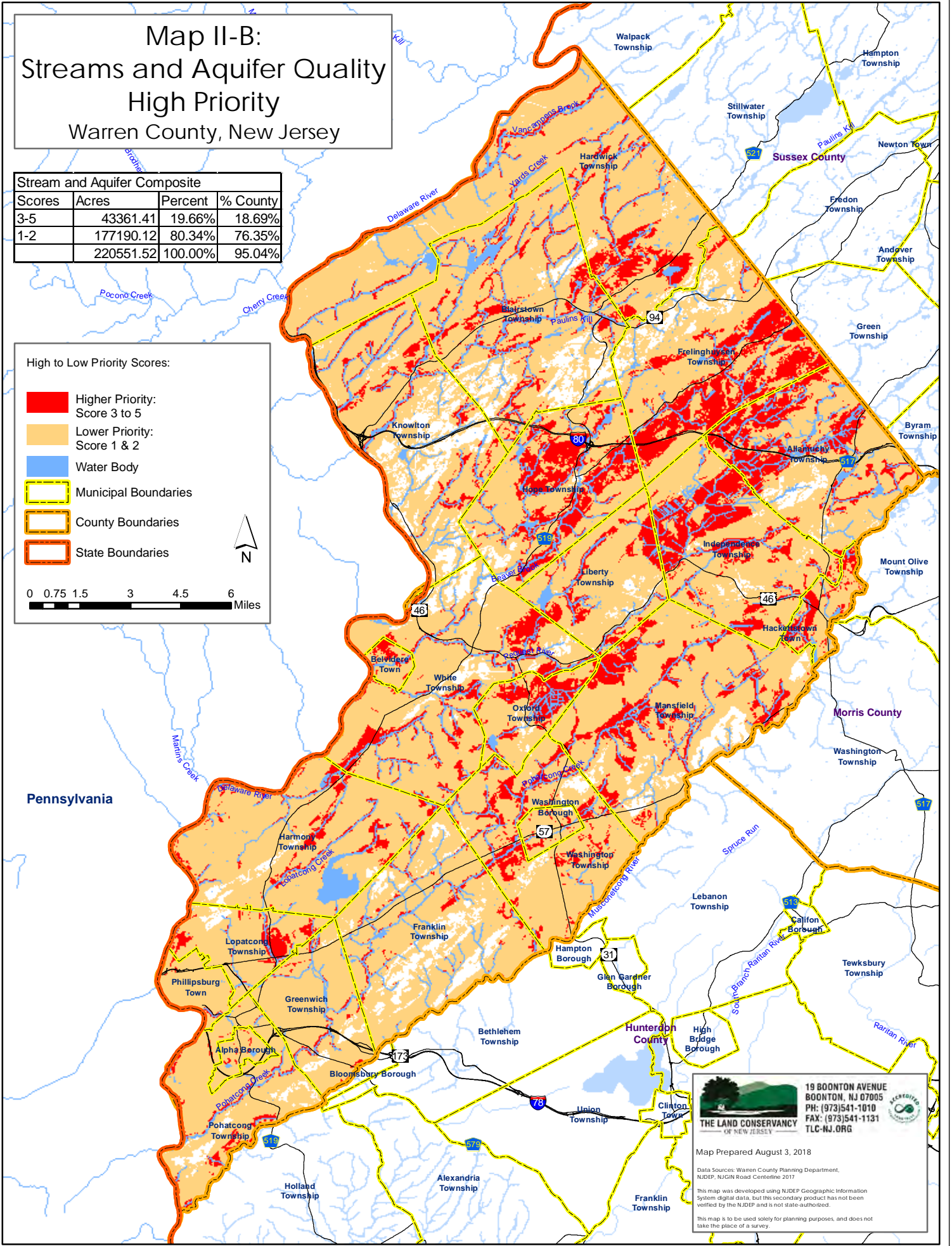
Stream and Aquifer Composite			
Scores	Acres	Percent	% County
3-5	43361.41	19.66%	18.69%
1-2	177190.12	80.34%	76.35%
	220551.52	100.00%	95.04%

High to Low Priority Scores:

- Higher Priority: Score 3 to 5
- Lower Priority: Score 1 & 2
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries



0 0.75 1.5 3 4.5 6 Miles




19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

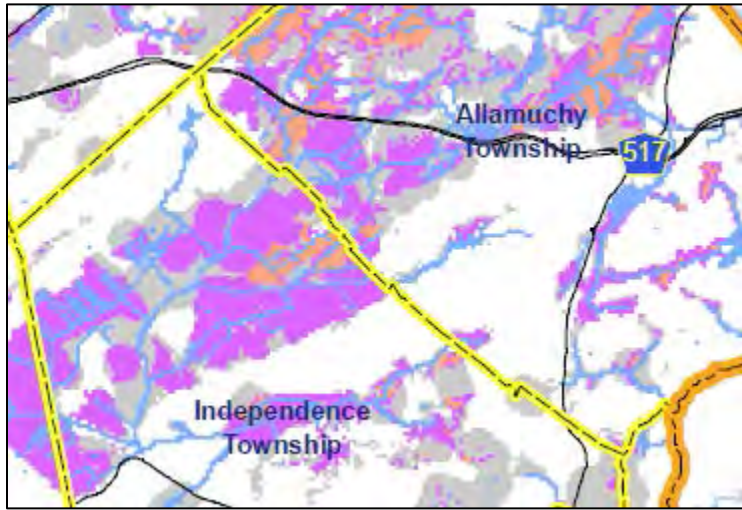
Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centerline 2017

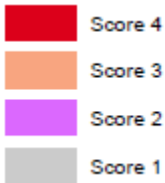
This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

Results – Aquatic Ecosystem Functions



Lands which are undeveloped and in the riparian corridor of headwater streams, high elevation water bodies, vernal habitat, and riparian and wetlands areas which provide habitat for threatened and endangered species (Map 10, 11, 12 and 13), are characteristic of unique aquatic habitats in Warren County. (Map III-A)



This land is limited to 26% of the County. The Pequest Valley in Allamuchy and Independence Townships is the largest concentration of unique aquatic habitats in Warren County. Of those lands with aquatic ecosystem functions features, the vast majority have only one or two of the four possible features.

Aquatic Ecosystems Functions (Map IIIA)			
Scores	Acres	% Functions	% County
4	100.39	0.16%	0.04%
3	3,975.69	6.53%	1.71%
2	17,391.56	28.56%	7.49%
1	39,436.52	64.75%	16.99%
Total:	60,904.17	100.00%	26.24%

Due to the rarity of this landscape, only 4,076 acres score high for aquatic ecosystem functions in Warren County.

Aquatic Ecosystems Functions: High Priority (Map IIIB)			
Scores	Acres	% Functions	% County
3-4	4,076.08	6.69%	1.76%
1-2	56,828.08	93.31%	24.49%
Total:	60,904.17	100.00%	26.24%

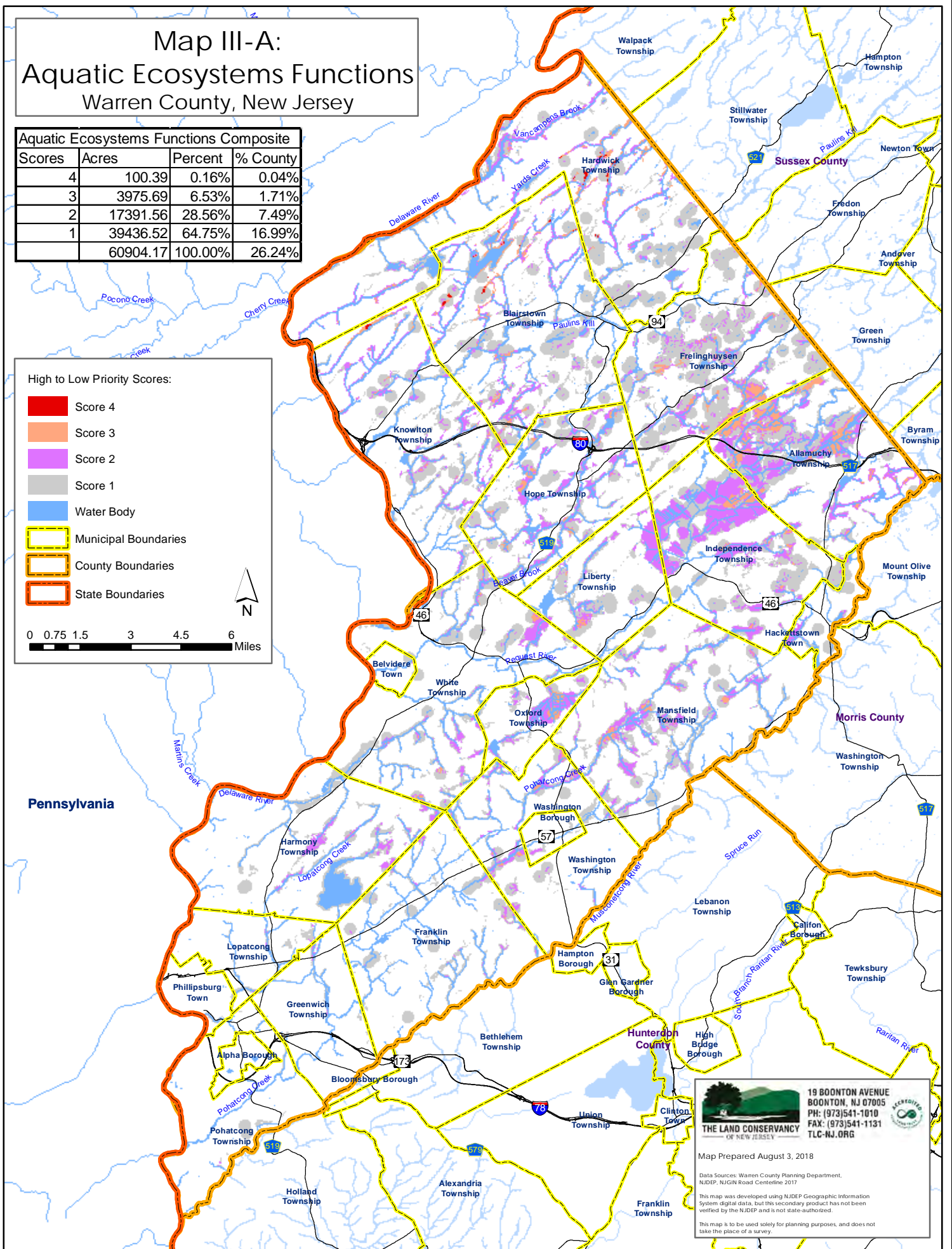
Map III-A: Aquatic Ecosystems Functions Warren County, New Jersey

Aquatic Ecosystems Functions Composite			
Scores	Acres	Percent	% County
4	100.39	0.16%	0.04%
3	3975.69	6.53%	1.71%
2	17391.56	28.56%	7.49%
1	39436.52	64.75%	16.99%
	60904.17	100.00%	26.24%

High to Low Priority Scores:

- Score 4
- Score 3
- Score 2
- Score 1
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries

0 0.75 1.5 3 4.5 6 Miles




19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.


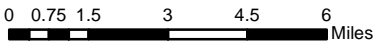
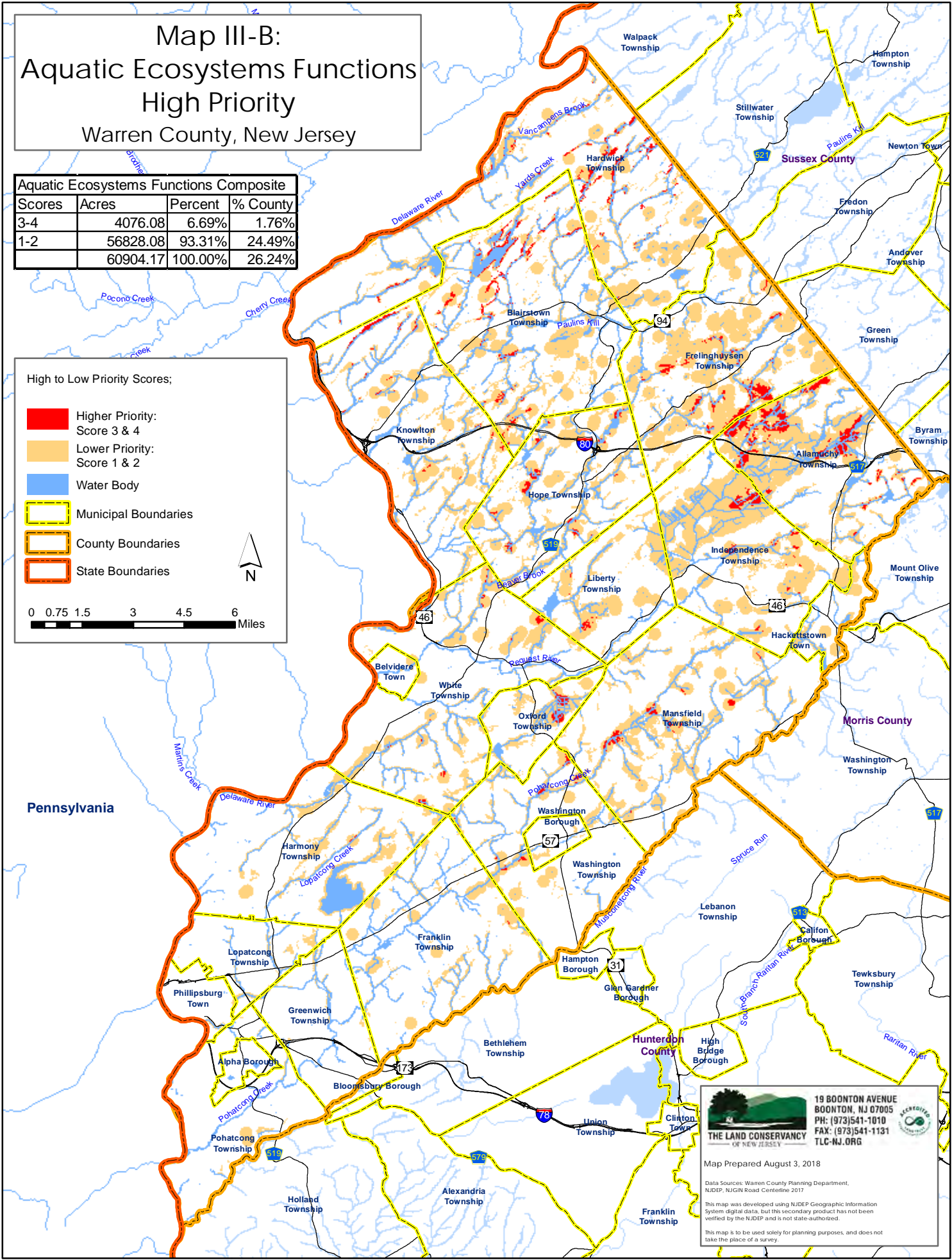

This map is to be used solely for planning purposes, and does not take the place of a survey.

Map III-B: Aquatic Ecosystems Functions High Priority Warren County, New Jersey

Aquatic Ecosystems Functions Composite			
Scores	Acres	Percent	% County
3-4	4076.08	6.69%	1.76%
1-2	56828.08	93.31%	24.49%
	60904.17	100.00%	26.24%

High to Low Priority Scores;

- Higher Priority: Score 3 & 4
- Lower Priority: Score 1 & 2
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

Overview for Composite Mapping

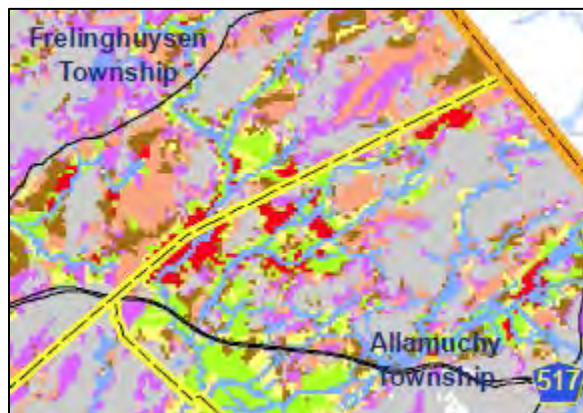
To identify lands not yet protected that would be high priority for acquisition for preservation, the analysis combined all of the attributes, and then excluded areas of preserved land from the identification of high priority lands. Promoting contiguity of preserved lands is a high priority for both the County and its municipalities. The final map illustrates all of those parcels which are within 300 feet of preserved land, and of those, which have the greatest percentage of their area scoring high for water resource protection.

Using the maps and the parcel data tables, a municipality, nonprofit, or other agency interested in land preservation for the protection of water quality and water resources can focus in on an area of interest and determine the priority ranking for that area and its suitability for acquisition.

Map IV-A. Hydrology, Streams & Aquifer Quality, and Aquatic Ecosystems Functions

Because there were virtually no areas where 11 or 12 of the characteristics were present, the mapping is in seven groupings: 1-3, 4, 5, 6, 7, 8-9 and 10-12. Areas with seven characteristics present total 9,588 acres, or 4% of the County, and those with 8 to 9 total another 8,817 acres; those with 10-12 total 1,273 acres. (*Map IV-A*) Of those lands with any of the characteristics, most have only a few of the 12 possible features, as seen in the table below under “% of Total.”

<i>Map IV-A. Composite: Hydrology, Streams & Aquifer Quality, Aquatic Ecosystem Functions</i>			
Scores	Acres	% of Total	% County
10-12	1,272.62	0.56%	0.55%
8-9	8,817.28	3.91%	3.80%
7	9,588.11	4.25%	4.13%
6	12,399.84	5.49%	5.34%
5	24,936.05	11.05%	10.75%
4	41,184.41	18.25%	17.75%
1-3	127,479.85	56.49%	54.93%
Total:	225,678.16	100.00%	97.25%



High composite scores are seen in Allamuchy into Frelinghuysen Township, bounded by Trout Brook, Bear Brook and Bear Creek. (*Map IV-A*)

Map IV-A. Composite: Hydrology, Streams & Aquifer Quality, and Aquatic Ecosystem Functions Warren County, New Jersey

High to Low Priority Scores:

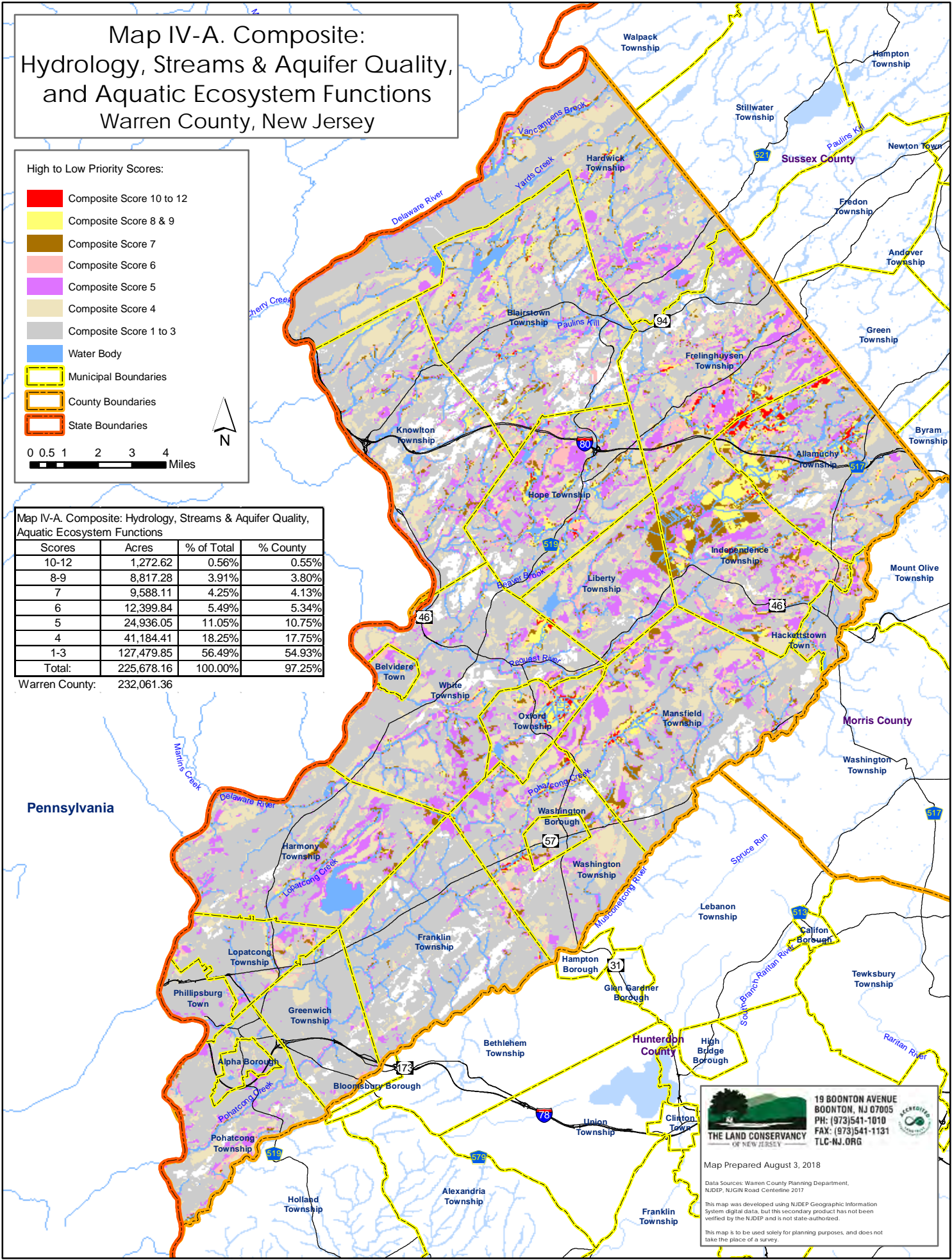
- Composite Score 10 to 12
- Composite Score 8 & 9
- Composite Score 7
- Composite Score 6
- Composite Score 5
- Composite Score 4
- Composite Score 1 to 3
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries

0 0.5 1 2 3 4 Miles



Scores	Acres	% of Total	% County
10-12	1,272.62	0.56%	0.55%
8-9	8,817.28	3.91%	3.80%
7	9,588.11	4.25%	4.13%
6	12,399.84	5.49%	5.34%
5	24,936.05	11.05%	10.75%
4	41,184.41	18.25%	17.75%
1-3	127,479.85	56.49%	54.93%
Total:	225,678.16	100.00%	97.25%

Warren County: 232,061.36




19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 3, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

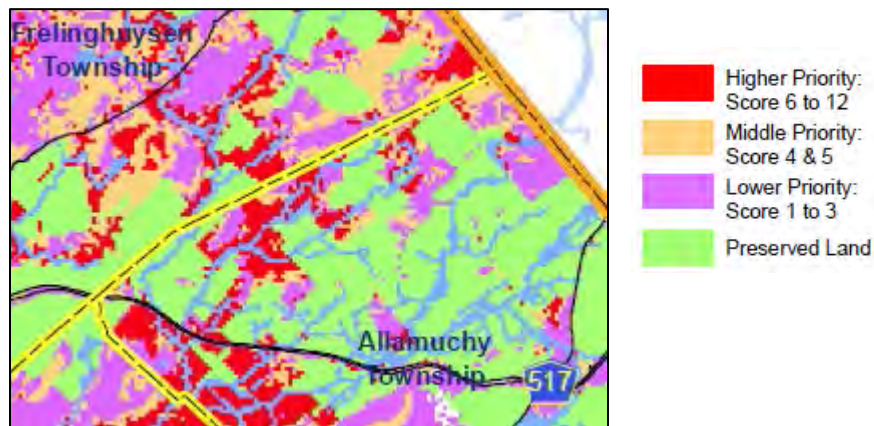
This map is to be used solely for planning purposes, and does not take the place of a survey.

Map IV-B. Medium and High Priority Lands (Unpreserved)

Aggregating the 12 characteristics into higher (6-12), middle (4-5) and lower (1-3) priority categories, results in 21,235 acres of higher priority lands, or 9% of the County. (*Map IV-B*)

<i>Map IV-B. Composite: Medium and High Priority Lands (Unpreserved)</i>			
Scores	Acres	% of Total	% County
6-12	21,235.38	13.64%	9.15%
4-5	45,023.38	28.92%	19.40%
1-3	89,406.14	57.44%	38.53%
Total:	155,664.90	100.00%	67.08%

In Allamuchy and Frelinghuysen Townships, the higher priority lands are associated with the riparian areas of the stream corridors (Bear Brook, Trout Brook, and Bear Creek). Preserved lands are now included on the map. (*Map IV-B*)



Map IV-B. Composite: Medium and High Priority Lands (Unpreserved) Warren County, New Jersey

High to Low Priority Scores:

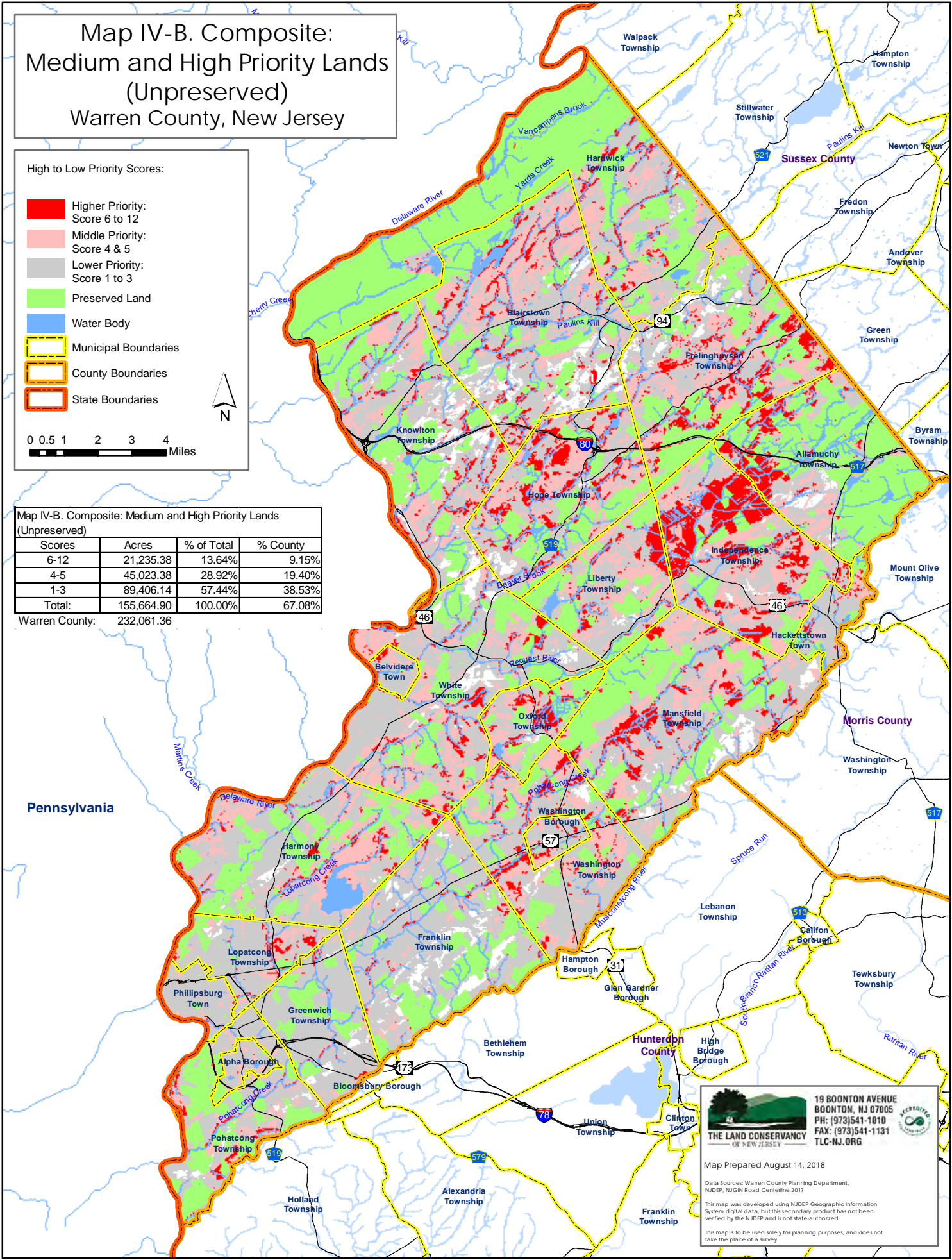
- Higher Priority:
Score 6 to 12
- Middle Priority:
Score 4 & 5
- Lower Priority:
Score 1 to 3
- Preserved Land
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries



0 0.5 1 2 3 4 Miles

Scores	Acres	% of Total	% County
6-12	21,235.38	13.64%	9.15%
4-5	45,023.38	28.92%	19.40%
1-3	89,406.14	57.44%	38.53%
Total:	155,664.90	100.00%	67.08%

Warren County: 232,061.36



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 14, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centeline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

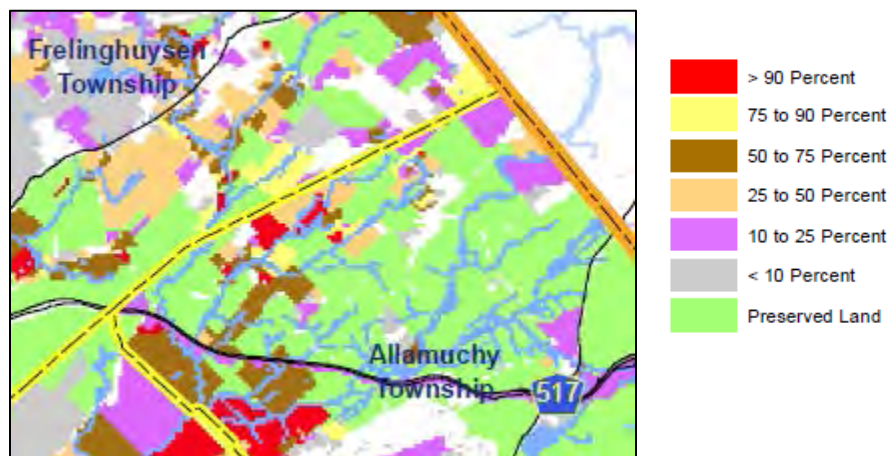
This map is to be used solely for planning purposes, and does not take the place of a survey.

Map IV-C. Percent of Unpreserved Parcels (>1 acre) with High Priority Scores (6-12)

Important to the decision as to whether to pursue a property for preservation, is how much of an individual tax lot has attributes for water resource protection and ranks higher in the analysis. (*Map IV-C*). In Warren County, there are 201 parcels totaling 2,848 acres (3% of the total high priority parcels) for which more than 90% of the parcel is high priority. This represents 1% of the County.

Map IV-C. Composite: Percent of Unpreserved Parcels (>1 acre) with High Priority Scores (6-12)								
% of Parcel	Number of Parcels	Parcel (Total Acres)	% of Total Parcel Acres	% of County	High Priority Portion of the Parcels			
					Parcel Acreage (High Priority)	Percent of the parcel which is High Priority	% of Total (High Priority)	% of County
> 90%	201	2,848.04	3.12%	1.23%	2,728.48	95.80%	13.30%	1.18%
75-90%	217	2,772.55	3.04%	1.19%	2,286.26	82.46%	11.14%	0.99%
50-75%	656	7,807.69	8.55%	3.36%	4,846.85	62.08%	23.62%	2.09%
25-50%	1,312	15,991.14	17.51%	6.89%	5,718.54	35.76%	27.87%	2.46%
10-25%	1,249	21,900.85	23.99%	9.44%	3,584.33	16.37%	17.47%	1.54%
<10%	2,206	39,989.60	43.80%	17.23%	1,351.68	3.38%	6.59%	0.58%
Total:	5,841	91,309.86	100.00%	39.35%	20,516.14	22.47%	100.00%	8.84%
Warren County (acres): 232,061.36								

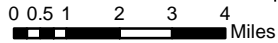
In Allamuchy and Frelinghuysen Townships, on a parcel basis, for unpreserved high priority parcels, there are very limited sites where more than 90% of the parcel acreage has high priority water resource attributes. (*Map IV-C*)



Map IV-C. Composite: Percent of Unpreserved Parcels (>1 acre) with High Priority Scores (6-12) Warren County, New Jersey

High to Low Priority Scores:

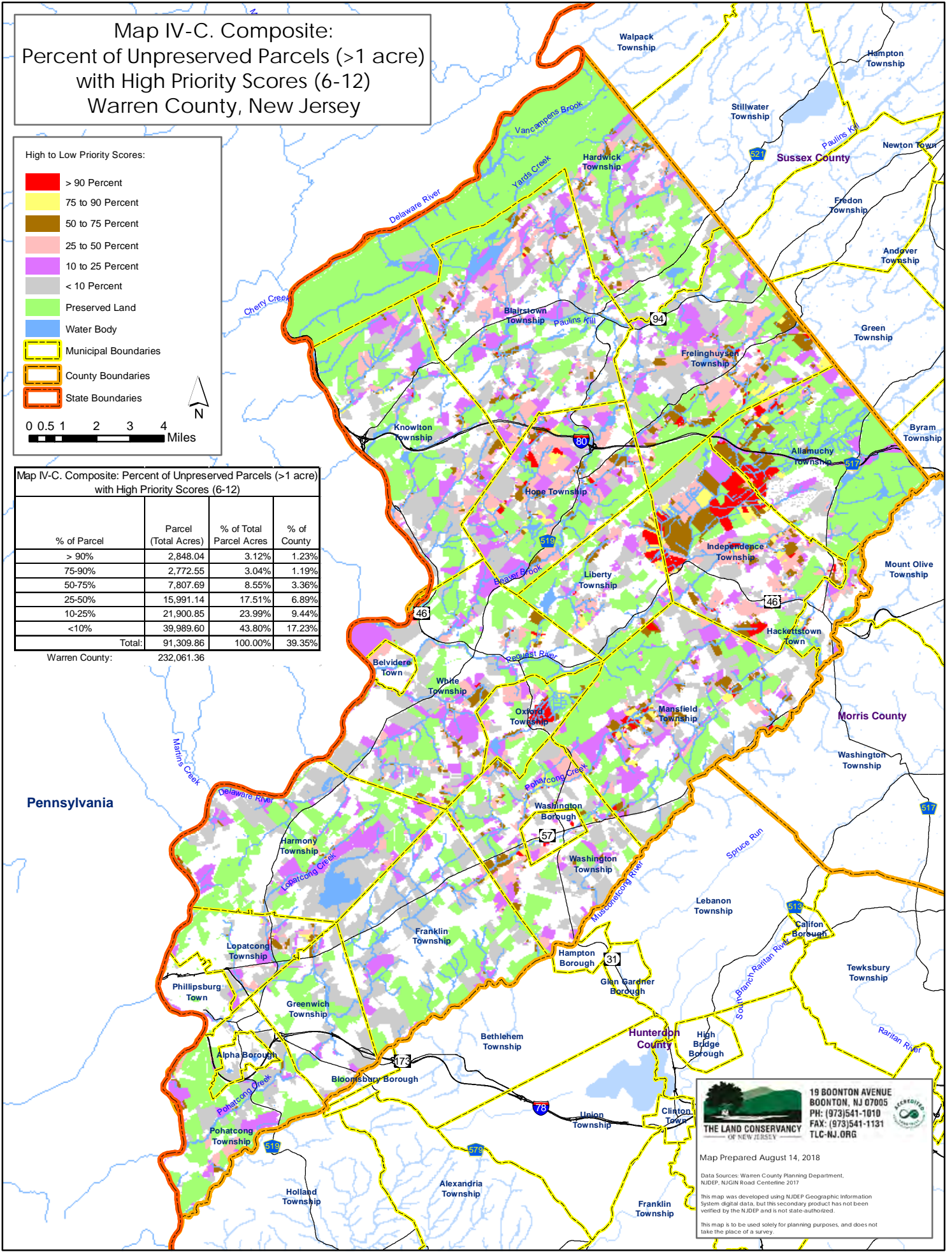
- > 90 Percent
- 75 to 90 Percent
- 50 to 75 Percent
- 25 to 50 Percent
- 10 to 25 Percent
- < 10 Percent
- Preserved Land
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries



Map IV-C. Composite: Percent of Unpreserved Parcels (>1 acre) with High Priority Scores (6-12)

% of Parcel	Parcel (Total Acres)	% of Total Parcel Acres	% of County
> 90%	2,848.04	3.12%	1.23%
75-90%	2,772.55	3.04%	1.19%
50-75%	7,807.69	8.55%	3.36%
25-50%	15,991.14	17.51%	6.89%
10-25%	21,900.85	23.99%	9.44%
<10%	39,989.60	43.80%	17.23%
Total:	91,309.86	100.00%	39.35%

Warren County: 232,061.36



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 14, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGIN Road Centeline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

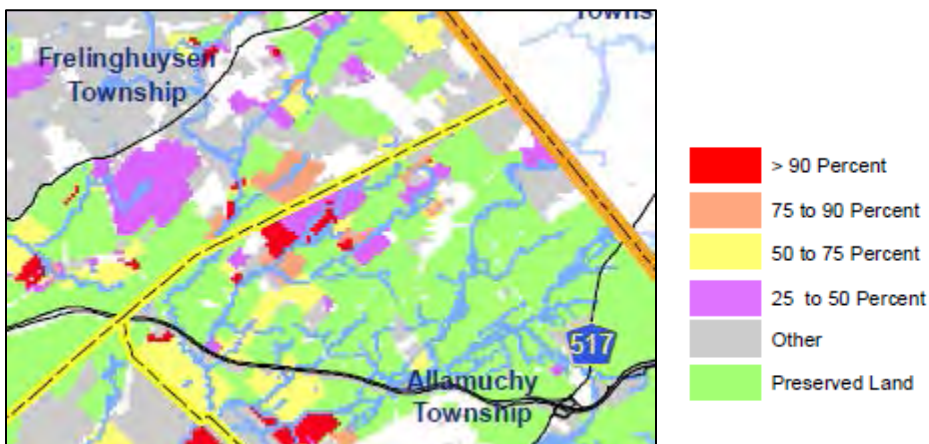
This map is to be used solely for planning purposes, and does not take the place of a survey.

Map IV-D:

To determine those parcels of greatest importance for water resource protection, the County identified those high priority parcels (scoring 6-12) which are greater than 1 acre in size and within 300 feet of already preserved land. There are 87 parcels, totaling 1,834 acres, for which more than 90% of the acreage scores between 6 and 12. This represents 8.5% of Warren County.

Map IV-D. Composite: Percent of Unpreserved Parcels (>1 acre) with High Priority Scores (6-12) within 300 feet of Preserved Land								
% of Parcel	Number of Parcels	Parcel (Total Acres)	% of Total	% of County	High Priority Portion of Parcels			
					Parcel Acreage (High Priority)	Percent of the parcel which is High Priority	% of Total (High Priority)	% of County
>90%	87	1,834.21	2.01%	0.79%	1,747.44	95.27%	95.27%	8.52%
75-90%	104	1,459.26	1.60%	0.63%	1,209.21	82.86%	82.86%	5.89%
50-75%	314	4,938.97	5.41%	2.13%	3,082.00	62.40%	62.40%	15.02%
25-50%	584	9,399.65	10.29%	4.05%	3,306.99	35.18%	35.18%	16.12%
<25%	4,752	73,677.77	80.69%	31.75%	11,170.50	15.16%	15.16%	54.45%
Total:	5,841	91,309.86	100.00%	39.35%	20,516.14	22.47%	22.47%	100.00%
Warren County:		232,061.36						

In Allamuchy and Frelinghuysen Townships, the high priority parcels are located along the municipal boundary, adjoining the state preserved land in the Pequest River Valley. (*Map IV-D*)



Appendix B includes the block and lots for all those parcels for which more than 90% of the site is a high priority for water resources, and the property is located within 300 feet of preserved land.

Map IV-D. Composite:
Percent of Unpreserved Parcels (>1 acre)
with High Priority Scores (6-12)
within 300 feet of Preserved Land
Warren County, New Jersey

Percent of Parcel which scores 6-12:

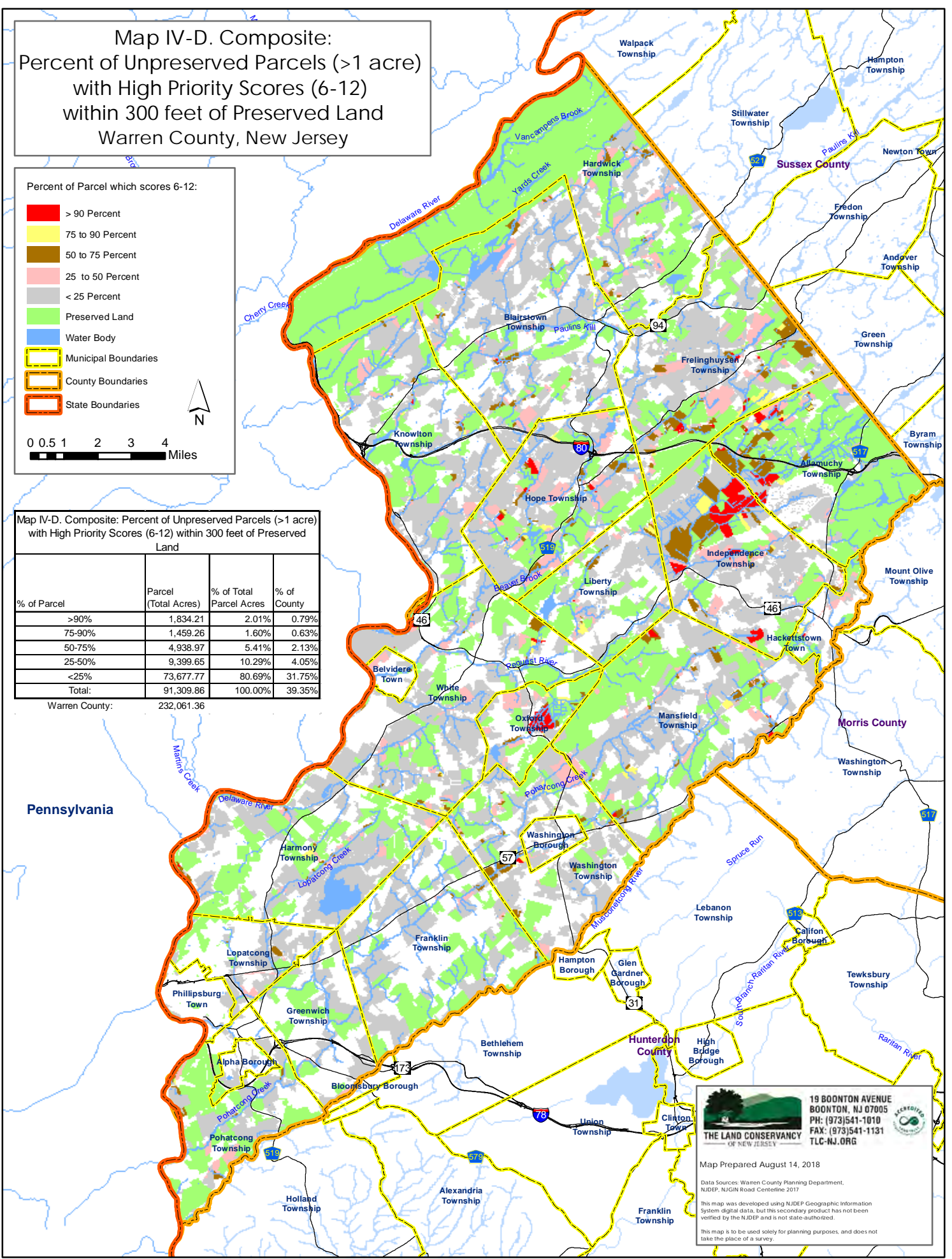
- > 90 Percent
- 75 to 90 Percent
- 50 to 75 Percent
- 25 to 50 Percent
- < 25 Percent
- Preserved Land
- Water Body
- Municipal Boundaries
- County Boundaries
- State Boundaries

0 0.5 1 2 3 4 Miles

Map IV-D. Composite: Percent of Unpreserved Parcels (>1 acre)
with High Priority Scores (6-12) within 300 feet of Preserved
Land

% of Parcel	Parcel (Total Acres)	% of Total Parcel Acres	% of County
>90%	1,834.21	2.01%	0.79%
75-90%	1,459.26	1.60%	0.63%
50-75%	4,938.97	5.41%	2.13%
25-50%	9,399.65	10.29%	4.05%
<25%	73,677.77	80.69%	31.75%
Total:	91,309.86	100.00%	39.35%

Warren County: 232,061.36



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared August 14, 2018
Data Sources: Warren County Planning Department,
NJDEP, NJGIN Road Centeline 2017
This map was developed using NJDEP Geographic Information
System digital data, but this secondary product has not been
verified by the NJDEP and is not state-authorized.
This map is to be used solely for planning purposes, and does not
take the place of a survey.

Modeling Consistency

2018 Warren County Open Space and Recreation Plan Update

In Warren County, the Planning Department and Land Preservation Department have identified Tier I and Tier II properties dependent upon their location within existing greenway/trail systems, such as the Morris Canal and Warren-Highlands Trail, and those sites that are consistent with the selection criteria identified in *Chapter VI* of the *2018 Update*. As noted in the report, the selection criteria identify those areas which “provide value to the region's economic, historic and recreation base, as well as provide identity to host communities”¹⁰ These criteria include:

- Terrain in excess of 15% slope
- Freshwater wetlands, lakes, and streams
- Stream corridors
- Aquifer recharge areas
- Wellhead protection zones
- Areas supporting endangered and threatened species
- Large, undisturbed forested tracts
- Scenic vistas, lakes, and areas of special interest, including historic and scenic sites

The water resource model developed for Warren County is consistent with the *2018 Plan Update* and identifies those tracts of land which support the selection criteria described in the report.

Conservation Blueprint

The Nature Conservancy and the New Jersey Conservation Foundation have partnered with Rowan University to develop a mapping tool to assist local decision makers and non-profit organizations in selecting properties for protection. Known as the *Conservation Blueprint*, this online, interactive mapping site was developed as part of a collaborative effort with a 22-member Steering Committee to identify priority land rankings based on four themes:

- Water quality – to protect surface water and groundwater
- Ecological – to support ecosystem health
- Agricultural – to support farming
- Community Green Space – to identify lands important for recreation and connecting people to nature

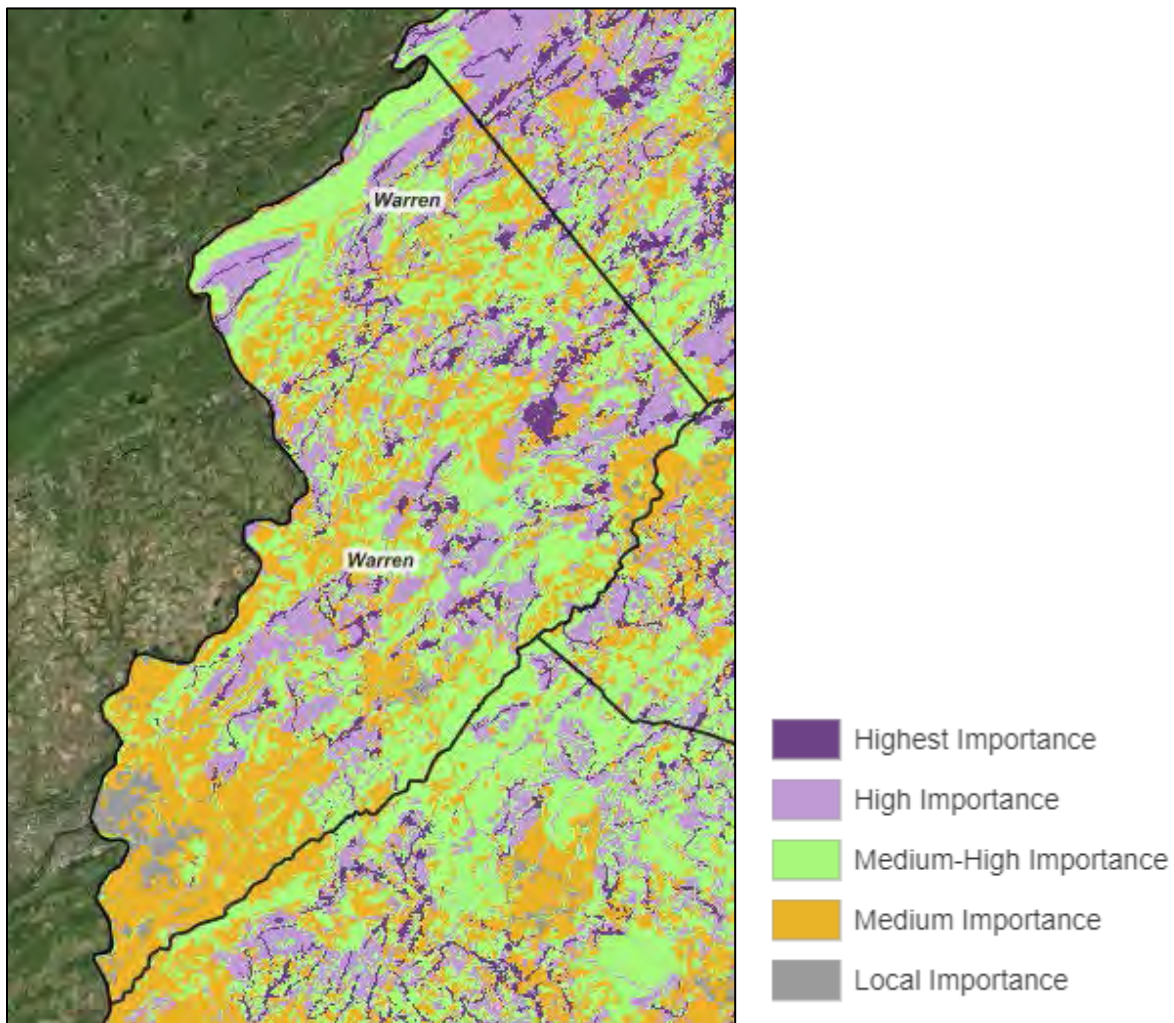
Each theme includes a series of component layers and reference layers. Component layers are used to establish priorities for each theme. Reference layers include additional information for the user to understand the functioning of the overall system for the local geography. For example, to identify those lands important to agriculture in New Jersey, *Conservation Blueprint* uses preserved farmland, agricultural soils and lands, parcels adjacent to preserved farms, infill lands between preserved farms, parcels within one-half mile of preserved farms, and agricultural threshold parcels as the component layers. Reference layers include farmland tax assessed parcels, open space, Pinelands Management Areas and National Reserve, Delaware River Watershed Initiative, Highlands Planning and Preservation Areas, Highlands Capability Zones, wastewater service

areas, County Agricultural Development Areas and Farmland Project Areas, Coastal Planning Areas, and highways. Each layer includes a digital map which the user can focus in to see a particular parcel of interest.

With funding support from the William Penn Foundation and the Geraldine R. Dodge Foundation, the purpose of the project is “to develop a shared, living blueprint of lands to be protected in the next few decades” and provide a “blueprint of conservation priorities to ensure a healthy New Jersey for future generations.”¹¹

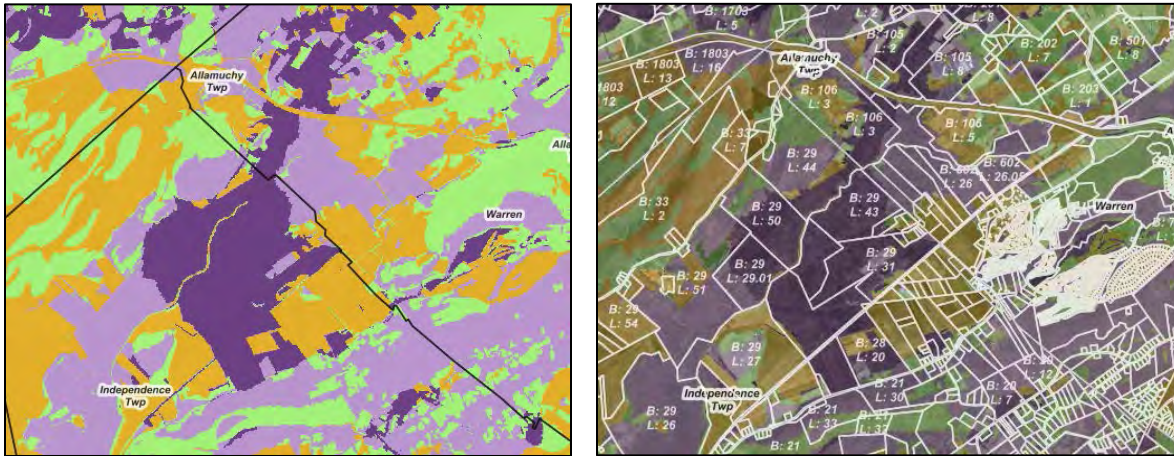
For water quality, *Conservation Blueprint* identifies land for New Jersey residents to access clean water and maintain healthy watersheds. Land is identified on a scale of importance, ranging from local to highest importance. According to the *Conservation Blueprint*, the southern region of Warren County contains land of medium importance with respect to water quality. The central and northeastern regions of Warren County contain large sections of land identified as high priority.

NJ MAP Conservation Blueprint – Warren County Water Quality Protection



On a local scale, *Conservation Blueprint* identifies high priority parcels spanning the border of Independence and Allamuchy Townships, along Shades of Death Road and Interstate Route 80. Located in the Pequest River valley, these parcels are identified as having characteristics important for water quality protection. Using the mapping in *Conservation Blueprint*, individual parcel information can be displayed including the assessment, use, ownership, and size. Much of this land is farmland assessed and over 100 acres in size.

High Priority Parcels (Block and Lot) in the Pequest Valley (*Conservation Blueprint – Water Quality*)



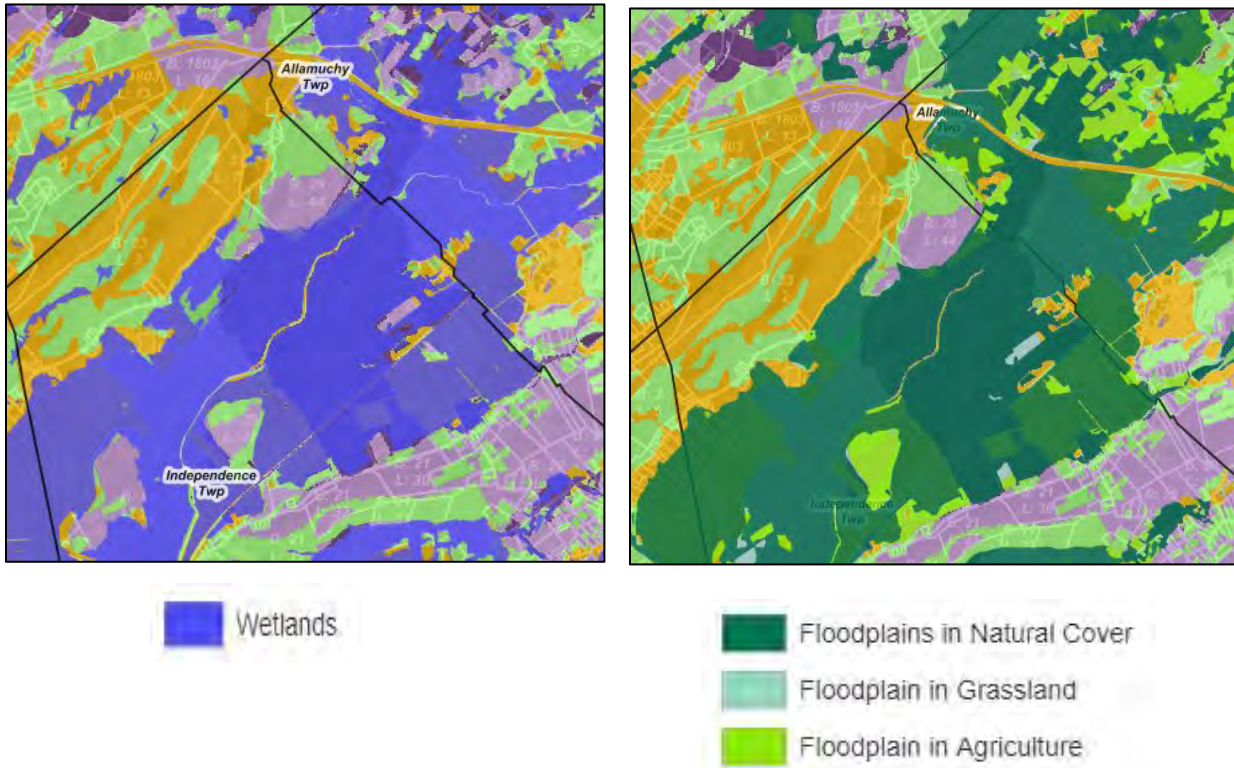
The water quality parameters including in the *Conservation Blueprint* are:

- Wetlands
- Groundwater recharge
- Headwaters
- Floodplains
- Impervious surface
- Vernal pools

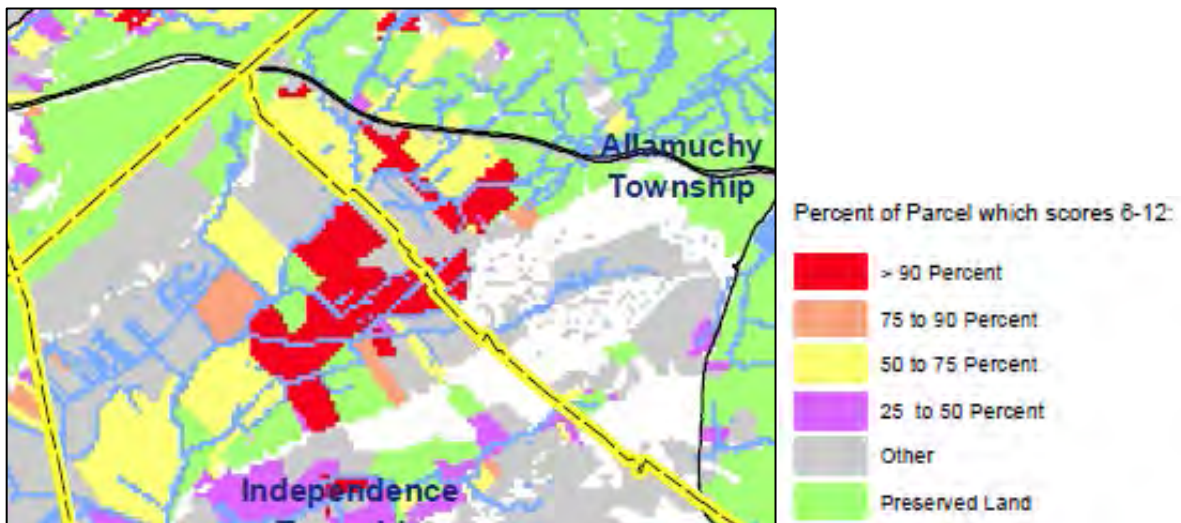
The parcels in the Pequest Valley consist of large concentrations of wetlands and floodplains. Wetlands provide habitat for wildlife and improve water quality. Floodplains are mostly flat areas near rivers and streams that are important for flood protection, water quality, and wildlife habitat. Floodplains help regulate temperature, the concentration of nutrients, and water flow.

When comparing the results of *Conservation Blueprint* and the composite mapping completed for Warren County as part of this *Water Resources Amendment*, both identify this region of Warren County as a high priority for preservation and water quality protection. The composite mapping, on a parcel basis, provides an additional level of detail which illustrates that more than 90% of these parcels contain water resource attributes, and are located within 300 feet of already preserved land.

Wetlands and Floodplains in the Pequest Valley (*Conservation Blueprint*)



High Priority Parcels within 300 feet of Preserved Land (*Composite Map IV-C*)



In Summary

There are 21,235 acres of high priority, unpreserved land, representing 9% of Warren County. When factoring in parcel layout and location, there are 1,089 parcels totaling 9,400 acres for which 25% or more of that parcel scores high for water resources, and the parcel itself is located within 300 feet of already preserved land. Scaling that further, when 90% of the individual parcel ranks high for water resources, this represents 87 properties in Warren County, totaling 1,834 acres. *Appendix B* includes a detailed property list for all of these properties, with location and owner information. Independence Township is home to the largest percentage of high priority parcels, totaling over 800 acres of land.

The tables are useful, in part to show that many tax parcels have relatively small high priority areas as a percentage of the overall property, or in terms of total high priority acres. If they are important links for river corridors or other masses of high priority areas, then the parcel may become a potential acquisition site, even though their total high priority area or percentage was low. Alternatively, if they are not important links, they may fall off the list.

There are many ways to review and use the water resource modeling results. The *Water Resources Amendment* provides the basis for local decision makers and acquisition entities to assess groups of parcels within project areas and see what works. The composite maps are a useful tool for this endeavor.

LAND STEWARDSHIP

The *Watershed Resources Amendment* for Warren County assesses existing public lands and open space to prioritize and implement land stewardship and preservation initiatives. The *Amendment* offers a targeted, site specific action program, in which projects are identified to protect water resources. Utilizing a watershed-based approach, the water resources model offers specific obtainable actions to improve water resources and expand land protection initiatives in Warren County. A field-based assessment of public open space, with an eye towards community based watershed restoration opportunities was completed as part of the *Amendment*.

Land Management: Warren County

Warren County owns 2,054 acres in natural areas and historic sites associated with the Morris Canal. Initially falling under the responsibility of the Planning Department, the Land Preservation Department is now responsible for the management and maintenance of the County parklands and properties. The County does this in partnership with a number of local and regional non-profit organizations. These are detailed below.

Morris Canal Sites:

Port Warren Park: Located along the Morris Canal Greenway Trail in Phillipsburg, it is home to the Jim and Mary Lee Museum and Inclined Plane 9 West (the longest inclined plane on the Morris Canal). Port Warren Park is managed in partnership with the New Jersey Youth Corps, the Warren County Parks Foundation, and the Morris Canal Committee.¹²

Bread Lock Park and Museum: Located in Stewartsville and Greenwich Township, the parks sits along the Morris Canal Greenway, Lock 7 West, and is part of the Warren Heritage Scenic Byway. It is named for the store at the Canal Lock which sold goods to passing boatmen, most notably homemade bread and pies. Bread Lock Park is managed in partnership with the New Jersey Youth Corps, and the Morris Canal Committee.¹³

Port Murray Park: Sitting alongside the Morris Canal Greenway in Mansfield Township, Port Murray Park offers visitors the opportunity to walk along sections of the towpath once used by mules to pull canal boats through the waters. Encompassing over 189 acres of preserved land, the park consists of predominantly upland forest with pockets of wetlands and meadows, as well as a small tributary to the Musconetcong River. Port Murray is managed in partnership with the New Jersey Youth Corps, the Metro Trails Hiking Group, the Warren County Parks Foundation, and the Morris Canal Committee.¹⁴

Dennis Bertland Heritage Area: Part of the Morris Canal Tow Path Trail near the Port Murray Boat Basin, in Port Murray, Mansfield Township. Dedicated prior to 2012, it provides access to the historic tow path and boat basin.¹⁵

Florence Kuipers Memorial Park: Located along the Morris Canal Greenway, this park contains more than a mile of the canal towpath and prism as it passes the nearby NJDEP Rockport Wildlife Management Area in Hackettstown. The park has a memorial dedicated to Florence Kuipers, an

early member of the Warren County Morris Canal Committee and Board of Recreation. Florence Kuipers Memorial Park is managed in partnership with the New Jersey Youth Corps and the Morris Canal Committee.¹⁶

Mount Rascal Park: Mount Rascal Park in Hackettstown, is currently under development, but is expected to be open to the public in 2018. Trails are under construction and the park will offer walking, hiking, bicycling, horseback riding, and picnicking. Mount Rascal Park is managed in partnership with the New Jersey Youth Corps, the Warren County Parks Foundation, and the Morris Canal Committee.¹⁷

Natural Resource Areas

Marble Hill Natural Resource Area: The Marble Hill Natural Resource Area is a beautiful 288-acre preserve along the Delaware River, north of Phillipsburg. It is home to a rich diversity of upland deciduous forest, which provides coverage for neo-tropical and migratory birds that use the Delaware River during migration. There are 4 miles of trails along the River, and is located along the Warren Highlands Trail. Marble Hill is managed in partnership with the New Jersey Youth Corps and the Metro Trails hiking group.¹⁸

Oxford Mountain Natural Resource Area: Oxford Mountain is a 349-acre preserve that offers a network of trails for hiking, biking, sightseeing, and hunting. The site also contains remnants of the mining that once took place on the property. Located in Oxford Township, this Natural Area is along the Warren Highlands Trail. The Oxford Mountain Natural Resource Area is managed in partnership with the New Jersey Youth Corps, the Warren County Parks Foundation, and the Metro Trails hiking group.¹⁹

White Lake Natural Resource Area: White Lake was preserved in 1997 by Warren County with funding from NJDEP Green Acres through a partnership with NJDEP Division of Fish and Wildlife, Warren County, and Ridge and Valley Conservancy.²⁰ The White Lake Natural Resource Area is a 394-acre preserve in Hardwick Township that offers hiking, boating, fishing, and wildlife habitat. White Lake, a 68-acre spring fed water body, is located in the preserve. The natural area is home to a variety of endangered and threatened plant species, and includes several cultural/historic sites including a lime kiln.²¹ The Ridge and Valley Conservancy (RVC) manages this property for Warren County.

The Use of Stewardship Criteria

Many public and private lands, which have water resource attributes, would benefit from additional restoration and stewardship actions within riparian areas, existing or former wetlands, and developed areas that contribute stormwater flows to surface waters. For Warren County, criteria were selected and mapped to identify areas where stewardship activities would provide a material benefit to water quality, water flows and ecological improvements. These criteria are indicators of sites for potential best management practices, and stewardship activities would only take place when conditions have been confirmed through field investigations. The purpose of the criteria is to help focus attention on the waters with the greatest potential benefits of stewardship. The more criteria are relevant to a specific area, the higher the likelihood that restoration and stewardship is

necessary to improve water resources. However, a high incidence of criteria may also indicate that stewardship costs will be correspondingly high, perhaps requiring structural engineering projects.

All of the selected criteria reflect attributes of water quality. Those specific to *water quality only* include:

- Stream habitat integrity and high slope stream segments, indicating erosion problems.
- High density of roads crossing streams.

Those which also address *water quantity* include:

- Sub-watersheds with high levels of impervious surface as well as those with streams that have high peaking rates (indicating flows during rainfall events are much higher than during dry periods).
- Impervious surfaces that are in close proximity to streams (providing more direct flow of stormwater into the streams).
- Stormwater outfalls directly from impervious areas and as outlets from stormwater basins.

Those which also include *ecological* factors are:

- Riparian areas, wetlands, and former wetlands that can be improved or restored.
- Existing wetlands and riparian areas in close proximity to developed areas.

Site evaluation can include the following steps:

1. Selection and mapping of stewardship criteria
2. Identification of areas that appear viable and high priority for stewardship actions:
 - a. Modification of the vegetative cover to improve water resources. These projects shift land from vegetative cover with higher runoff and pollutant loads to those with lower runoff and pollutant loads, through creation of riparian buffers, revegetation of agriculturally-modified wetlands, and more.
 - b. Modification of stormwater systems to reduce stormwater volume, rate of discharge, water pollutant loads, or some combination thereof. This approach includes green infrastructure, modification of uncontrolled outfalls, modification of existing stormwater basins (such as changing detention basins to infiltration basins), and more.
 - c. Reconstruction of stream channels, stream corridors, riparian areas and flood plains, ponds and lakes. Reconstruction requires physical modification of the land surface, not only the vegetative cover.
3. Identification of viable partners for stewardship activities within high priority areas. There will be more areas which require more attention than available resources can meet. It is appropriate to focus efforts on areas that have good partnership potential. It is likely that within areas with available partnerships, there will be more than one possible project area for stewardship projects.
4. Field evaluation of potential stewardship projects within the areas that have good partnerships, to identify the projects that most clearly would benefit water resources and require actions that are appropriate for the skill set of the partners.

5. Determine which partner will have responsibility for each aspect of the project. Identify relevant funding and other implementation resources. Funding potential is likely to be an initial screening approach used by the partnerships, but at this point, specific funding needs will be identified and sought.

Maps were developed to illustrate characteristics used to identify opportunities for land stewardship projects to protect water resources in Warren County. Each map targets a defining characteristic important to water quality and/or quantity. *Appendix C* includes the metrics used to develop the maps:

Maps A-C focus on the reduction of direct stormwater flows.

Map D-F focus on the reduction of stream erosion.

Maps G-I focus on the restoration of riparian areas and wetlands.

Map A shows the amount of impervious surface within each watershed in Warren County. The different levels are broken up by percent of impervious surface out of the total surface of the watershed.

Map B further breaks down the percent of impervious surface within riparian areas by sub-watersheds.

Map C displays where each stormwater outfall, basin, and inlet is located throughout the County.

Map D marks the AMNET^c stream habitat scores throughout the County, displaying the integrity of each stream.²² The different habitat categories are optimal, suboptimal, and marginal.

Map E counts the amount of road crossings per stream mile. The individual crossings are shown, as well as the density of road crossings for each sub-watershed.

Map F identifies high slope stream segments that are 500 feet or above.

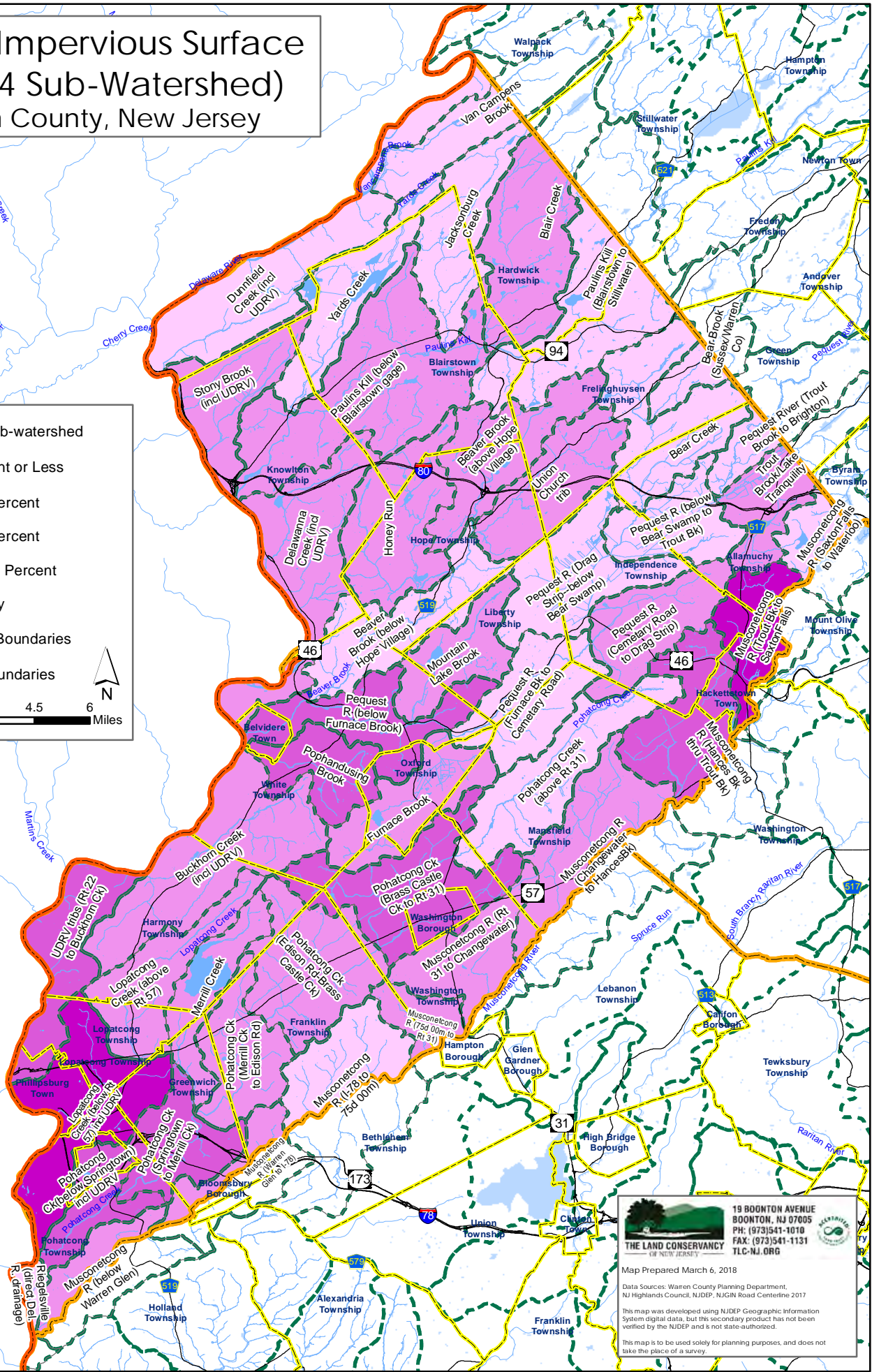
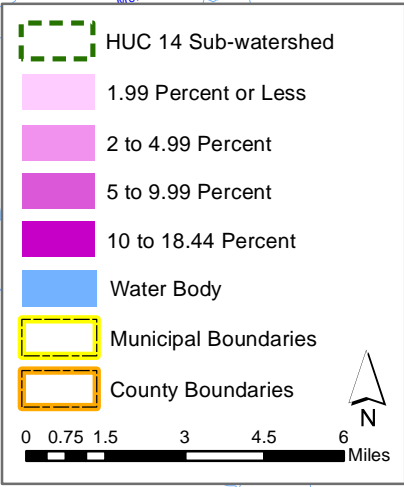
Map G shows riparian areas in altered conditions, to identify former riparian areas that can be improved or restored.

Map H illustrates agriculturally altered wetlands as well as other wetlands and preserved farms within the County. This results in the identification of areas with high potential for wetlands restoration.

Map I identifies wetlands and riparian areas within 500 feet of developed lands. Due to their proximity to development, these areas are likely to be disrupted.

^c Ambient Biological Monitoring Network (AMNET). In 1992, a network of over 800 stream sites were established in New Jersey to provide long-term biological data measuring quality of surface waters throughout the State. Designed and conducted by the Bureau of Freshwater and Biological Monitoring, the AMNET program routinely samples and analyzes aquatic macroinvertebrate populations at each site, employing USEPA-developed Rapid Bioassessment (RBP) methods to provide an index of stream water and habitat quality.

Map A: Impervious Surface (HUC 14 Sub-Watershed) Warren County, New Jersey



THE LAND CONSERVANCY OF NEW JERSEY

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared March 6, 2018


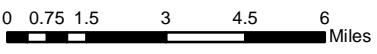
Data Sources: Warren County Planning Department, NJ Highlands Council, NJDEP, NJGIN Road Centerline 2017

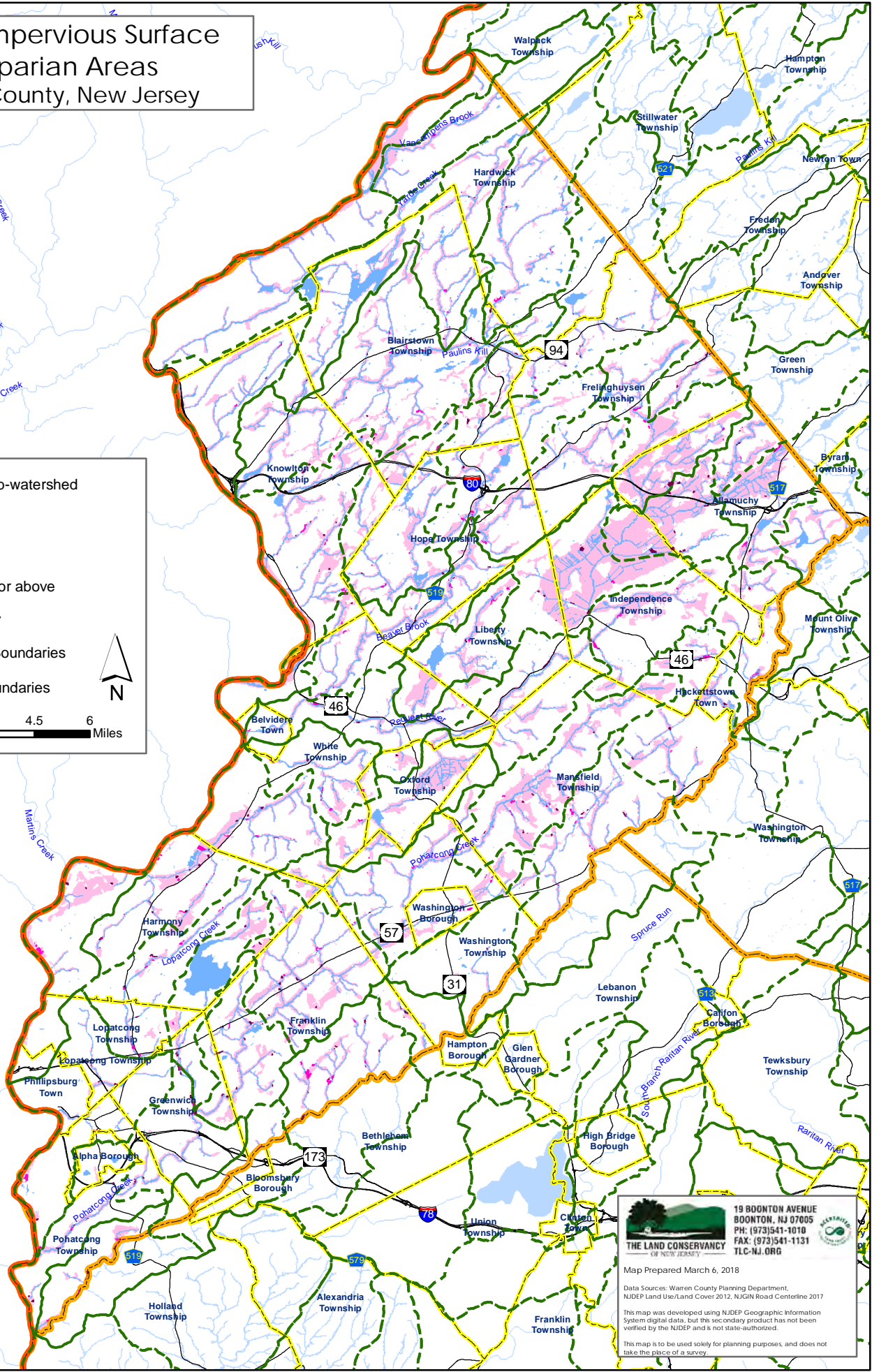
This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.


This map is to be used solely for planning purposes, and does not take the place of a survey.

Map B: Impervious Surface in Riparian Areas Warren County, New Jersey

 HUC 14 Sub-watershed
 0 Percent
 5 Percent
 10 Percent or above
 Water Body
 Municipal Boundaries
 County Boundaries















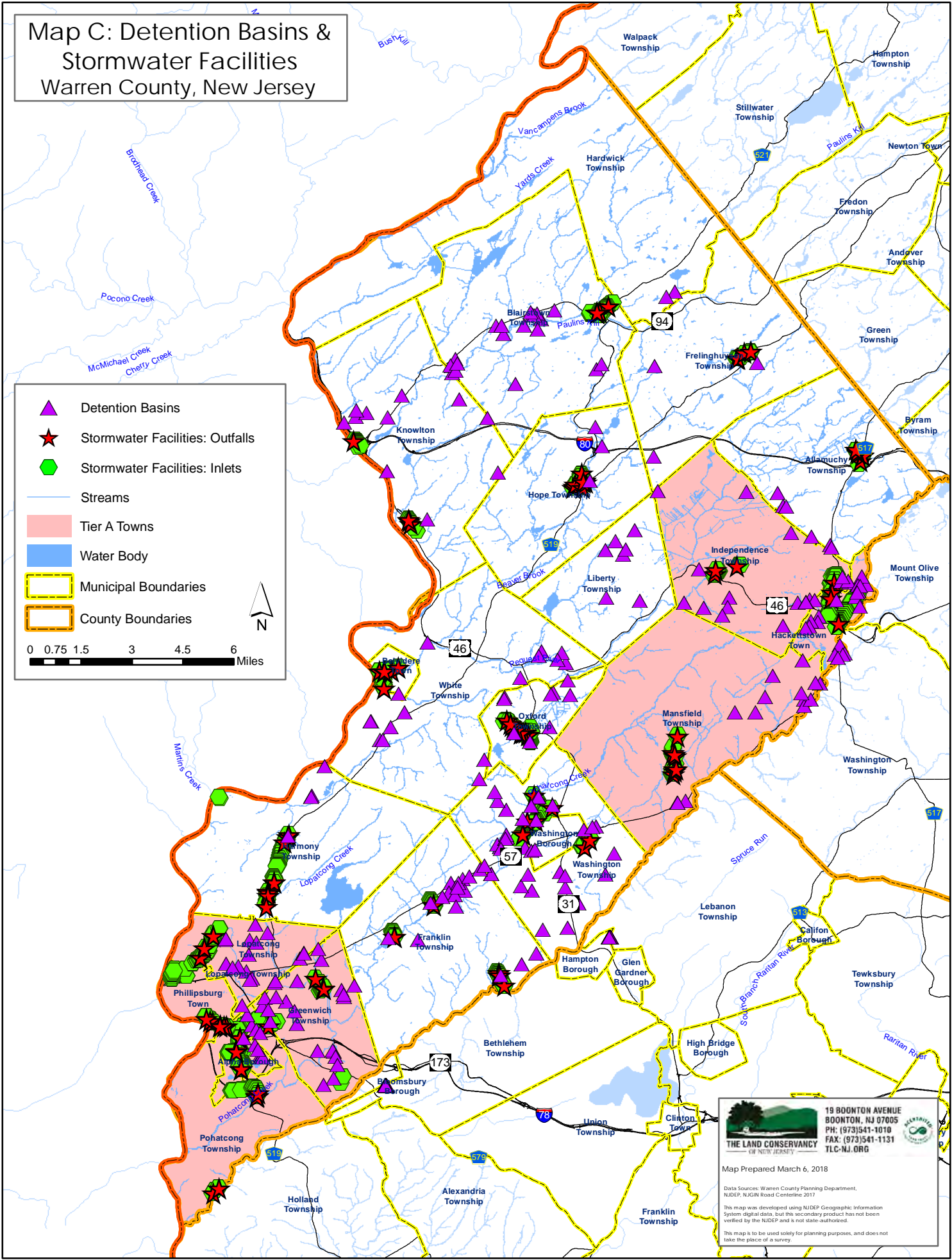


19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared March 6, 2018
 Data Sources: Warren County Planning Department,
 NJDEP Land Use/Land Cover 2012, NJGIN Road Centerline 2017
 This map was developed using NJDEP Geographic Information
 System digital data, but this secondary product has not been
 verified by the NJDEP and is not state-authorized.
 This map is to be used solely for planning purposes, and does not
 take the place of a survey.

Map C: Detention Basins & Stormwater Facilities Warren County, New Jersey

-  Detention Basins
-  Stormwater Facilities: Outfalls
-  Stormwater Facilities: Inlets
-  Streams
-  Tier A Towns
-  Water Body
-  Municipal Boundaries
-  County Boundaries

0 0.75 1.5 3 4.5 6 Miles

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared March 6, 2018

Data Sources: Warren County Planning Department, NJDEP, NJGRN Road Centerline 2017

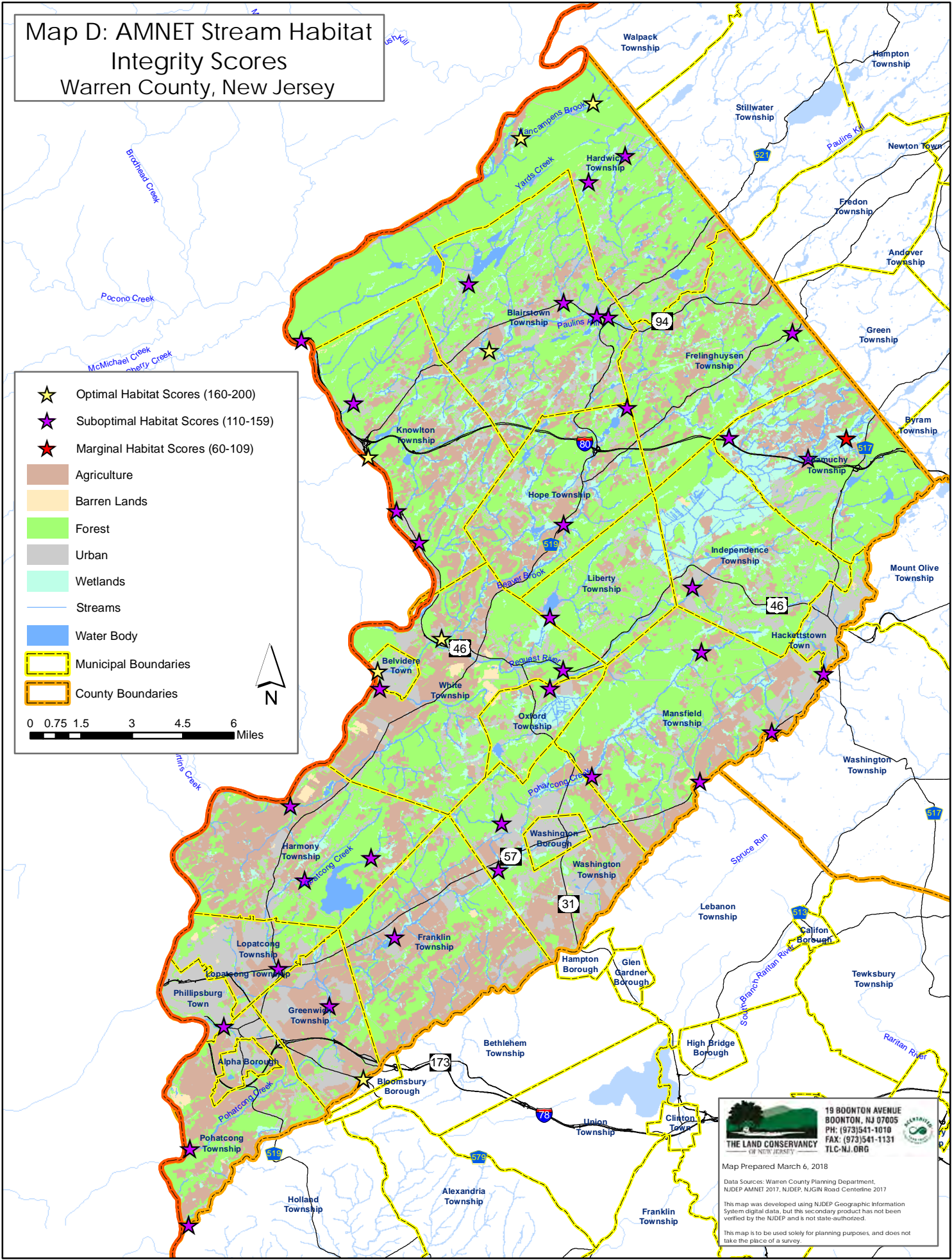
This map was developed using NJDEP Geographic Information System digital data, but the secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

Map D: AMNET Stream Habitat Integrity Scores Warren County, New Jersey

- ★ Optimal Habitat Scores (160-200)
- ★ Suboptimal Habitat Scores (110-159)
- ★ Marginal Habitat Scores (60-109)
- Agriculture
- Barren Lands
- Forest
- Urban
- Wetlands
- Streams
- Water Body
- Municipal Boundaries
- County Boundaries

0 0.75 1.5 3 4.5 6 Miles



THE LAND CONSERVANCY OF NEW JERSEY

19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

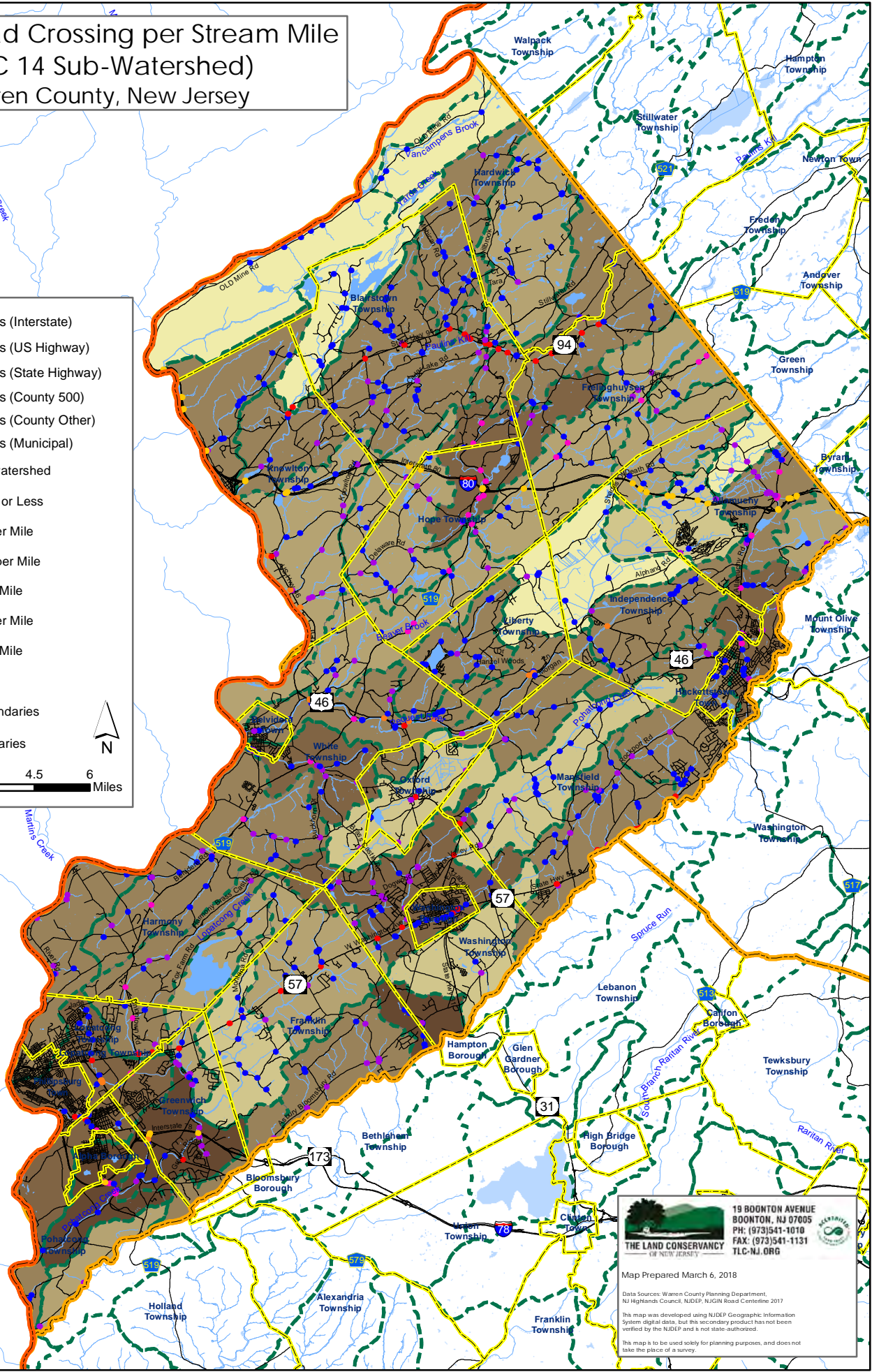
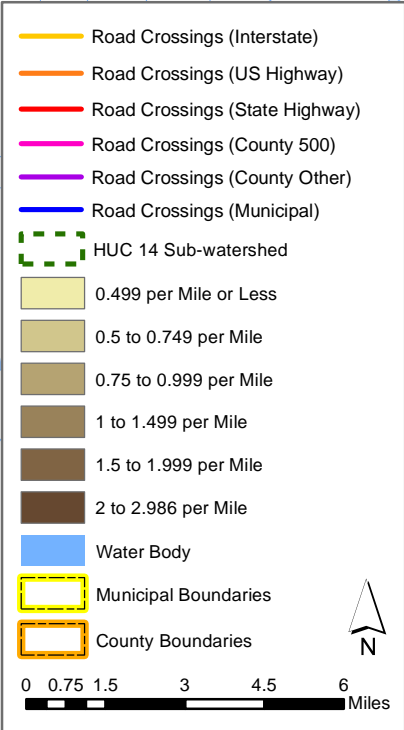
Map Prepared March 6, 2018

Data Sources: Warren County Planning Department, NJDEP AMNET 2017, NJDEP, NJGIN Road Centerline 2017

This map was developed using NJDEP Geographic Information System digital data, but this secondary product has not been verified by the NJDEP and is not state-authorized.

This map is to be used solely for planning purposes, and does not take the place of a survey.

Map E: Road Crossing per Stream Mile (HUC 14 Sub-Watershed) Warren County, New Jersey



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared March 6, 2018

Data Sources: Warren County Planning Department,
NJ Highlands Council, NJDEP, NJGIN Road Centeline 2017

This map was developed using NJDEP Geographic Information System digital data, but the secondary product has not been verified by the NJDEP and is not state-authored.

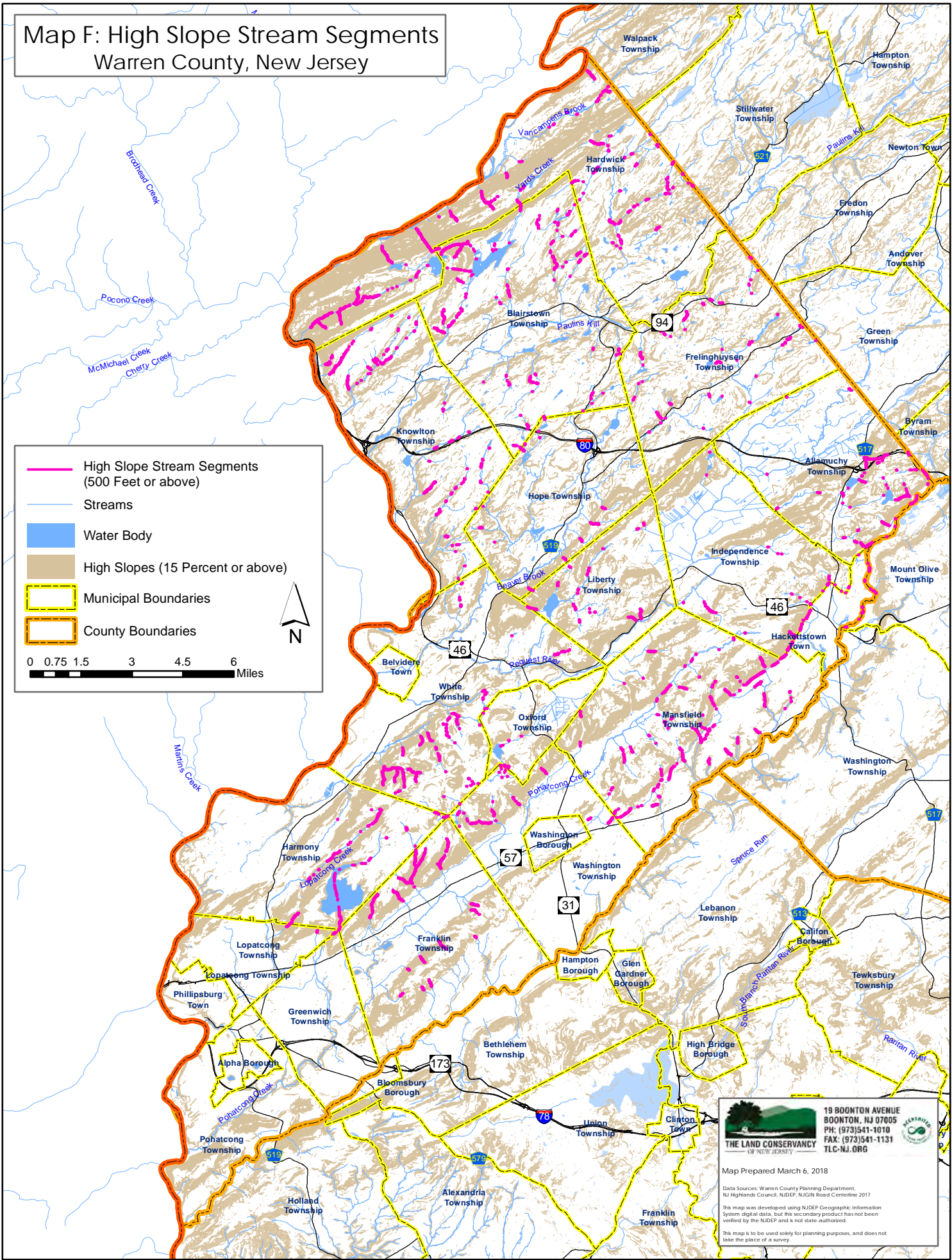
This map is to be used solely for planning purposes, and does not take the place of a survey.

Map F: High Slope Stream Segments Warren County, New Jersey

— High Slope Stream Segments (500 Feet or above)
— Streams
 Water Body
 High Slopes (15 Percent or above)
 Municipal Boundaries
 County Boundaries

N

0 0.75 1.5 3 4.5 6 Miles



19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG

Map Prepared March 6, 2018

Data Sources: Warren County Planning Department,
NJ Highlands Council, NJDEP, NJGIN Road Centeline 2017

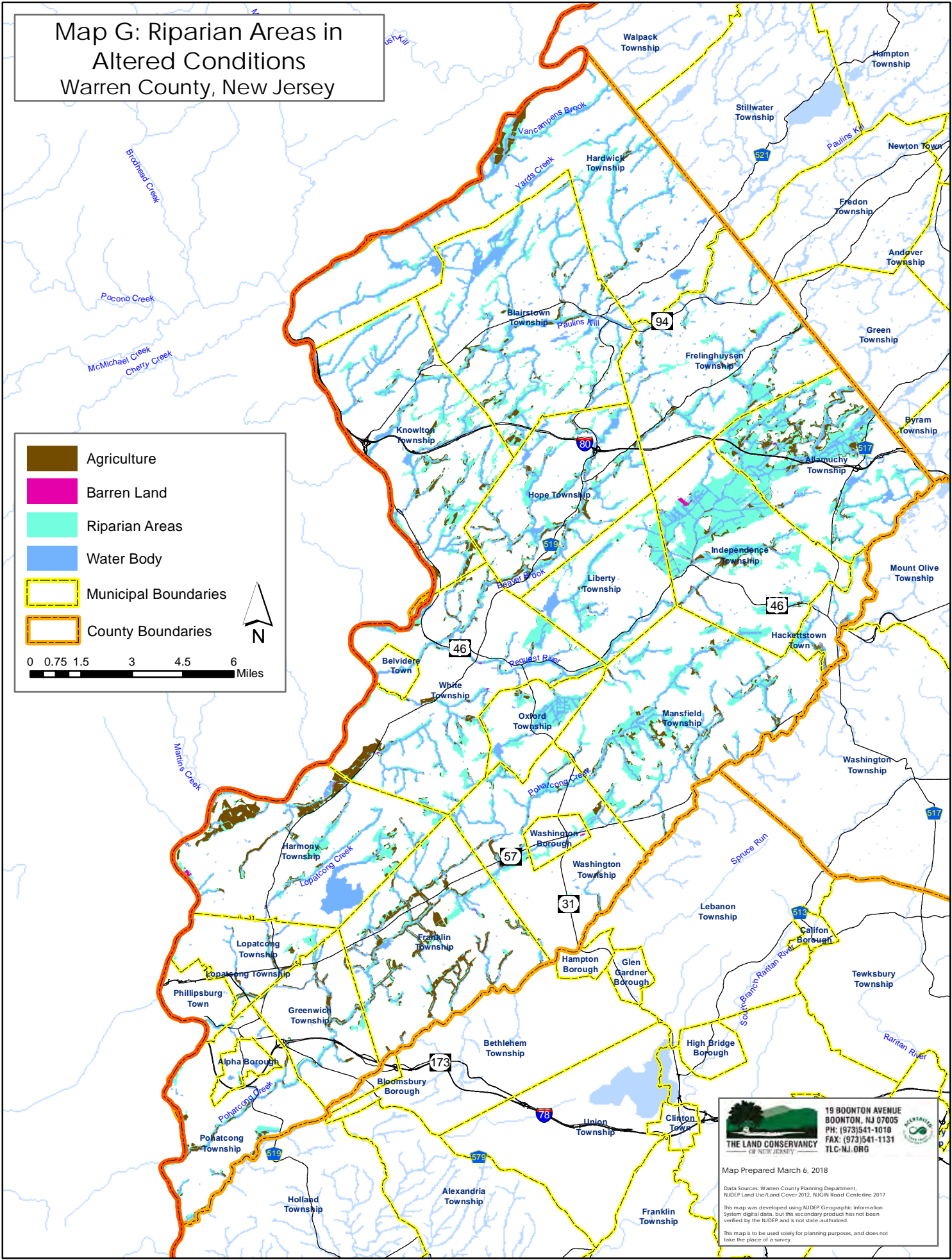
This map was developed using NJDEP Geographic Information System digital data, but the secondary product has not been verified by the NJDEP and is not state-authored.

The map is to be used solely for planning purposes, and does not take the place of a survey.

Map G: Riparian Areas in Altered Conditions Warren County, New Jersey

Agriculture
 Barren Land
 Riparian Areas
 Water Body
 Municipal Boundaries
 County Boundaries

N
 0 0.75 1.5 3 4.5 6 Miles



THE LAND CONSERVANCY
 OF NEW JERSEY


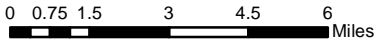
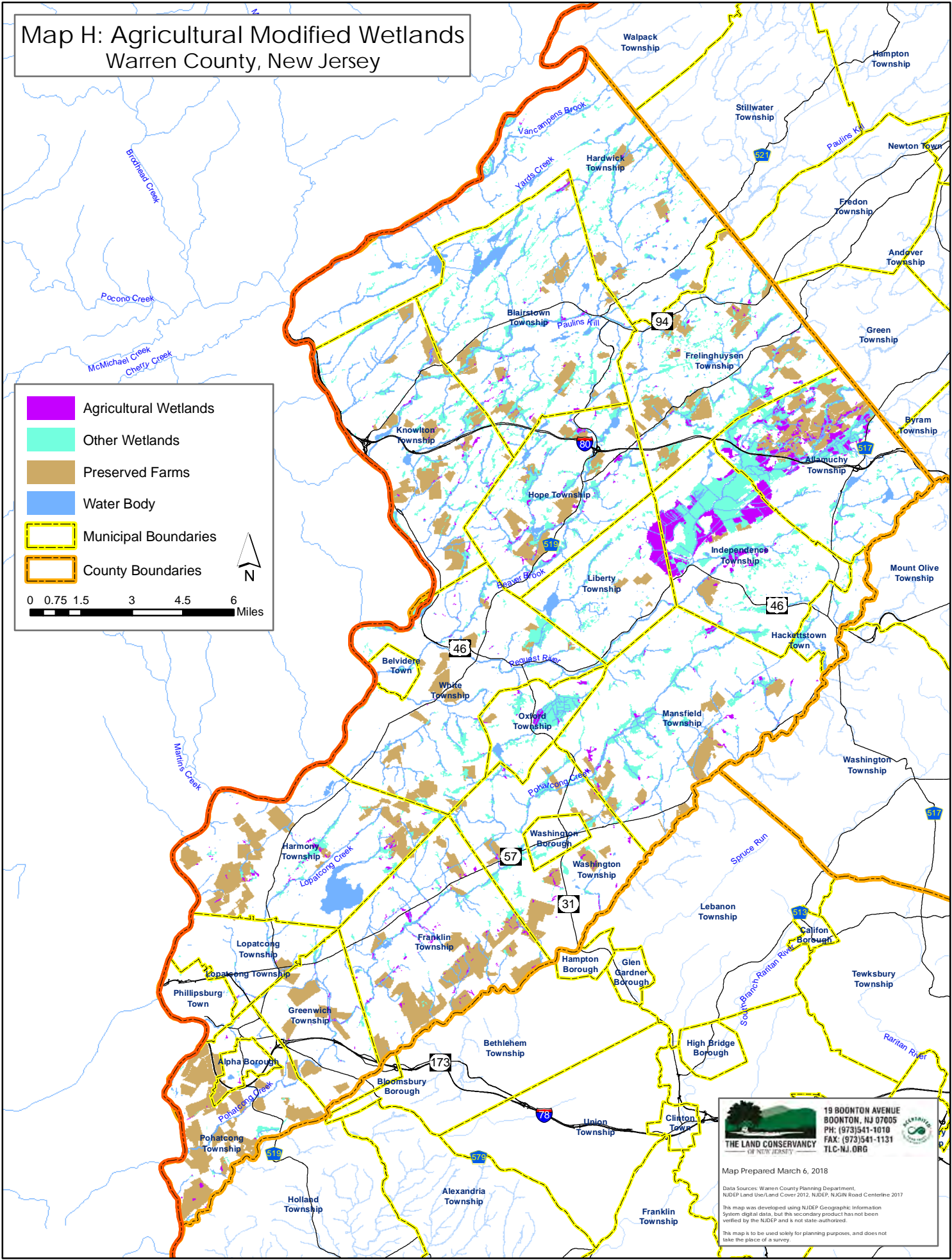

19 BOONTON AVENUE
 BOONTON, NJ 07005
 PH: (973)541-1010
 FAX: (973)541-1131
 TLC-NJ.ORG

Map Prepared March 6, 2018

Data Sources: Warren County Planning Department,
 NJDEP Land Use/Land Cover 2012, NJGRN Road Centerline 2017
 This map was developed using NJDEP Geographic Information
 System digital data, but the 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.

Map H: Agricultural Modified Wetlands Warren County, New Jersey

Agricultural Wetlands
 Other Wetlands
 Preserved Farms
 Water Body
 Municipal Boundaries
 County Boundaries


19 BOONTON AVENUE
 BOONTON, NJ 07005
 PH: (973)541-1010
 FAX: (973)541-1131
 TLC-NJ.ORG

Map Prepared March 6, 2018

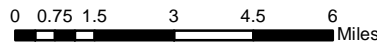
Data Sources: Warren County Planning Department, NUDEP Land Use/Land Cover 2012, NUDEP, NJGN Road Centerline 2017. This map was developed using NUDEP Geographic Information System digital data, but the secondary product has not been verified by the NUDEP and is not state-authorized. The map is to be used solely for planning purposes, and does not take the place of a survey.

Map I: Wetlands & Riparian Areas within 500 Feet of Developed Lands Warren County, New Jersey

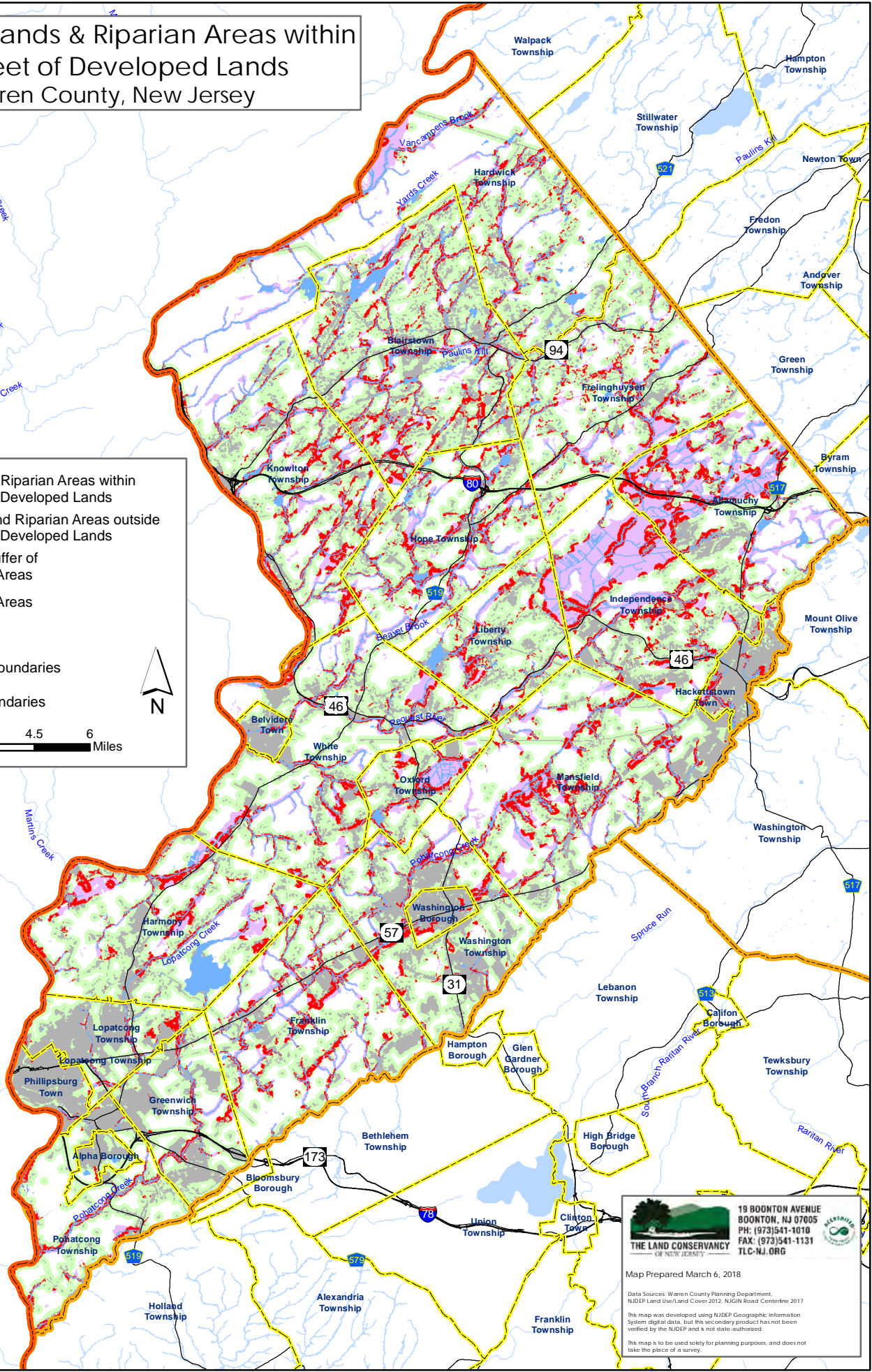
- Wetlands & Riparian Areas within 500 Feet of Developed Lands
- Wetlands and Riparian Areas outside 500 Feet of Developed Lands
- 500 Feet Buffer of Developed Areas
- Developed Areas
- Water Body
- Municipal Boundaries
- County Boundaries




N




0 0.75 1.5 3 4.5 6 Miles





19 BOONTON AVENUE
BOONTON, NJ 07005
PH: (973)541-1010
FAX: (973)541-1131
TLC-NJ.ORG



Map Prepared March 6, 2018

Data Sources: Warren County Planning Department, NIDEF Land Use/Land Cover 2012, NUGIN Road Centerline 2017

This map was developed using NIDEF Geographic Information System digital data, but this secondary product has not been verified by the NIDEF and is not state authorized.

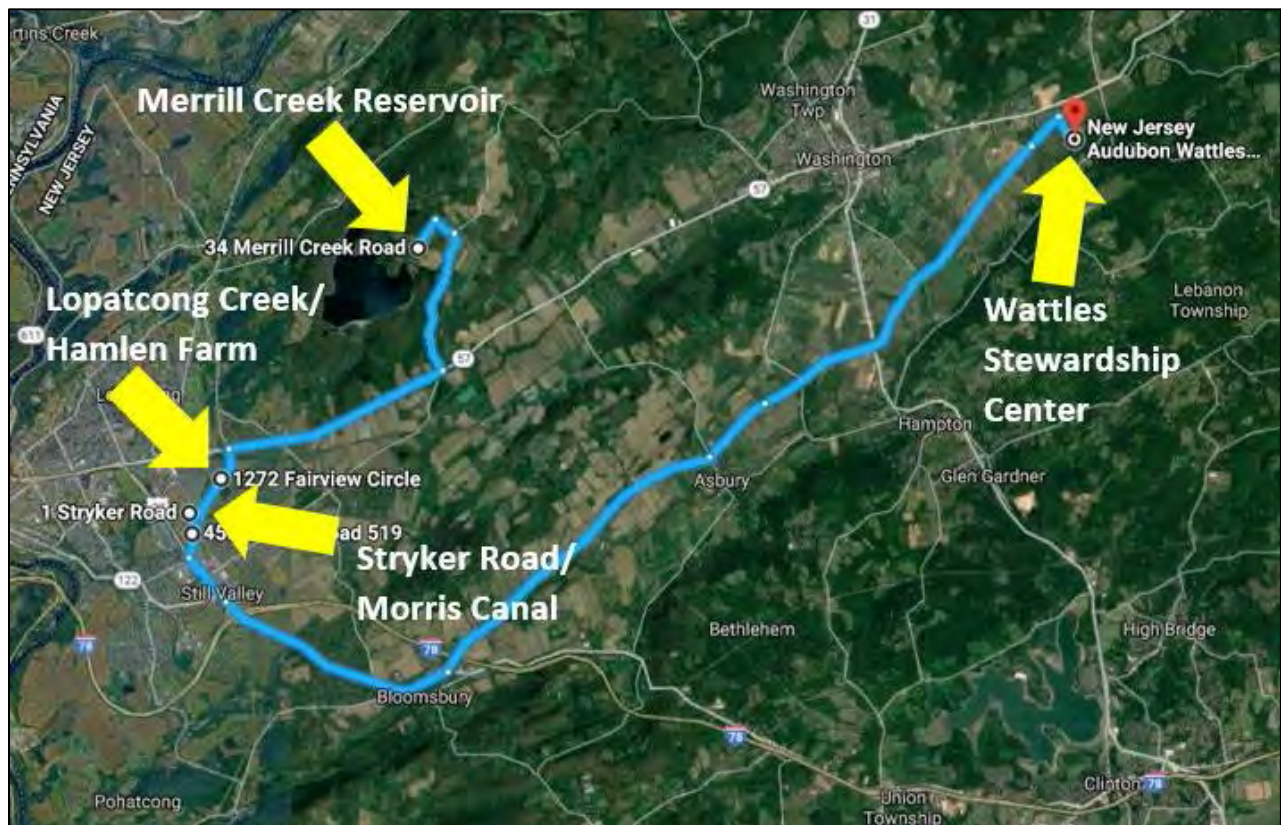
This map is to be used solely for planning purposes, and does not take the place of a survey.

Case Studies: Land Stewardship Projects in Warren County

Representatives of the Warren County Planning Department and the Land Preservation Department attended two all-day site visits highlighting forest stewardship, stream restoration, riparian buffer, and green infrastructure projects. Properties included those that were in the process of being restored, and those that had been completed previously to gauge whether the efforts were successful.

Southern Warren County – Day 1

Merrill Creek Reservoir in Harmony Township has instituted forestry best management practices at the Reservoir and its Environmental Preserve. Hamlen Farm at the Lopatcong Creek and the Morris Canal at Stryker Road are stream restoration/riparian buffer projects. The Hamlen Farm riparian buffer was completed in 2006 and the Stryker Road initiative is part of a larger-scale project to restore the banks of Lopatcong Creek along the Morris Canal. Concluding at New Jersey Audubon's (NJA) Wattles Stewardship Center participants discussed how cover crops, vernal pool creation, and invasive species management can interrelate successfully.



Northern Warren County – Day 2

Starting at the Pequest Kenco Restoration Site in Independence Township, where the discussion focused on the ongoing wetlands/riparian restoration and instream habitat improvements taking place on the property. At the Asbury Mill, owned by the Musconetcong Watershed Association, green infrastructure and pervious paving have been installed to slow stormwater entering the river. Warren County, through the Municipal and Charitable Conservancy Trust Fund Committee, has provided funding support for the restoration of the Asbury Mill.



The following section includes a detailed description of the case studies evaluated for the *Water Resources Amendment* including land management strategies, funding, and partnerships.

OPEN SPACE

LAND MANAGEMENT STRATEGY



RIPARIAN
BUFFERS



AGRICULTURAL
LANDS



GRASSLANDS

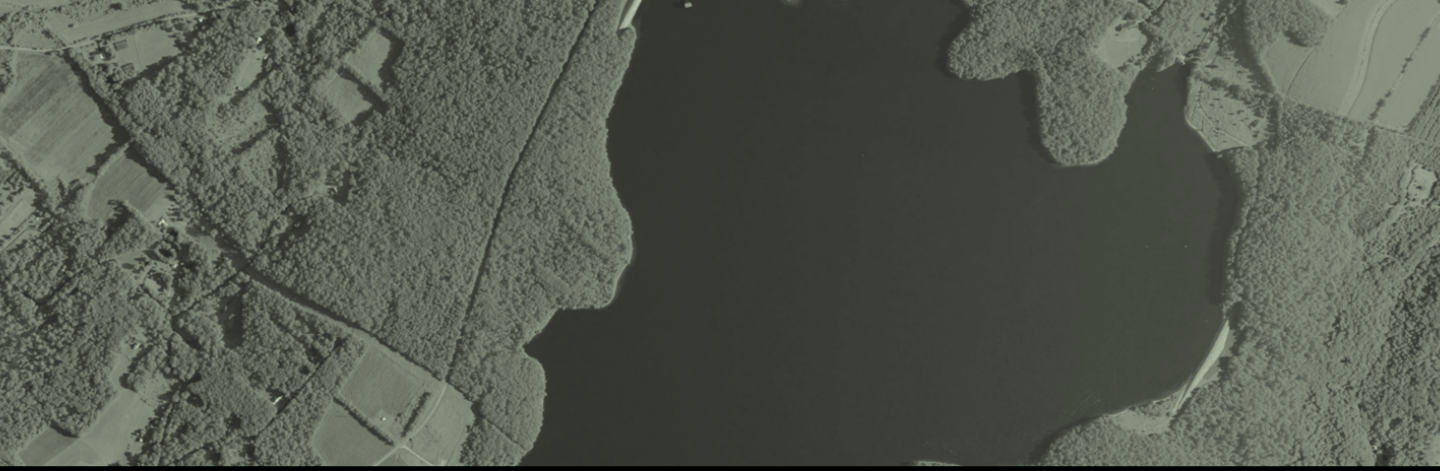


FORESTS



HISTORIC SITES

CASE STUDIES



MERRILL CREEK RESTORATION

A PRESERVE MANAGED FOR NATURAL RESOURCE PROTECTION

**Merrill Creek
Reservoir
Harmony, NJ**

LAT: 40.739279
LONG: -75.110268

Merrill Creek Reservoir is a 650-acre reservoir surrounded by a 290-acre Environmental Preserve and 2000 additional acres of woods and fields. A consortium of energy companies hold the property to protect a water supply used to replenish the Delaware River during significant drought years. The land is managed for outdoor recreation (hiking), water resource protection, and wildlife.

A forest stewardship plan was prepared in 2009 to improve forest health for watershed values and wildlife habitat. Merrill Creek began to implement their forest stewardship plan by selectively thinning their even-aged forests and removing non-native tree species. They also converted hayfields into warm season grasses in order to provide bird habitat.

SUMMARY OF MANAGEMENT STRATEGIES

IN FOREST AREAS

Selection cutting is the silvicultural practice of harvesting trees in a way that moves a forest stand towards an uneven-aged stand. The practice improves seedling regeneration, creates more diverse wildlife habitat and can generate additional revenue.

Older, conifer dominated plantations have relatively low ecological values, and in some cases, may be vulnerable to mass deforestation events during large storms. These areas should be clear-cut and replanted with native species.

IN HAY FIELDS AND LAWNS

In actively managed hay fields, delayed mowing and hay harvest can create habitat for endangered grassland birds.

Consider reseeding using native warm-season grasses. These provide optimum habitat conditions to more native wildlife species than cool season grasses.

SITE RESOURCE CONSIDERATIONS

Merrill Creek contains approximately 290 acres of conifer plantations. These plantations are 70 to 80 years old and include species not well-suited to the area, such as red pine. These stands are marked by poor health, low vigor, little to no regeneration, and significant invasive plant pressure, thereby threatening watershed values near the headwaters of Merrill Creek. Super-storm Sandy devastated many of these forest stands, creating large regions susceptible to takeover by invasive species.

Deciduous forests within the Preserve were losing young forest habitat. The reduction in young, small-diameter forest stands has implications for wildlife habitat and forest resilience. Wildlife species that require early successional habitat, i.e. young forests, have been critically uncommon in the Northeast largely because forests have matured. A diversity of structural stages (young, mature, and old forests) across the landscape can increase resilience against climate change. In forest stands with other similar attributes, young stands have been shown to be less susceptible to damage during severe wind storms because of their low stature and flexibility.

ACTIVE STEWARDSHIP WORK

Merrill Creek worked with Stryker Forest Products to salvage harvest on a storm damaged site, leaving other damaged sites as a control. Though the salvage was difficult and did not generate a profit for the landowner or logger, initial results suggest tree regeneration is better on the salvaged site. The salvaged area had two-and-a-half times the tree regeneration and twice the regeneration diversity of the unsalvaged site. It is still too early to tell how the two types of sites will develop, but additional surveys will help guide Merrill Creek's management. Salvaging dead or dying trees can reduce fire risk and contain outbreaks of insects and disease. Removing high-risk or infected trees can maintain forest health and vigor, thereby reducing the stand's susceptibility to outbreaks.

Merrill Creek Reservoir (MCR) staff worked with New Jersey Audubon to re-forest an area of the Environmental Preserve. Even-aged deciduous forests were selectively thinned to improve wildlife habitat. New Jersey Audubon selected some tree species for removal in order to provide more light for other tree species to improve seedling germination. This practice provides a diversified wildlife habitat while promoting new young tree growth.

FUNDING AND PARTNERSHIPS

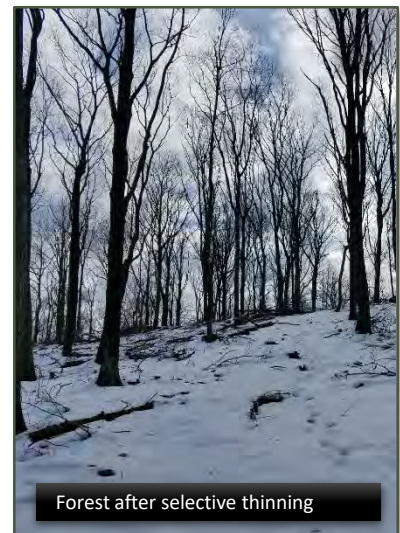
- MCR received a grant from the New Jersey Tree Foundation for 2,500 trees of several species to promote future resiliency of the forest.
- Forest stand improvement initiatives can be funded using revenue generated harvesting trees.
- The trees were planted by college and high school interns interested in environmental study and stewardship.



Newly planted trees in logged conifer plantation



Conifer plantation after storm damage



Forest after selective thinning



SITE RESOURCE CONSIDERATIONS

Areas of the preserve are leased to local farmers for hay production. The timing of hay harvest can interfere with grassland bird nesting. Nests, eggs, and flightless young of ground-nesting grassland birds are vulnerable to the tractor wheels and mowing equipment.

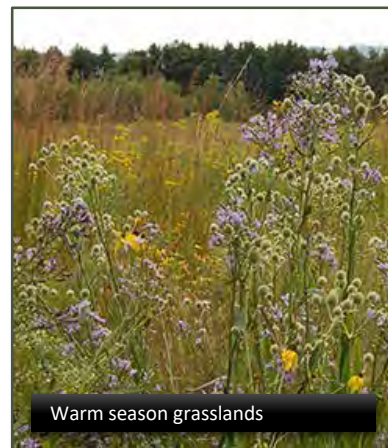
ACTIVE STEWARDSHIP WORK

To avoid interfering with grassland bird nesting, the field was plowed and reseeded with native warm season grasses using a no-till drill. Native warm season grasses provide optimum habitat conditions for native wildlife species. They provide three of the basic habitat requirements of grassland wildlife species – food, shelter, and space.

In the Northeast, true grassland habitats require repeated mowing to keep a dominant grassy structure. These grasslands are the type of habitat birds such as bobolinks, meadowlarks, and grassland sparrows seek. To be considered a good habitat for grassland birds, a field needs to remain unmown through the bird breeding season. No field cutting is allowed between April 1 and September 1, which is when grassland birds nest. Following this, the hay is removed and sold as mulch.

FUNDING AND PARTNERSHIPS

- New Jersey Audubon received funding from NRCS EQIP to reseed the field.
- Field maintenance is provided by a local farmer who sells the hay to local mushroom farms.





HAMLEN FARM RESTORATION

STREAM CORRIDORS

**Stewartsville,
NJ 08886**

40.696805,
-75.137270

The project site is off County Route 519 North, just east of State Route 22 prior to the intersection with County Route 57. The property is a county owned open space parcel. East and south of the creek there is a privately owned farm house and two agricultural fields north and south of the farm house that are owned by the County and rented out for agricultural purposes. The Lopatcong Creek flows southwest in this area and is designated as a freshwater trout production category one waterway (FW-TPC1). From here the Lopatcong Creek drains to the Delaware River about eight miles downstream.

In 2001 a riparian restoration plan was implemented on the property that included the planting of trees and shrubs and the regarding and installation of bio-engineering practices along the Creek. North Jersey Resource Conservation and Development (RC&D) planted additional native plants in 2006. The buffer was 2,500 feet long and 6 acres in size. Riparian buffers are made up of trees, shrubs and native grasses in areas immediately adjacent to streams and lakes. These buffers help the environment by improving water quality, enhancing wildlife habitat and reducing downstream flooding.

SUMMARY OF MANAGEMENT STRATEGIES

**IN AREAS THAT
ARE LAWN,
GRASS, OR
AGRICULTURAL
FIELD**

Narrow corridors between road and stream are ideal for establishment of riparian buffer.

Where native streamside vegetation is gone but soil remains, change mowing and cutting practices to allow gradual natural succession of native plants. Better yet, plant groups of attractive native shrubs and trees to hasten buffer restoration.

**IN AREAS THAT
HAVE EXISTING
BUFFERS**

Replant/reseed any areas where needed. Empty soil spaces are an invitation for weeds and invasive plants to grow.

Monitor buffers annually to track any necessary maintenance. Mow as needed to allow newly planted trees to thrive. Maintain tree tubes and remove when no longer needed.

SITE RESOURCE CONSIDERATIONS

Development, particularly in narrow valleys, has brought traffic close to water, with long lasting effects on riparian areas. Prior to restoration, this narrow stream belt corridor was originally planted in cool season grasses and frequently mowed up to the stream edge. There was no streamside buffer to filter stormwater runoff, shade the steam, or create riparian habitat.

ACTIVE STEWARDSHIP WORK

In 2006, North Jersey Resource, Conservation and Development (RC&D) planted 251 native trees, representing 10 different species, and 481 native shrubs representing 9 different species, within the floodplain. The resulting buffer was 2,500 feet long. All selected species were deer resistant and flood tolerant. Large trees were planted along the streambank to provide shade for the trout in this Category One waterway.

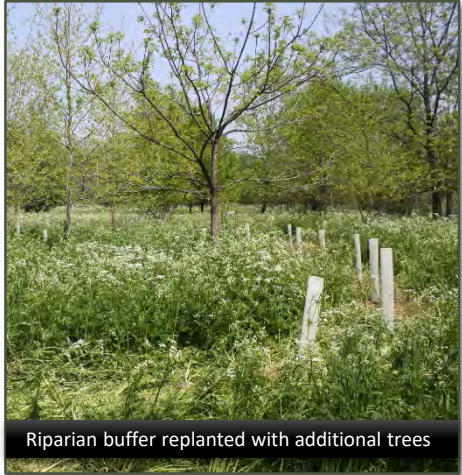
In 2018, areas to the north of the site received additional plantings in an effort by New Jersey Audubon, Trout Unlimited, North Jersey RC&D and the New Jersey Youth Corps of Phillipsburg. Organization employees and volunteers planted 200 containerized 1-3 gallon natives, planted live stakes directly into the streambank, and mowed around the trees.

FUNDING AND PARTNERSHIPS

- Originated from U.S. Environmental Protection Agency Non-point Source Pollution 319h grant program administered by the NJ Department of Environmental Protection through a grant awarded to the North Jersey RC&D. Additional funds utilized from the NRCS Wildlife Habitat Incentives Program (WHIP).
- The riparian forest buffer demonstration is part of a larger regional project, that was coordinated and implemented by North Jersey RC&D. The design was created by North Jersey RC&D and Natural Resources Conservation Service (NRCS) staff. Volunteers from NJ Youth Corps, Warren County Department of Transportation, Warren County Department of Corrections Sheriff's Labor Assistance Program and Chip Pfeiffer Contracting, LLC were participants in the planting and establishment.



Riparian buffer along Lopatcong Creek



Riparian buffer replanted with additional trees



Mowing with buffer to control invasive plants





STRYKER ROAD RESTORATION

AREAS THAT SHAPE COMMUNITY CHARACTER OR DESIGN

**Stewartsville,
NJ 08886**

**40.696805,
-75.137270**

Lopatcong Creek is the largest limestone spring-fed tributary to the Delaware River in New Jersey. It has historically been home to native eastern brook trout, but these indicators of exceptional water quality have seen a dramatic population decline as part of the creek’s overall water quality decline. As of 2012, the Lopatcong has been listed as impaired for total phosphorus, E.coli, and streambank erosion has contributed to total suspended solid (TSS) yields ranging from 72% to 45%. This water quality decline has been due in part to urban runoff and poor agricultural land management practices throughout the watershed.

A section of the river is close to population centers, adjacent to the historic Morris Canal and between two existing open space parcels. At the proposed restoration site, the channel has become extremely incised and disconnected from its floodplain, heavy bank erosion and sedimentation is present and there is little to no riparian buffer.

SUMMARY OF MANAGEMENT STRATEGIES

**IN AREAS WITH
LITTLE TO NO
STREAMSIDE
VEGETATION**

Where native streamside vegetation is limited but soil remains, change mowing and cutting practices to allow gradual natural succession of native plants. Better yet, plant groups of attractive native shrubs and trees to hasten buffer restoration.

**IN STREAMS AND
RIVERS WITH
STEEP BANKS
AND EROSION
CONCERNS**

Consider stream restoration to stabilize stream banks and restore natural channel design. The practices can halt bank erosion, create fish habitat and improve macroinvertebrate habitat.

SITE RESOURCE CONSIDERATIONS

As of 2012, Lopatcong Creek has been listed as impaired for total phosphorus and E.coli; streambank erosion has contributed to total suspended solid (TSS) yields ranging from 72% to 45% (2018, Phase 2 New Jersey Highlands Plan). The water quality decline has been attributed to agricultural land management practices throughout the entire watershed. At the proposed restoration site, the channel has become incised and disconnected from its floodplain, heavy bank erosion and sedimentation is present and there is little to no riparian buffer.

ACTIVE STEWARDSHIP WORK

Trout Unlimited (TU) is working to restore the 1.84 miles of Lopatcong Creek. This restoration project will restore hydrologic processes, stabilize banks to mitigate erosion and reduce sedimentation, reconnect and restore the stream's natural floodplain, reduce and filter polluted stormwater runoff, and reduce stream temperature, thereby improving conditions for native eastern brook trout and macroinvertebrate diversity.

TU will implement spring-creek restoration techniques. The project will reconnect the floodplain through bank terracing and re-sloping at a natural 3:1 slope, stabilize banks and mitigate erosion using willow fascines, boulder structures and woody debris installment, and restore the riparian corridor by planting native trees and shrubs.

This will also ensure improved habitat and water quality conditions to improve the creek's population of native eastern brook trout, as well as macroinvertebrate diversity.

FUNDING AND PARTNERSHIPS

Trout Unlimited is the project lead with New Jersey Audubon Society, North Jersey Resource Conservation and Development and the Lopatcong Creek Initiative, as well as Warren County Department of Land Preservation and local TU chapters offering additional assistance. The project is seeking funding from various grants and initiatives.



Lopatcong creek after being straightened



Stream migration and erosion threaten infrastructure





WATTLES STEWARDSHIP CENTER RESTORATION

RESOURCE LAND - FARMLAND

1024 Anderson Rd, Port Murray, NJ 07865

40.762993,
-74.920679

The Wattles Stewardship Center is a 51-acre wildlife sanctuary and is also the location of New Jersey Audubon's northern Stewardship Program staff. Acquisition of the property was made possible by Mr. Gurdon Wattles, who donated the house and barn, and through New Jersey Green Acres program.

NJ Audubon maintains the Wattles Stewardship Center as a model for blending environmental awareness, wildlife habitat, and agriculture. The site has fields in agricultural production and land managed for wildlife, water and habit. Two of the fields are managed by a local farmer for crops including corn, sunflower, and soybeans. Other portions of the property serve as critical wildlife habitat for grassland birds and provides important natural resource benefits to the region and other on-site farming activities.

SUMMARY OF MANAGEMENT STRATEGIES

PRODUCTIVE FARMLAND SLATED TO CONTINUE BEING FARMED

Encourage farmer to implement best management practices outlined in an NRCS Conservation Plan.

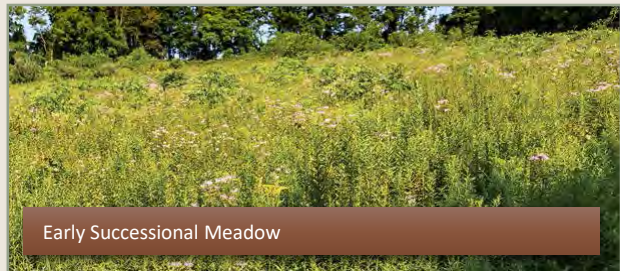
Encourage farmers to be certified River Friendly promoting their positive stewardship of the land.



Corn Field in Cover Crop

FARMLAND AND PASTURE THAT WILL BE TAKEN OUT OF PRODUCTION

Consider reseeding using native warm-season grasses and creating an early successional meadow to provide optimum habitat conditions for native birds.



Early Successional Meadow

SITE RESOURCE CONSIDERATIONS

Most of the site was previously leased and farmed by a local farmer. The fields were continuously tilled and left bare in the winter, which resulted in loss of organic matter and soil. The fields were poor quality habitat for native wildlife.

ACTIVE STEWARDSHIP WORK

New Jersey Audubon encouraged the existing farmer to implement conservation practices including reduced tillage, cover crop, and wider stream buffers. The Wattles property was designed to be a working conservation model farm.

The lowest, rockiest and steepest field was enrolled in the NRCS Conservation Reserve Program (CREP) and State Acres for Wildlife Enhancement (SAFE). The field was reseeded with native warm season grasses to create habitat for grassland birds, to control soil erosion and improve water quality. The field is mowed once annually to maintain grassland habitat.

The Wattles Stewardship Center was certified as a River-Friendly Farm in recognition of their implementation of best management practices focused on protecting water quality. River-Friendly Certified Farms have demonstrated a commitment to

- Reduce soil loss
- Decrease pesticide run-off
- Prevent manure fertilizer pollution
- Vegetative stream buffers
- Proper management of livestock and pastures

FUNDING AND PARTNERSHIPS

NJ Audubon has worked with several groups, including the U.S. Department of Agriculture’s Natural Resource Conservation Service (NRCS), the USDA Farm Service Agency (FSA), and the U.S. Fish and Wildlife Service (USFWS) on a number of on-site conservation related projects. Projects were funded through the enrollment of the land in the following conservation cost-share programs: State Acres for Wildlife Enhancement (SAGE), Wildlife Habitat Incentives Program (WHIP), Conservation Reserve Enhancement Program (CREP), the Partners for Fish and Wildlife Program (PFW), the Forest Stewardship Program (FSP), and the Environmental Quality Incentive Program (EQIP), as well as with private philanthropic support.



Commodity Crop field with cover crops



Wattles Farm awarded River Friendly Farm Certification



Signage throughout farm explains conservation practices





PEQUEST KENCO RESTORATION

OPEN SPACE – RECREATION AND WETLAND RESTORATION

**31 Alphano Rd,
Great Meadows,
NJ 07838**

40.884858,
-74.898448

This large scale wetland restoration project addressed 90-acres of state owned land adjacent to the Pequest River in Township of Independence, Warren County. The majority of the project site (70-acres) was historically a sod farm, where much of the black dirt unique to the area had been previously removed. Since the State’s purchase of the land in 2012, the fields had not been cultivated. The remainder of the site is a mature forested wetland, approximately 20 acres in size.

With funding from the New Jersey Wetland Mitigation Council, the land was cleared of invasive species, regraded, and replanted. The rivers’ natural channel design was restored and stabilized. The resulting 90 acre wetland is planned as a prime wildlife habitat and recreational spot. The restoration project will replace the lost functions and values of regionally impacted wetlands by restoring native wetland plant communities to provide wildlife habitat, enhance water quality, provide flood storage and provide public benefit by offering opportunities for hiking and similar resource-based “passive” recreation.

SUMMARY OF MANAGEMENT STRATEGIES

PROJECTS THAT
ARE VERY LARGE

Hire a qualified environmental consulting company to handle the design, permitting, reporting, and monitoring.

IN WETLANDS THAT
ARE FARMED OR IN
PASTURE

Consider wetland restoration programs that enhance the region’s natural flood control and drainage functions and provide optimum wildlife habitat.



Wetland Restoration



Wetland Restoration

IN STREAMS AND
RIVERS WITH
STEEP BANKS AND
EROSION
CONCERNS

Consider stream restoration to stabilize stream banks and restore natural channel design. The practices can halt bank erosion and create fish habitat and other macroinvertebrate habitat.



Streambank Restoration

SITE RESOURCE CONSIDERATIONS

The site's natural floodplain and wetland habitat was destroyed after years of regrading and draining when the area was converted to agricultural lands. Runoff from the onsite and upstream agricultural fields previously flowed through the site via an extensive surface ditch system, connected to larger collector ditches, and eventually drained to the Pequest River. The former ditch system functioned to drain the project area and adversely affected the wetland hydrology, including the hydrology in the forested wetlands.

The fallow land became infested with non-native and evasive species. The banks of the river were severely incised and quickly eroding. The river channel was straightened and much the native fish habitat was lost.



ACTIVE STEWARDSHIP WORK

The floodplain forest area was established along the corridor the Pequest River. A floodplain bench was created to provide flood relief and stabilize banks in times of high flows. All debris and non-native material were removed. The restored stream corridor and riparian zone was seeded with an appropriate native seed mix and planted with suitable native woody plant material.

In-stream structures, such as rock weirs, root wads, and log-vanes, were incorporated to redirect velocities from outer banks and act as a grade control and also create fish habitat. The introduction of coarse woody debris and logs is naturally beneficial to aquatic habitats and trout populations.

Ditches were plugged in multiple locations to stop rapid drainage. Within inner portions of the site, wetland basins were carved in low lying areas to provide waterfowl habitat and vernal habitat. The wetland basins are designed to be periodically flooded, shallow water emergent wetlands. These fields were restored to native wetland plant communities.



FUNDING AND PARTNERSHIPS

North Jersey RC&D managed the restoration project. The wetland restoration project team also includes the landowners of the property; NJ DEP Division of Fish and Wildlife as well as NJDEP Division of Parks and Forestry.

All work was completed by Amy S. Greene Environmental Consultants Inc. and their subcontractors. They were responsible for the design and construction, as well as managing the five-year maintenance period.





ASBURY MILL RESTORATION

HISTORIC SITES

**17 Mill Ave,
Asbury, NJ 08802**

40.695210,
-75.010398

The Asbury Grist Mill speaks to the early industrial character of Franklin Township, Village of Asbury. The mill was constructed along the Musconetcong River (circa 1865) originally as a gristmill. The building characterized the early industrial might of New Jersey with its use of water wheel and turbine to power the early machines of industry. Production in the mill ceased in the 1970's and the building was abandoned and fell into disrepair. In 1999, the building and surrounding 3.5 acres, was donated to the Musconetcong Watershed Association (MWA).

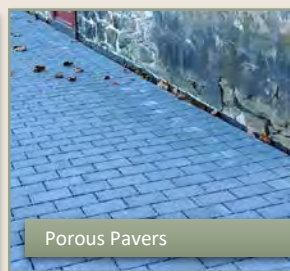
Today, the building is being restored by the Musconetcong Watershed Association, with generous assistance from Warren County – Municipal and Charitable Conservancy Trust Fund, Franklin Township – Open Space Trust Fund, Asbury Carbons and the Riddle Family, The New Jersey Historical Trust – 1772 Foundation, The Gullage Family & The Verizon Foundation, The Hyde and Watson Foundation, and The Society for the Preservation of Old Mills (SPOOM).

Once the restoration is complete, the facility will be open for public use and will provide office space for the Association. The lower floors will serve as an environmental education center and will incorporate a museum of agriculture and milling technology. Green infrastructure was installed in the exterior spaces to manage the sites stormwater and showcase best management practices.

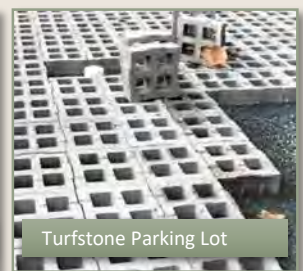
SUMMARY OF MANAGEMENT STRATEGIES

**PARKING LOTS
AND WALKWAYS
AROUND
HISTORIC
BUILDINGS**

To showcase green infrastructure and protect historic resources from stormwater, consider installing the porous pavers and turfstone parking.



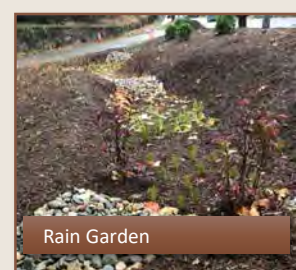
Porous Pavers



Turfstone Parking Lot

**LANDSCAPING
AROUND
HISTORIC
BUILDINGS**

To showcase green infrastructure and reduce long-term landscape maintenance costs, consider installing rain gardens to collect and filter rainwater runoff from surrounding roads and roofs.



Rain Garden

SITE RESOURCE CONSIDERATIONS

Stormwater from the nearby road regularly flowed past catch basin infrastructure and into the building's parking lot. The stormwater would pick up contaminants from the impervious surfaces and create muddy puddles, eventually flowing to the Musconetcong River.

ACTIVE STEWARDSHIP WORK

Construction began on the stormwater green infrastructure project at the Asbury Mill in late October of 2017. Wogisch Landscapes constructed the rain gardens, and installed the porous pavers and turfstone parking lot. The project took approximately one month to complete and was done in stages – first the base layer and underground piping for the porous pavers around the building were installed, followed by the construction of the rain gardens, and then installation of the pavers and turfstone in the parking lot. Two rain gardens and 2,000 square feet of porous pavers were installed. This project resulted in the capture stormwater runoff from a drainage area of approximately of 12,000 square feet.

USEFUL RESOURCES

The Rutgers Cooperative Extension's (RCE) Water Resources Program developed customized green infrastructure plans and developed Impervious Cover Assessments, and Impervious Cover Reduction Action Plans for many municipalities in New Jersey.

FUNDING AND PARTNERSHIPS

This project was funded by North Jersey RC&D through a New Jersey Department of Environmental Protection Section 319(h) Nonpoint Source Pollution Control grant. Planning and design for the project was completed by Rutgers Water Resources Program. The Construction was completed by Wogisch Landscapes. The project is being maintained by the Musconetcong Watershed Association.



Preparing for rain garden installation



Drainage grate moves stormwater from the road to the rain garden



Planting rain garden



Laying porous pavers in lieu of sidewalk



APPENDIX

Appendix A. Open Space in Warren County (Table I Warren County Open Space and Recreation Plan Update 2018)

Appendix B. High Priority (>90%) Parcels within 100 and 300 feet of Preserved Land in Warren County

Appendix C. Water Resource Priorities for Land Stewardship in Warren County

TABLE I - AMOUNT OF OPEN SPACE ACREAGE IN PUBLIC, NON-PROFIT, SEMI PUBLIC, AND PRIVATE OWNERSHIP

Municipality	Amount of						Sub-Total Open Space Preserved	Semi Public	Private	Grand Total
	Federal	State	County	Municipal Open and Recreation Space	School Rec. Space Provided (2012)	Non-Profit Preserved				
Northern Region										
Blairstown township	435	1,388	0.0	188	20.2	66	2,097	850	436	3,383
Frelinghuysen township	0	1,262	0.0	203	5.2	540	2,010	0	561	2,571
Hardwick township	8,206	5,984	395.0	93	0.0	2,031	16,709	421	1,252	18,382
Hope township	0	1,444	0.0	164	2.4	39	1,649	0	95	1,744
Knowlton township	947	1,936	0.0	220	3.1	0	3,106	0	526	3,632
Regional total (Acres)	9,588	12,014	395	868	31	2,676	25,572	1,271	2,870	29,713
Percent of Total	100.0%	39.3%	19.2%	13.5%	9.6%	79.3%	48.8%	31.5%	91.7%	49.9%
Central Region										
Allamuchy township	0	5,192	0.0	635	6.6	32	5,866	0		5,866
Belvidere town	0	36	4.0	60	25.3	4	129	0		129
Hackettstown town	0	479	16.0	90	51.6	0	637	0		637
Independence township	0	1,111	148.0	298	7.7	155	1,720	0	87	1,807
Liberty township	0	1,981	0.0	81	5.3	0	2,067	0		2,067
Mansfield township	0	4,121	277.0	237	9.7	33	4,678	0	35	4,713
Oxford township	0	739	167.0	739	2.1	0	1,647	0		1,647
Washington borough	0	0	0.0	46	17.8	0	64	0		64
Washington township	0	349	295.0	1279	47.6	0	1,971	0		1,971
White township	0	2,500	0.0	388	6.5	50	2,944	0		2,944
Regional (Acres)	0	16,507	907	3,853	180	274	21,721	0	122	21,843
Percent of Total	0.0%	54.0%	44.2%	59.8%	56.2%	8.1%	41.5%	0.0%	3.9%	36.7%
Southern Region										
Alpha borough	0	0	0.0	105	2.1	0	107	0		107
Franklin township	0	362	184.0	276	28.8	33	884	178	47	1,109
Greenwich township	0	0	128.0	308	17.2	0	453	0		453
Harmony township	0	1,334	196.0	298	6.8	208	2,043	2,584	78	4,705
Lopatcong township	0	47	244.0	390	11.8	14	707	0	14	721
Phillipsburg town	0	7	0.0	115	35.5	0	157	0		157
Pohatcong township	0	309	0.0	230	7.1	169	715	0		715
Regional total (Acres)	0	2,059	752	1,722	109	424	5,066	2,762	139	7,967
Percent of Total	0.0%	6.7%	36.6%	26.7%	34.1%	12.6%	9.7%	68.5%	4.4%	13.4%
Total Warren County	9,588	30,580	2,054.0	6,443.0	320.4	3,374	52,360	4,033	3,131	59,524

Prepared by Warren County Planning Department 5/04/17
 * From the 2012 NJDEP Land Use Coverage Data

Appendix B. High Priority (>90%) Parcels within 100 and 300 feet of preserved land in Warren County

Municipality	Block	Lot	Property Location	Class	Acres (Tax Assessor)	Owner's Name	Parcel Acres (GIS)	High Priority Acres	Percent High Priority	Category High Priority	Distance from Preserved Lands
Allamuchy Twp.	201	3	203 BEAR CREEK RD	2	84.65	GV TROUT BROOK, LLC	88.27	85.09	96.4%	> 90 %	< 100 Feet
Allamuchy Twp.	602	26.05	ALPHANO RD	15C	52.26	TOWNSHIP OF ALLAMUCHY	52.33	50.52	96.5%	> 90 %	< 100 Feet
Allamuchy Twp.	602	12	16 YOUNGS ISLAND RD	3A	-	PRYSLAK FARMS	49.60	46.43	93.6%	> 90 %	< 100 Feet
Allamuchy Twp.	201	26	51 KASPER RD	1	10.60	SAYER, RALPH V C/O GORDON	10.69	10.61	99.3%	> 90 %	< 100 Feet
Allamuchy Twp.	106	1	230 SHADES OF DEATH RD	3B	9.88	RUSSO, LAWRENCE	9.79	9.31	95.2%	> 90 %	< 100 Feet
Allamuchy Twp.	602	15	22 YOUNGS ISLAND RD	3B	7.54	LENCEWICZ, WALTER	9.07	8.51	93.8%	> 90 %	< 100 Feet
Allamuchy Twp.	104	4.01	223 BEAR CREEK RD	1	6.40	KRYSPIN, ALFRED	6.78	6.17	91.0%	> 90 %	< 100 Feet
Allamuchy Twp.	602	18.01	20 YOUNGS ISLAND RD	15C	4.84	ALLAMUCHY TOWNSHIP	4.73	4.33	91.4%	> 90 %	< 100 Feet
Allamuchy Twp.	301	2.02	228 JOHNSONBURG RD	1	3.79	ARMBRUSTER, BEVERLY	3.52	3.32	94.2%	> 90 %	< 100 Feet
			Total (Allamuchy Twp.):		179.96		234.78	224.28			
Blairstown Twp.	1503	8.17	44 SAND HILL RD	2	15.64	MILLER, JAMES T	6.92	6.71	97.0%	> 90 %	< 100 Feet
Blairstown Twp.	1503	9	5 SIPLEY RD	15C	3.86	BLAIRSTOWN TOWNSHIP	3.39	3.12	92.1%	> 90 %	< 100 Feet
Blairstown Twp.	1501	13	211 ROUTE 94	15C	63.16	BLAIRSTOWN TOWNSHIP	1.20	1.10	91.5%	> 90 %	< 100 Feet
			Total (Blairstown Twp.):		82.66		11.51	10.93			
Franklin Twp.	48	8	MOUNTAIN VIEW RD, 27	3B	2.02	KITCHARDEN, VANJAI	2.17	2.14	98.9%	> 90 %	< 100 Feet
Frelinghuysen Twp.	901	15	272 MAIN ST	3A	1.50	BANTA, JAMES & LINDA	24.67	22.22	90.1%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1701	10	47 HELLER RD	3B	14.81	HOFMEISTER, RAYMOND G	16.79	15.84	94.3%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1701	11	65 HELLER RD	3A	1.00	KUHN, GEORGE & LISA	16.32	14.98	91.8%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1501	2	129 BEAR CREEK RD	2	11.35	JAMES BRIAN L / BRYAN VIVIAN G	11.00	10.67	97.0%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1701	3	ROUTE 519	1	4.75	KALEDA, PAUL & BARBARA	4.67	4.67	100.0%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1701	11.01	59 HELLER RD	3B	3.07	KUHN, LISA	3.09	3.09	100.0%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1301	15.03	25 GREENDELL RD	1	3.00	FRITZ, HERVEY	3.06	3.05	99.8%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1802	5.01	64 HELLER RD	3B	3.02	DE CAROLIS, ALAN	2.89	2.89	100.0%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1703	3.02	120 SOUTH TOWN RD	3B	3.06	DE CAROLIS, ALAN	2.32	2.32	100.0%	> 90 %	< 100 Feet
Frelinghuysen Twp.	1703	3.01	128 SOUTH TOWN RD	3B	3.00	DE CAROLIS, ALAN	2.19	2.19	100.0%	> 90 %	< 100 Feet
			Total (Frelinghuysen Twp.):		48.56		87.00	81.93			
Hackettstown Town	41	18	680 GRAND AVE	15C	4.70	TOWN OF HACKETTSTOWN	5.07	5.07	100.0%	> 90 %	< 100 Feet
Hackettstown Town	107	37.01	ROUTE 57	15C	3.09	HACKETTSTOWN MUA	3.15	2.96	94.1%	> 90 %	< 100 Feet
Hackettstown Town	119	82.02	SEBER RD	15C	2.00	TOWN OF HACKETTSTOWN	1.81	1.81	100.0%	> 90 %	< 100 Feet
Hackettstown Town	135	2	WILLOW GROVE ST	15F	2.53	PARK DEP	1.80	1.78	98.8%	> 90 %	< 100 Feet
Hackettstown Town	4	5.01	HIGH ST	1	0.60	TOWPATH ASSOC C/O SALEM MGT	1.73	1.73	99.9%	> 90 %	< 100 Feet
			Total (Hackettstown):		12.92		13.57	13.36			

Appendix B. High Priority (>90%) Parcels within 100 and 300 feet of preserved land in Warren County

Municipality	Block	Lot	Property Location	Class	Acres (Tax Assessor)	Owner's Name	Parcel Acres (GIS)	High Priority Acres	Percent High Priority	Category High Priority	Distance from Preserved Lands
Hardwick Twp.	1002	1.04			-		4.36	4.36	100.0%	> 90 %	< 100 Feet
Harmony Twp.	47.01	21	RIVER RD	1	3.90	MARTIN RUTH	3.75	3.73	99.6%	> 90 %	< 100 Feet
Harmony Twp.	48	3	RIVER FRONT	3B	2.15	SHANDOR, JOSEPH SR.	1.34	1.30	97.1%	> 90 %	< 100 Feet
			Total (Harmony Twp.):		6.05		5.09	5.03			
Hope Twp.	1200	1700	94 LOCUST LAKE RD	3B	59.16	MT HERMON HILLS C/O DENEUFVILLE	54.53	50.84	93.2%	> 90 %	< 100 Feet
Hope Twp.	700	600	482 DELAWARE RD	3A	1.00	NIESWAND, GEORGE H & ANNA M	22.00	20.29	92.2%	> 90 %	< 100 Feet
Hope Twp.	2700	4900	338 JOHNSONBURG RD	2	18.63	KLISIEWICZ, RAFAL & AMY	17.62	15.91	90.3%	> 90 %	< 100 Feet
Hope Twp.	700	107	216 HONEY RUN RD	1	6.00	VAN BLARCOM, DENNIS JR	6.32	6.11	96.6%	> 90 %	< 100 Feet
Hope Twp.	1200	3100	OFF DELAWARE RD	1	5.50	ALBANO, THOMAS & MARSHA	5.53	5.53	100.0%	> 90 %	< 100 Feet
Hope Twp.	1200	3200	OFF DELAWARE RD	1	5.00	STROUD, KAREN & DAVID W	4.96	4.96	100.0%	> 90 %	< 100 Feet
Hope Twp.	5200	1500	1 WILLOW CT	1	2.92	RI ROB PROPERTIES, LLC	2.99	2.99	100.0%	> 90 %	< 100 Feet
			Total (Hope Twp.):		98.21		113.95	106.61			
Independence Twp.	29	31	N/S L & H RR	1	191.41	THE SOUTHLAND CORP TAX DEPT	196.36	178.35	90.8%	> 90 %	< 100 Feet
Independence Twp.	29	29	N/S L & H RR	3B	185.90	LEE, BEOM JOON & KAP CHOI	184.63	183.58	99.4%	> 90 %	< 100 Feet
Independence Twp.	29	43	S/S PEQUEST RIVER	3B	110.35	MOUNTFORD, THOMAS A & JEAN M	143.18	138.19	96.5%	> 90 %	< 100 Feet
Independence Twp.	1.01	47	10 POHATCONG DR	3B	67.59	CHARPENTIER, CAROL LEE	66.88	66.15	98.9%	> 90 %	< 100 Feet
Independence Twp.	28	19	N/S ALPHANO RD	3B	68.04	CHO, JUSTINE H & YOUNG H CHO	65.75	63.22	96.2%	> 90 %	< 100 Feet
Independence Twp.	29	11	E/S ISLAND RD	3B	41.32	KOWALICK, CATHERINE	41.58	37.59	90.4%	> 90 %	< 100 Feet
Independence Twp.	21	13	BACON RUN	3B	38.36	BADUINI, LOUIS & ANNE M	39.47	39.14	99.2%	> 90 %	< 100 Feet
Independence Twp.	29	12	E/S ISLAND RD	1	22.48	BOYADJIS, LILLIAN %A BOYADJIS	22.99	21.62	94.1%	> 90 %	< 100 Feet
Independence Twp.	28	53	S/S L & H RR	3A	-	TRZECIAKIEWICZ, EDWARD S	15.30	15.30	100.0%	> 90 %	< 100 Feet
Independence Twp.	1.01	46	7 POHATCONG RD	3B	13.62	CHARPENTIER, CAROL LEE	14.05	13.44	95.7%	> 90 %	< 100 Feet
Independence Twp.	28	54	S/S L & H RR	3A	-	TRZECIAKIEWICZ, EDWARD & ANNA	11.20	11.07	98.8%	> 90 %	< 100 Feet
Independence Twp.	28	52	S/S L & H RR	3B	11.17	TRZECIAKIEWICZ, EDWARD & ANNA	10.63	10.55	99.2%	> 90 %	< 100 Feet
Independence Twp.	28	48	S/S L & H RR	4B	9.32	THE SOUTHLAND CORP TAX DEPT	8.99	8.81	98.0%	> 90 %	< 100 Feet
Independence Twp.	28	51	S/S L & H RR	3B	7.03	TRZECIAKIEWICZ, EDWARD S	6.77	6.77	100.0%	> 90 %	< 100 Feet
Independence Twp.	28	4	N/S ROUTE 46	1	2.51	COLON, HECTOR E	2.48	2.46	99.1%	> 90 %	< 100 Feet
Independence Twp.	28	50	S/S L & H RR	3B	1.92	TRZECIAKIEWICZ, EDWARD & ANNA	1.97	1.97	100.0%	> 90 %	< 100 Feet
Independence Twp.	28	49	S/S L & H RR	3B	1.18	TRZECIAKIEWICZ, EDWARD S	1.16	1.16	100.0%	> 90 %	< 100 Feet
			Total (Independence Twp.):		772.20		833.38	799.36			
Knowlton Twp.	32	3	527 RTE 94	3B	7.64	MATHEZ, RENE	6.31	5.68	90.1%	> 90 %	< 100 Feet
Knowlton Twp.	3	15.01	59 HEMLOCK RD	3B	4.60	GERARDI, ENZO & FRANCESCA	4.34	4.34	100.0%	> 90 %	< 100 Feet
Knowlton Twp.	13	6	105 HAINESBURG RIVER RD	1	2.75	HUDDLESTON, NEIL H & LAURIE A	2.73	2.59	94.7%	> 90 %	< 100 Feet

Appendix B. High Priority (>90%) Parcels within 100 and 300 feet of preserved land in Warren County

Municipality	Block	Lot	Property Location	Acres			Parcel Acres (GIS)	High Priority Acres	Percent High Priority	Category High Priority	Distance from Preserved Lands
				Class	Tax Assessor	Owner's Name					
Knowlton Twp.	13	4	109 HAINESBURG RIVER RD	2	2.21	WASHBURN, RITA	2.30	2.12	92.4%	> 90 %	< 100 Feet
Knowlton Twp.	44	13	110 POLKVILLE RD	1	2.00	MCGROARTY, PAMELA CLAUSE	2.17	2.17	100.0%	> 90 %	< 100 Feet
Knowlton Twp.	67	2			-		1.11	1.01	91.3%	> 90 %	< 100 Feet
			Total (Knowlton Twp.):		19.20		18.95	17.91			
Mansfield Twp.	1202	3	ROUTE 57	1	37.15	CENTENARY COLLEGE	36.54	34.00	93.0%	> 90 %	< 100 Feet
Mansfield Twp.	101.02	34	520 TOWNSBURY RD	3B	23.63	STICKEL	25.05	24.15	96.4%	> 90 %	< 100 Feet
Mansfield Twp.	601.01	3.02	PORT COLDEN	1	11.40	MEIXSELL, DONNA M	11.11	11.01	99.1%	> 90 %	< 100 Feet
Mansfield Twp.	601.01	1.03	WESTERVELT RD	3B	88.38	HOUND N HORSE LLC	3.89	3.89	100.0%	> 90 %	< 100 Feet
Mansfield Twp.	2004	2	HIGHLAND AVE	15C	-	HMUA	1.08	1.08	100.0%	> 90 %	< 100 Feet
			Total (Mansfield Twp.):		160.56		77.67	74.13			
Oxford Twp.	33	4	115 AXFORD AVENUE	1	166.33	ECOLOGIC MITIG. OXFORD,LLC	253.07	236.85	93.6%	> 90 %	< 100 Feet
Pohatcong Twp.	117	13	HUGHESVILLE	3B	5.26	KOERNER, FREDERICK J. & NORENE	6.17	5.69	92.2%	> 90 %	< 100 Feet
Pohatcong Twp.	97	46	385 RIVER RD	3B	1.98	SNYDER, KEVIN & STEPHANIE L	2.53	2.49	98.3%	> 90 %	< 100 Feet
			Total (Pohatcong Twp.):		7.24		8.70	8.18			
Washington Twp.	67	62	39 MILL POND RD	1	16.63	LONGFORD HOMES OF NJ, LLC	16.76	15.27	91.1%	> 90 %	< 100 Feet
White Twp.	69	24.23	43 TAMARACK RD	3A	1.00	BABICH, RONALD, ELLEN & PAUL	18.60	16.82	90.4%	> 90 %	< 100 Feet
White Twp.	52	13.03	557 ROUTE 46	1	6.21	FOX FRED JR. & LYNN LODWICK	9.09	8.94	98.4%	> 90 %	< 100 Feet
White Twp.	52	13.02	559 ROUTE 46	1	6.21	BUGGE, JEFFREY H	4.49	4.10	91.2%	> 90 %	< 100 Feet
White Twp.	14	1	2 SPRING LA	1	3.89	NEW JERSEY AMERICAN WATER CO	4.30	3.94	91.6%	> 90 %	< 100 Feet
White Twp.	52	4	MANUNKA CHUNK RD	15C	1.43	TOWNSHIP OF WHITE	1.34	1.34	100.0%	> 90 %	< 100 Feet
			Total (White Twp.):		18.74		37.82	35.13			
			Total:		1,591.28		1,718.76	1,635.48			
Allamuchy Twp.	602	26	ALPHANO RD REAR	15C	67.09	TOWNSHIP OF ALLAMUCHY	61.91	60.40	97.6%	> 90 %	< 300 Feet
Blairstown Twp.	2101	5.06	9 MUD POND RD	15C	1.10	BLAIRSTOWN TOWNSHIP	1.06	0.96	90.5%	> 90 %	< 300 Feet
Blairstown Twp.	1503	8	44 SAND HILL RD	2	15.64	MILLER, JAMES T	2.87	2.87	99.9%	> 90 %	< 300 Feet
Frelinghuysen Twp.	1501	3.09	115 BEAR CREEK RD	1	7.63	TOWEY, MICHAEL & CHERYL	7.54	6.94	92.0%	> 90 %	< 300 Feet
Independence Twp.	28	30	OFF KRESTREL LANE	3A	-	PRYSLAK FARMS	16.06	16.06	100.0%	> 90 %	< 300 Feet
Liberty Twp.	22	27	278 MOUNTAIN LAKE RD	2	1.00	MUNYAK, ALICE % MUNYAK,DAVID	1.03	1.00	96.4%	> 90 %	< 300 Feet
Mansfield Twp.	1603	6	7 TOWPATH RD	1	1.14	KELLY, MICHAEL E & ANDREA C	1.01	0.93	91.3%	> 90 %	< 300 Feet

Appendix B. High Priority (>90%) Parcels within 100 and 300 feet of preserved land in Warren County

Municipality	Block	Lot	Property Location	Acres		Parcel Acres (GIS)	High Priority Acres	Percent High Priority	Category High Priority	Distance from Preserved Lands
				Class	(Tax Assessor) Owner's Name					
Mansfield Twp.	805	2	MITCHELL RD	2	0.25 ESPOSITO, ALFRED & MADELINE	1.49	1.36	91.7%	> 90 %	< 300 Feet
Mansfield Twp.	1202	5	ROUTE 57	1	3.14 AZR 1, LLC	4.13	4.13	99.8%	> 90 %	< 300 Feet
Mansfield Twp.	1203	2.03	ROUTE 57	15C	5.65 NJ DEPT OF TRANSPORTATION	6.32	6.32	100.0%	> 90 %	< 300 Feet
Mansfield Twp.	2004	19	1 HEATHER CT	15C	3.00 MANSFIELD TOWNSHIP	6.72	6.13	91.2%	> 90 %	< 300 Feet
Oxford Twp.	42	14	374 ROUTE 31	15C	4.20 OXFORD TOWNSHIP	5.30	4.88	92.0%	> 90 %	< 300 Feet
			Total:		109.84	115.45	111.96			
			Total (<100Ft & <300Ft):		1,701.12	1,834.21	1,747.44			

Appendix C. Water Resource Priorities for Land Stewardship in Warren County

The Warren County *Water Resources Amendment* includes *Maps A-I* which identify opportunities for land management (stewardship) projects using water quality and/or quantity as the measuring foundation for assessment. This table provides the characteristics, purpose, metrics and data.

Characteristics	Purpose	Metrics and Data	Map
Hydrology –Maps A, B, and C			
Stewardship: Reduce Direct Stormwater Flows	Implementation of stormwater management practices to slow or avoid direct runoff, discharge from older stormwater basins at rates that exceed current standards, etc. Green infrastructure and modifications to gray infrastructure.	<p>Map A: Subwatershed percent impervious surface using NJDEP 2012 Land Use/Land Cover (LU/LC). Identification of streams with high peaking rates using USGS stream gauging stations, where statistical information is available, as a check on percentage estimates.</p> <p>Map B: Subwatershed analysis of impervious surface in proximity to streams</p> <p>Map C: Municipal mapping of stormwater outfalls per MS4 permits with the identification of Tier A towns. County outfalls and catch basins are mapped. Soil Conservation District (SCD) or other mapping of existing stormwater detention basins www.Hydro.rutgers.edu. SCD has added basins beginning in 1976.</p>	<p>Map A. Impervious Surface (HUC 14 Subwatershed)</p> <p>Map B. Impervious Surface Riparian Areas</p> <p>Map C. Stormwater Outfalls and Basins</p>
Stream and Aquifer Quality – Maps A, B, C, D, E, F, G, and H			
Stewardship: Reduce Direct Stormwater Flows	Implementation of stormwater management practices to filter direct runoff, improve water quality discharged from detention stormwater basins, etc. Green infrastructure and modifications to gray infrastructure.	<p>Map A: Subwatershed percent impervious surface using NJDEP 2012 Land Use/Land Cover (LU/LC). Identification of streams with high peaking rates using USGS stream gauging stations, where statistical information is available, as a check on percentage estimates.</p> <p>Map B: Subwatershed analysis of impervious surface in proximity to streams</p> <p>Map C: Municipal mapping of stormwater outfalls per MS4 permits with the identification of Tier A towns. County outfalls and catch basins are mapped. Soil Conservation District (SCD) or other mapping of existing stormwater detention basins www.Hydro.rutgers.edu. SCD has added basins beginning in 1976.</p>	<p>Map A. Impervious Surface (HUC 14 Subwatershed)</p> <p>Map B. Impervious Surface Riparian Areas</p> <p>Map C. Stormwater Outfalls and Basins</p>

Characteristics	Purpose	Metrics and Data	Map
Stewardship: Reduce Stream Erosion	Stream erosion from excessive stormwater, stream encroachments and agriculture can contribute the majority of sediment and phosphorus loads in a stream (as much as 80%).	<ul style="list-style-type: none"> • Map D. AMNET results for stream habitat integrity (not total score) • Map E. Evaluation of number of road crossings per stream mile by HUC 14 (bridges tend to have uncontrolled stormwater discharges and create breaks in habitat) • Map F. High slope stream segments (LIDAR data with National Hydrologic Data Set), 500 feet or above. 	<ul style="list-style-type: none"> • Map D. AMNET Stream Habitat Integrity Scores • Map E. Road Crossing per Stream Mile (HUC 14 Subwatershed) • Map F. High Slope Stream Segments
Stewardship: Restore Riparian Areas and Wetlands	Restoration of riparian areas, floodplains and wetlands to natural vegetation can reestablish water quality benefits to streams, as the most directly connected lands.	<ul style="list-style-type: none"> • Map G. Riparian area evaluation to identify former riparian areas that can be improved or restored, including farmlands (for agriculture and barren lands) • Map H. Agriculturally modified wetlands, to identify areas with high potential for wetlands restoration (NJDEP LULC data, NRCS SSURGO database) 	<ul style="list-style-type: none"> • Map G. Riparian Areas in Altered Conditions • Map H. Agriculturally Modified Wetlands
AQUATIC ECOSYSTEM FUNCTIONS: Land Protection Priorities (Maps G, H, and I)			
Stewardship – Restore Riparian Areas and Wetlands	Former wetlands and riparian areas may be candidates for restoration to mitigate past losses. Existing wetlands and riparian areas in close proximity to developed areas are likely to have been impaired by that development, and may be candidates for improvement projects to enhance their current ecosystem services to natural levels.	<ul style="list-style-type: none"> • Map G. Identify former wetlands and riparian areas that are in land uses subject to modification, especially former or existing agricultural areas that are transitioning from agriculture or are of minimal agricultural value. • Map H. Agriculturally modified wetlands, to identify areas with high potential for wetlands restoration • Map I. Identify existing wetlands and riparian areas in close proximity to developed areas (500 feet). 	<ul style="list-style-type: none"> • Map G. Riparian Areas in Altered Conditions • Map H. Agriculturally Modified Wetlands • Map I. Wetlands and Riparian Areas within 500 feet of Developed Lands

REFERENCES

- ¹ Warren County Open Space and Recreation Plan update. June 2018.
http://www.co.warren.nj.us/Planning/open_space_plan2018.html. Accessed July 2018.
- ² Warren County 2017 Budget.
http://www.co.warren.nj.us/budget/Budget%202017/2017_Warren_County_Budget_final.pdf. Accessed July 2018.
- ³ Warren County Department of Land Preservation. Personal Communication. Corey Tierney, Administrator. August 2018.
- ⁴ Warren County Department of Land Preservation. 2017 Annual Report.
http://www.co.warren.nj.us/Annual%20Land%20Preservation%20Report/2017_LPD_Annual_Report_presentation.pdf. Accessed July 2018.
- ⁵ Warren County Open Space Plan. 2008.
http://www.co.warren.nj.us/planning/open_space_plan2008.html. Accessed July 2018.
- ⁶ Warren County Open Space and Recreation Plan update. June 2018..
http://www.co.warren.nj.us/Planning/open_space_plan2018.html. Accessed July 2018.
- ⁷ Warren County Open Space and Recreation Plan Update. June 2018.
http://www.co.warren.nj.us/Planning/open_space_plan2018.html. Accessed July 2018.
- ⁸ New Jersey Geological and Water Survey. <https://www.state.nj.us/dep/njgs/enviroed/infocirc/valley-ridge.pdf>. Accessed September 2018.
- ⁹ United States Geologic Survey. <https://water.usgs.gov/edu/hydrology.html>. Accessed August 2018.
- ¹⁰ Warren County Open Space and Recreation Plan Update. June 2018.
http://www.co.warren.nj.us/Planning/open_space_plan2018.html. Accessed July 2018.
- ¹¹ New Jersey Map. Conservation Blueprint. <https://www.njmap2.com/blueprint/>. Accessed August 2018.
- ¹² Port Warren Park. <http://warrenparks.com/park/port-warren-park/>. Accessed July 2018.
- ¹³ Bread Lock Park. <https://warrenparks.com/park/bread-lock-park/>. Accessed July 2018.
- ¹⁴ Port Murray Preserve. <https://warrenparks.com/park/port-murray-preserve/>. Accessed July 2018.

-
- ¹⁵ Morris Canal Greenway 25-Year Action Plan. New Jersey Transportation Planning Authority (NJTPA). http://www.njtpa.org/getmedia/096f38da-4ee1-4f21-940e-f7fed464c195/FinalMorrisCanalGreenwayPlanRevised12_20_12.pdf.aspx. Accessed July 2018.
- ¹⁶ Florence Kuipers Park. <https://warrenparks.com/park/florence-kuipers-park/>. Accessed July 2018.
- ¹⁷ Mount Rascal Park. <http://warrenparks.com/park/mount-rascal-park/>. Accessed July 2018.
- ¹⁸ Marble Hill Natural Resource Area. <http://warrenparks.com/park/marble-hill-natural-resource-area/>. Accessed July 2018.
- ¹⁹ Oxford Mountain Natural Resource Area. <http://warrenparks.com/park/oxford-mountain-natural-resource-area/>. Accessed July 2018.
- ²⁰ Warren County Open Space and Recreation Plan Update. June 2018. http://www.co.warren.nj.us/Planning/open_space_plan2018.html. Accessed July 2018.
- ²¹ Warren County. Department of Land Preservation. <http://www.co.warren.nj.us/Land%20Preservation%20Dept/WhiteLake.html>. Accessed July 2018.
- ²² NJDEP. AMNET. <https://www.state.nj.us/dep/wms/brochure/AMNET.pdf>. Accessed August 2018.