



Water Use and Conservation Management Plan

For Pilot Area 5:

HUC14 02020007040040 Highland Lake/ Wawayanda Lake

Pilot Area includes all or portion of the following municipality:
Vernon Township (Sussex County)

Prepared by the State of New Jersey Highlands Water Protection and Planning Council as part of the Highlands Water Use and Conservation Management Plan (WUCMP) Pilot Program. This WUCMP was developed through the provisions of a State of New Jersey Highlands Water Protection and Planning Council Grant and may assist in the development of municipal WUCMPs in support of Highlands Regional Master Plan Conformance.

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Water Use and Conservation Management Plan for
HUC14 02020007040040

WATER USE AND CONSERVATION MANAGEMENT PLAN

for
HIGHLANDS REGIONAL MASTER PLAN CONFORMANCE

HUC14 02020007040040
HIGHLAND LAKE/WAWAYANDA LAKE

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Executive Summary

Introduction

There are 183 subwatersheds within the Highlands region. One of the highest priority objectives described in the Regional Master Plan (RMP) is to protect restore and enhance water resources within the Highlands region. To help achieve this objective, the Highlands Council has developed model Water Use and Conservation Management Plans (WUCMPs) for pilot areas throughout the Highlands region.

The development of WUCMPs specific to HUC14 subwatersheds is intended to address the requirements of this objective in a practical way that is applicable to each study area. The pilot areas were chosen to include a wide range of use types and water availability, and are geographically dispersed throughout the Highlands region. Pilot areas range in size and include between one and three subwatersheds. While the pilot areas were not developed based on municipal boundaries, the WUCMPs are intended to be used as Planning Tools to help municipalities develop their own plans.

Each WUCMP includes the following components:

- **WUCMP Area Characteristics** – Summarizes high level information such as land use capability/land cover, land use/zoning, major hydrologic features, geology, and soil characteristics.
- **Identification of Water Sources and Types** – The Highlands region uses both groundwater and surface water for potable water supply. Additional use types include, but are not limited to agricultural, commercial, industrial, and institutional.
- **Stakeholders** – a listing of stakeholders who can assist in the implementation of the WUCMP.
- **Revaluation of Net Water Availability** - Original calculations of Net Water Availability (NWA) were based on maximum water use in 2003 using a region-wide analysis at the HUC14 scale. This analysis has been expanded to include available data from 2000-2009 and has several refinements to the NWA computations. Since NWA is calculated on a HUC14 subwatershed basis, municipalities can calculate NWA for each subwatershed using the approach outlined within these WUCMPs.
- **Deficit Mitigation Strategies** – Strategies are provided on both supply-side conservation measures (e.g., leak detection, water auditing, well network optimization) and demand-side conservation measures (such as high efficiency irrigation techniques, rainwater harvesting, and low-flow plumbing fixtures), review of reuse potential, and storage alternatives have been identified. While each WUCMP includes a comprehensive list of deficit mitigation strategies, it is understood the application of individual strategies will vary amongst municipalities. In addition, municipalities may have additional strategies that are not included. Deficit mitigation strategies have been ranked within these WUCMPs but the rankings are subject to change, based on municipal preference.

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- **Funding opportunities** –Funding opportunities are listed that may be available to fund the mitigation actions.
- **Monitoring Plan** – Each WUCMP will include a description of ongoing monitoring of water use and validation of the performance of mitigation actions.
- **Deficit Mitigation Implementation Plan** – Each planning tool identifies deficit reduction targets, responsible parties, a schedule for action and implementation, and funding mechanisms.

While only a portion of a municipality may be included in certain study areas, that particular municipality can utilize these Planning Tools to help characterize a portion of the water use and conservation management requirements within their municipality.

Municipal based WUCMPs should reflect all HUC14 subwatersheds within the municipality. However, the implementation for municipal based WUCMPs will only include the portions of the HUC14 subwatersheds that lie within the boundary of the municipality. Municipalities can and should use information included in these Planning Tools where subwatersheds intersect their WUCMP planning boundary.

The WUCMP Planning Tools outline a straightforward approach and provide a solid framework that can be directly modified by municipalities to develop specific municipal based WUCMPs.

Summary

This Planning Tool covers the following HUC14 subwatershed:

- 02020007040040 (Highland Lake/Wawayanda Lake)

This subwatersheds is within the Township of Vernon in the County of Sussex

Major water services included in planning are the Highlands Lakes area of Vernon Township.

Net Water Availability

The analysis of net water availability (NWA) for this planning area indicates the following variation in NWA between 2000 and 2009.

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Summary of Variation in Net Water Availability - 2000 - 2009

HUC14	Minimum	Maximum
02020007040040 Highland Lake/Wawayanda Lake	-0.0104	-0.0072
mgd = million gallons per day		

Summary of Significant Causes of Deficit

Causes of the deficits noted above include:

- 02020007040040 Highland Lake/Wawayanda Lake - the deficit in this subwatershed is driven primarily by the consumptive public supply pumpage associated with the United Water – Highland Lakes system.

Water Conservation and Deficit Reduction and Elimination Strategies

The following preliminary strategies have been identified for this planning area. These strategies are not prescriptive. All municipalities are able to select alternative strategies that best suit the needs and goals of their specific WUCMP.

- Water Bill Structure/Comparison – highlight historical use patterns for residential customers
- Irrigation System Design – promotion of intelligent irrigation system design
- Leak Detection and Repair – implement programs to identify water system leaks and eliminate them.
- Rate Structure – develop water utility rate structures that promote water conservation.
- Golf Course Water Use – work with golf courses to promote water conservation efforts
- Stormwater Ordinance – promote recharge and or infiltration within the subwatershed.

Monitoring and Implementation Plans

The mitigation strategies selected to reduce the deficit in the subwatersheds must be evaluated periodically. An annual review of each strategy will be conducted to determine its effectiveness, and a more detailed biennial review will update the Net Water Availability tables of this WUCMP.

It is important that annual determinations/analysis/monitoring be conducted to verify the effectiveness of the implementation plan.

Introduction

Purpose and Scope

The Highlands Regional Master Plan (RMP) requires that conforming municipalities develop a “Water Use and Conservation Management Plan” that reflects the policies and objectives of the RMP. Specifically, conforming municipalities are required to develop Water Use and Conservation Management Plans “that will set priorities for the use of available water (where net water availability is positive) and will establish methods to reduce and, where feasible, eliminate deficits where they exist”.¹

Implementation of the RMP will require extensive cooperation among all municipal governing bodies and major water users in the region. Conformance with the RMP is intended to align municipal and county plans, regulations and programs with the goals, policies, and objectives of the RMP, including preservation of the availability and quality of surface water and ground water resources throughout the Highlands region.

One of the highest priority objectives described in the RMP is to restore and protect water resources within the Highlands Region. The development of Water Use and Conservation Management Plans specific to HUC14² subwatersheds is intended to address the requirements of this objective in a practical way that is applicable to each subwatershed.

The RMP provides a method for determining how much water is routinely available for human use, as differentiated from water available for maintenance of ecosystem integrity and for maintenance of minimum levels in reservoirs and other surface water. The method determines Net Water Availability for each HUC14 subwatershed.³ Where Net Water Availability is positive, future human use of water supply is supported. Where Net Water Availability is negative, action is needed to address the deficit.

This document serves as a Planning Tool for municipalities to ultimately develop Water Use and Conservation Management Plans specific for that particular municipality. Although HUC14s included within this document do not encompass an entire municipality, municipalities can use the Plan developed for these subwatersheds as examples and guidelines for developing full scale municipal plans.

¹ Highlands Regional Master Plan, (Highlands Council, 2008), p. 159.

² Referring to the Hydrologic Unit Code (HUC) system established by the United States Geological Survey.

³ Highlands Regional Master Plan, (Highlands Council, 2008), p. 160, Policy 2B2.

Water Use and Conservation Management Plan (WUCMP)

Goals and Policy Overview

Net Water Availability is total available groundwater minus consumptive and depletive water uses. Net Water Availability varies greatly from one area within the Highlands Region to another. Some areas have a water surplus (positive Net Water Availability). Other areas are in significant deficit (negative Net Water Availability). To reduce or eliminate the water deficits within the Region, Water Use and Conservation Management Plans are required under RMP Objective 2B8c:

Water Use and Conservation Management Plans shall be required through municipal Plan Conformance for all subwatersheds to meet the policies and objectives of Goal 2B, to ensure efficient use of water through water conservation and Low Impact Development Best Management Practices, and to avoid the creation of new deficits in Net Water Availability. Where developed for Current Deficit Areas, the plans shall include provisions to reduce or manage consumptive and depletive uses of ground and surface waters as necessary to reduce or eliminate deficits in Net Water Availability, or to ensure continued stream flows to downstream Current Deficit Areas from Existing Constrained Areas, to the maximum extent practicable within each HUC14 subwatershed. Water Use and Conservation Management Plans shall demonstrate through a detailed implementation plan and schedule how and when the current deficit will be resolved in a subwatershed prior to approval for new water uses in the subwatersheds with the most severe deficits (e.g., in excess of 0.25 million gallons per day or mgd), and the plan shall be implemented prior to initiation of new water uses.

Implementation Strategy

Implementation of the goals, policies and objectives of the RMP regarding water deficit restoration consists of the following components, which will be incorporated into each WUCMP by subwatershed for the Highlands Region (from Highlands Council, 2008):

- Identify HUC14 subwatersheds that have a deficit of water availability or a surplus of water availability
- Verify the net water availability analysis and any associated deficits
- Develop a Water Use and Conservation Management Plan for conforming municipalities, especially those whose water supply is in a deficit subwatershed
- For complex systems or where the development of deficit reduction plans for multiple subwatersheds is more appropriate, collaborate with NJDEP and affected interests to develop Water Use and Conservation Management Plans at a larger scale
- Coordinate with NJDEP so that the water allocation permit process, including transfers of water between subwatersheds where required, supports the reduction and elimination of water deficits

This WUCMP includes the following components:

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- **Identification of water sources and uses** – The Highlands Region uses both groundwater and surface water for potable water supply. Additional uses include irrigation (including agricultural), commercial, industrial and institutional.
- **Expanded evaluation of Net Water Availability** (expanded from the original analysis in the RMP) – Original calculations of Net Water Availability were based on maximum water use in 2003. This analysis has been expanded to include available data from 2000-2009.
- **Deficit mitigation strategies** – This section includes water conservation measures (such as high efficiency irrigation techniques, rainwater harvesting, and low-flow plumbing fixtures), review of reuse potential, and storage alternatives.
- **Funding opportunities** – Approaches that may be available to fund the mitigation actions specified within this plan.
- **Monitoring plan** – Ongoing monitoring of water use and validation of the performance of mitigation actions.
- **Deficit reduction and elimination strategy and implementation plan**– Identify deficit reduction targets, responsible parties, a schedule for action and implementation, and funding mechanisms.

Scope and Applicability

This WUCMP covers 6.2 square miles within the Highlands Region and includes Vernon Township in Sussex County (Figure 1). The area included in this WUCMP consists of one subwatershed designated by Hydrologic Unit Code (HUC14) as follows:

- 02020007040040 (Highland Lake/Wawayanda Lake)

As mentioned above, the WUCMP presented within this document serves as a Planning Tool for each municipality. Implementation strategies presented herein are offered as examples, and may not be suitable for each particular municipality. Participants are encouraged to review various implementation strategies (whether listed in this WUCMP or not) and identify those that represent the best opportunity to achieve their planning goals.

The municipal plan for Vernon Township will include numerous HUC14 subwatersheds beyond the single subwatershed in this document. Fifteen HUC14 subwatersheds intersect the boundary of Vernon Township. However, there are several subwatersheds that intersect the Township boundary, but have no major water uses or returns within Vernon Township. Therefore, only the anticipated water use associated with domestic supply for that portion of the Township within those subwatersheds is required for inclusion into the municipal WUCMP (in the case of Vernon Township, eight of the fifteen subwatersheds). A full calculation of Net Water Availability for the remainder of these subwatersheds is not necessary. The data included in this WUCMP can be included in the municipal plan.

However, in cases where significant water use occurs within a subwatershed, and is located both within and outside the Township boundary, a full analysis on that particular subwatershed would be required.

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Responsibility for implementing strategies within that subwatershed would be assigned to each contributing municipality based on a flow (or use)-weighted approach.

WUCMP Area Characteristics

Background

The subwatershed is located entirely within the Township of Vernon in the County of Sussex.

The WUCMP area is generally recognized to include the Highlands Lakes area of Vernon Township, which is tracked by the US Census as a “census designated place” for statistical purposes.

Land Use Capability/Land Cover

Land Use Capability Zones

The Highlands Region is classified into three Land Use Capability Zones, within which there are multiple sub-zones:

- **Protection Zone** – Areas having high value in terms of forested resources, critical habitat, water quality and quantity, and ecological function, and having limited or no capacity to support human development without adversely affecting the overall ecological function of the Highlands Region. This zone has one sub-zone, Wildlife Management.
- **Conservation Zone** - Areas that have significant environmental features that should be preserved and protected from non-agricultural development. This zone has one sub-zone, Conservation Environmentally-Constrained.
- **Existing Community Zone** - Areas characterized by extensive and intensive existing development that may have capacity to support additional human development without adversely affecting the ecological value of the Highlands Region. This zone has two sub-zones: Existing Community Environmentally-Constrained, and Lake Community.

Of the 6.2 square miles covered by this WUCMP, 76% is in the Protection Zone and 24% is in the Existing Community Zone (primarily the Lake Community Subzone).

Figure 2 shows the Land Use Capability Map of the three zones described above for this WUCMP.

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Preservation and Planning Areas

This WUCMP falls entirely within the Preservation Area boundary.

Figure 3 shows the delineation of the Preservation and Planning Areas in the vicinity of this WUCMP area.

Land Use/Zoning

The land WUCMP area is primarily residential and forested land. Figure 4 depicts the layout of all land use within the subwatershed. Due to the small amount of urban development in the subwatershed the area can be considered a rural domestic area.

The Highland Lakes makes up the majority of the residential (urban) land in this subwatershed. Historically, the land in this area was used for dairy farming, but was also a summer time retreat for families from metropolitan areas. The summer homes initially built were of lake or log cabin style and only occupied seasonally. Today, many of the homes retain the original architecture of the area, but have been converted into permanent residences.

NJDEP 2007 impervious surface estimates for this subwatershed are shown on Figure 5.

Figure 6 shows an aerial view of this subwatershed.

Major Hydrologic Features

The HUC14 subwatershed addressed by this WUCMP consists of many hydrologic features. Of these features, Wawayanda Lake and Highland Lake are the largest.

Wawayanda Lake is tributary of Wawayanda Creek, flowing from the northeast, which is a tributary of the Wallkill River in Sussex County. Historically, this man-made lake was dammed in 1846 to provide waterpower to mills in the area. Currently, water spills over the earthen construction gravity dam, Wing Dam, on the east side of the lake into Laurel Pond. Lake Wawayanda and the Wing Dam, located within Wawayanda State Park, are owned by the Division of Parks and Forestry.

Highland Lake, the other major hydrological feature in this subwatershed, is a naturally existing lake surrounded by residential lots.

Other minor lakes in this subwatershed include: Lake Wanda, Upper Highland Lake, Upper East Highland Lake, East Highland Lake and West Highland Lake. There are no USGS Stream gauge sites or monitoring stations within the subwatershed. Figure 7 shows the location of USGS Stream Gauge Sites in the vicinity of the subwatershed.

Geology and Soil Properties

The subwatersheds in the WUCMP area are located within the Highlands Physiographic Province, characterized by a series of discontinuous rounded ridges separated by deep narrow valleys. The Highlands Physiographic Province consists of igneous and metamorphic formations, although sedimentary and meta-sedimentary rocks are also present

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Overall, the bedrock in this area is mapped primarily as igneous and metamorphic rocks include granite, gneiss and schist. Figure 8 displays the bedrock geology within the subwatershed. Igneous rock is formed through the cooling and solidification of magma or lava. Metamorphic rock is rock transformed by heat and pressure. These rock types are more dense than sedimentary rock. Recharge tends to be minimal and ground water supplies limited because there is very limited pore space or fractures for water to enter.

Rocks of the Green Pond Mountain Region are bedrock of sandstone, siltstone, shale and limestone that underlies mountain flanks and adjacent valleys. The water quality from this type of bedrock is generally good but chemical treatment may be necessary to address hardness, iron and manganese.

Identification of Water Sources and Uses

Water System Profile

Description

One water system serves this WUCMP area: United Water - Vernon Valley. Homes and businesses outside the public water service areas are served by privately owned ground water wells.

Facilities

Figure 9 indicates the public supply wells identified within the WUCMP area.

Service Areas

The service areas within the WUCMP area are:

- United Water – Vernon Valley
- United Water – Barry Lakes – this system is predominantly outside this WUCMP area.

The service areas stated above can be seen in Figure 10.

Allocation and Firm Capacity

Table 2 lists the existing public groundwater wells in this WUCMP.

Firm capacity is defined as the pumping and/or treatment capacity of the water system when the largest pumping unit or treatment unit is out of service. Subtracting the total peak daily demand from the firm capacity may result in a water supply deficit (when the total peak is greater than firm capacity) or a surplus.

Firm capacity and allocation are based on an entire water system, not individual wells. There may be wells outside of the particular HUC14 that are included within the water system, and thus the allocation and firm capacity numbers.

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Table 1 - Summary of Public Groundwater Wells in HUC14 02020007040040

Water Purveyor	System	Well ID No.	Pump Rate (GPM)	Allocation (MGM)	Firm Capacity (MGD)
United Water	Highland Lakes	Highland Lakes Well		See Note 1	NA
		1	20		
		2			
	Barry Lakes	1	22.2	NA	0.02
		2	20		
		3*	0		

Note 1: The Highlands Lakes systems does not have a separate permitted monthly allocation. It is grouped together with the other United Water Vernon systems into a combined monthly allocation of 27 MGM.

NA = not available

Remaining Firm Capacity

The remaining firm capacity of the United Water - Highland Lakes system is unknown as data for the United Water - Highland Lakes system is not currently available through NJDEP's Division of Water Supply and Geoscience.

Wastewater Management

Description

The entire subwatershed is served by individual subsurface sewage disposal (septic systems).

Facilities

There are no public wastewater facilities in this subwatershed.

Stakeholders

Potential stakeholders within this subwatershed include the following:

- Highland Lakes Improvement Company – this water purveyor is associated with a single well in this subwatershed.
- United Water New Jersey – this water purveyor is associated with three wells in this subwatershed, but likely serves areas outside this subwatershed.
- Residents of Highlands Lakes and the surrounding areas
- Vernon Township Municipal Government – this subwatershed is located entirely within the municipal boundary of Vernon Township.

Vernon Township and United Water New Jersey participated in the development and review of this WUCMP. The WUCMP will be available for public review and comment prior to consideration and final approval by the Highlands Council.

Analysis of Net Water Availability

Introduction

Net Water Availability is Ground Water Availability minus consumptive and depletive water uses. Ground Water Availability is the portion of Ground Water Capacity that can be provided for human use without harm to other ground water users, aquatic ecosystems or downstream users. The Highlands RMP defines Ground Water Capacity based on the Low Flow Margin component of the Low Flow Margin of Safety Method. Low Flow Margin and Ground Water Availability are discussed below.

Low Flow Margin

Low Flow Margin is the margin between two stream low flow statistics: September median flow and 7 day-10 year low flow (7Q10). Low Flow Margin is derived for each HUC14 subwatershed using data from streams in a relatively unaltered state. The 7Q10 is the lowest total flow over seven consecutive days during a ten year period. It has been used in quantifying passing flow requirements. The 7Q10 is also often used to define an extreme low flow condition for water quality based effluent limits applied to wastewater discharges. A critical flow regime for aquatic ecosystems is the lowest monthly flow, which in New Jersey and the Highlands tends to occur in September. The Low Flow Margin is the difference between 7Q10 and September median flow, which in the Highlands is always a positive sum.⁴

Low Flow Margin is used to calculate Ground Water Capacity, or the natural ability of the watershed to support base flow.⁴ Ground Water Capacity is derived from Low Flow Margin, but is adjusted for the consumptive uses incorporated into the stream flow statistics used to derive Low Flow Margin. Ground Water Capacity equals Low Flow Margin multiplied by 1.02, based on a USGS study that showed existing consumptive uses are roughly 2 percent of Low Flow Margin.

Ground Water Availability

Ground Water Availability is that portion of Ground Water Capacity that is available for human consumption (absent other constraints).⁴

⁴ Highlands Council Technical Report, Water Resources Volume II Water Use and Availability” (Highlands Council, 2008), p. 46.

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The following threshold values were established by the Highlands Council:

Table 2 - Ground Water Availability Thresholds as Percentage of Ground Water Capacity⁵

Land Use Capability Zone	Standard Threshold Capability
Protection Zone	5% LFM
Conservation Zone	5% LFM (non-agricultural) 10% LFM (agricultural)
Existing Community Zone	20% LFM

These subwatersheds addressed by this WUCMP are predominantly within the Protection Zone, so according to the rules established in the Highlands RMP and Technical Report Vol. II, the Ground Water Capacity is multiplied by 5% to arrive at Ground Water Availability. The Groundwater Availability for the three subwatersheds is presented below:

Table 3 - Ground Water Availability

HUC14 Description	Ground Water Availability (mgd)
HUC14 02020007040040 Highland Lake/ Wawayanda Lake	0.0344

Net Water Availability

Calculation of Net Water Availability

Net Water Availability (NWA) is Ground Water Availability minus any consumptive and depletive uses within the subwatersheds. When NWA is positive, ground water supply is available for human uses. When NWA is negative, insufficient ground water is available to support additional human use.

Consumptive water use is defined as water that is lost within the subwatersheds and is not returned as recharge or as discharge to a stream within the subwatersheds. An example of a consumptive use is irrigation, in which most of the water evaporates and does not recharge the aquifer system. Depletive water uses are those in which water is exported out of the subwatersheds. A typical example of depletive use is conveyance of wastewater out of the subwatersheds to a wastewater treatment plant that discharges in another subwatershed.

NWA was originally calculated using maximum water withdrawals from 2003, which represented the most recently available compiled and checked data. The NWA values for the subwatersheds in the

⁵ Highlands Council Technical Report, Water Resources Volume II Water Use and Availability” (Highlands Council, 2008), p. 121.

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Highlands Council Technical Report Water Resources Volume II Water Use and Availability (2008) are presented below:

Table 4 - Published Net Water Availability

HUC14 Description	Net Water Availability (mgd)
02020007040040 Highland Lake/Wawayanda Lake	-0.0032
TOTAL	-0.0032

The total published NWA reflects a deficit of approximately 3,200 gallons per day.

As part of this analysis, updates to the NWA calculation were performed for this subwatershed to adjust for the following:

- Additional data for the period 2000-2002 and 2004-2009
- Septic return for those areas served by public water but not by public sewer.

Water uses within this subwatershed are predominantly domestic ground water and public community supply.

Public Community water supply use is listed in Table 5.

Water Supply

Public Community Supply

Following is a summary of Community Public Supply withdrawals within these subwatersheds associated with the peak deficit NWA calculations

Table 5 - Water Supply Withdrawals

Water Purveyor	System	Well ID No.	Category	Withdrawals*	
				Peak Month	Peak Withdrawal (MGM)
United Water	Highland Lakes		Public	June 2000	0.716
	Barry Lakes	1	Public		
		2			
		3			

*Raw pumpage

Barry Lakes Well 3 is within the HUC14 although pumpage data are not available. Pumpage data for this HUC14 provided by United Water did not specify system and is assumed to be for the Highland Lakes system.

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A significant portion of this subwatershed is served by the United Water –Vernon Valley system. The water sources supplying this system have historically come from three wells, one of which is outside HUC14 02020007040040. As such, this use represented an import of water with no associated withdrawal within the HUC14. However, United Water has reported that this well is now abandoned (as of 2011), and that the service area in this subwatershed is now entirely dependent on the two wells within the same subwatershed. Therefore, for the purposes of this WUCMP, the historic diversions from the outside well are accounted for as uses from within the subwatershed, to better assess future conditions.

Domestic Well Ground Water Usage

Domestic Well Ground Water Usage is an estimate of private well withdrawals within the subwatersheds for areas not served by the public supply. It was calculated based on population estimates for the subwatersheds from the 2000 Census, multiplies by a factor of 100 gallons per person per day per as identified by the Highlands Council.⁶

Table 6 - Domestic Ground Water Usage

HUC	Domestic Ground Water Usage (mgd)
02020007040040	0.144

Municipal Consumptive/Depletive Uses

Groundwater models used in support of the Highlands Regional Net Water Availability analysis show that the impact on September stream flows of consumptive/depletive (C/D) ground water use during the summer is not 1:1, but roughly 1:0.9.⁷ In other words, 1 gallon of C/D water use is calculated to reduce Ground Water Availability in September by 0.9 gallons. Therefore, ground water use (raw pumpage) during the summer month with the highest demand was multiplied by 0.9 to reflect this impact. The factor is not applied to surface water diversions, which are based on September withdrawals that have an immediate impact on stream flows.

Consumptive water uses such as irrigation are further adjusted using consumptive use coefficients. In many instances, the water is not conveyed a long distance through a water utility network. Therefore, it is assumed that the withdrawal, use and discharge occur in the same location. Consumptive use coefficients reflect the percentage of the consumptive use that is lost and is not returned to the aquifer.⁸

⁶ Highlands Regional Master Plan, (Highlands Council, 2008), p. 96.

⁷ Highlands Council Technical Report, “Water Resources Volume II Water Use and Availability” (Highlands Council, 2008), p. 116.

⁸ Highlands Council Technical Report, “Water Resources Volume II Water Use and Availability” (Highlands Council, 2008), p. 119.

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For public community water uses, the calculation of consumptive and depletive uses must consider the possible import/export of water, and the potential return of the water as a wastewater discharge. In these situations, consumptive/depletive use in the portion of the water supply service area that is coincident with a wastewater service area is associated with the wastewater discharge from that sewerage area. Any remainder of the consumptive use is allocated among the areas on public water service that discharge to individual septic systems. Water exported to a different subwatershed, such as a wastewater treatment plant, are considered depletive. Depletive uses, by their nature, have an effective consumptive use coefficient of 1.0.

Revised Net Water Availability

As part of this analysis, revisions to the Net Water Availability calculation were conducted to include more recent public supply water use data.

Net Water Availability was calculated for each of the years 2000-2009, incorporating additional water supply pumpage data from users in the subwatersheds. Pumping during summer months is typically greatest and has the largest impact on September base flow, which is used in calculating Net Water Availability. Therefore, maximum aggregate monthly water usage from June, July or August was used to calculate updated C/D use for these subwatersheds.

It should be noted that the maximum month in this planning document may vary from subwatershed to subwatershed. There are instances where a portion of a water supply system is included within the subwatershed from more than one purveyor. For the municipal analysis, the total distribution system pumping (by pressure zone, if available) for each water purveyor should be calculated for each water purveyor and the maximum month chosen based off of that calculation.

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Table 7 - Re-evaluated Net Water Availability

Year	Ag Ground Water Availability (mgd)	Non-Ag Ground Water Availability (mgd)	Total Non-Ag Consumptive Use (mgd)¹	Imported Septic Return (mgd)²	Ag Net Water Availability (mgd)	Non-Ag Net Water Availability (mgd)³	Surplus for Potential Use (mgd)⁴
Published	0	0.0344	0.0376	0	0	-0.0031	N/A
2000	0	0.0344	0.0449	0	0	-0.0104	0
2001	0	0.0344	0.0433	0	0	-0.0089	0
2002	0	0.0344	0.0446	0	0	-0.0101	0
2003	0	0.0344	0.0424	0	0	-0.0080	0
2004	0	0.0344	0.0429	0	0	-0.0084	0
2005	0	0.0344	0.0429	0	0	-0.0085	0
2006	0	0.0344	0.0417	0	0	-0.0072	0
2007	0	0.0344	0.0419	0	0	-0.0075	0
2008	0	0.0344	0.0430	0	0	-0.0085	0
2009	0	0.0344	0.0432	0	0	-0.0087	0

¹ [Adjusted Consumptive Domestic Use] + [Consumptive Public Supply Use] + [Total Non-Ag Consumptive Use from Surface Water] + [Other Non-Ag Consumptive Use from Ground Waters].

² From Public Supply wells outside the HUC and/or wastewater return to groundwater originating outside HUC.

³ [Non-Ag Ground Water Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return]

⁴ Occurs when there is an import of water which is returned to the HUC through septic return.

“Missing Data”: One or more sources of data were not reported.

“N/A”: One or more of the components to C/D use is missing and C/D use and NWA could not be calculated.

Refer to Appendix for further explanation of terms.

Summary of Significant Causes of Deficit

Following is a summary of the range of re-evaluated NWA calculations:

Table 8 - Summary of NWA Results

HUC	NWA – Minimum (mgd)	NWA Maximum (mgd)
02020007040040 Highland Lake/Wawayanda Lake	-0.0104	-0.0072

mgd = million gallons per day

Causes of the deficits noted above include:

- 02020007040040 Highland Lake/Wawayanda Lake - the deficit in this subwatershed is driven primarily by the consumptive public supply pumpage associated with the United Water – Highland Lakes system.

Characterization of Deficit

The NWA deficit in this subwatershed is within the range 0 to -0.1 mgd, and is considered marginal.

The most recent available data up to and including 2009 suggests that the use patterns for public supply are consistent and that no significant trend upward or downward is evident. However, the industrial and irrigation pumping variation suggests that deficit mitigation planning should be based on years when these maximums occur.

Water Conservation/Deficit Mitigation Strategies

The following table summarizes the water use management techniques and mitigation strategies that this WUCMP could use to reduce and/or eliminate the water deficit in these subwatersheds.

Table 9 - Summary of Deficit Mitigation Strategies

Measure	Residential	Com/ Indust/ Inst	Water Purveyor	Municipal
Water Use Reduction				
Heating System Upgrades		✓		
Hot Water Heater Upgrade	✓	✓		
Hydrant Locks			✓	
Avoid Overspray	✓	✓		
Building and Pipe Insulation	✓	✓		
Cleaning	✓	✓		
Community Garden	✓			✓
Cooling System Upgrades		✓		
Dishwasher Upgrade	✓	✓		
Drip Irrigation	✓	✓		
Drought Contingency Plans			✓	✓
Equipment Condensation		✓	✓	
Irrigation Conservation	✓	✓		✓
Irrigation Education			✓	✓
Irrigation System Design	✓	✓		✓
Landscape Design	✓	✓		
Landscape Incentive Program				✓
Leak Detection and Repair	✓	✓	✓	
Low Flow Faucets/Faucet Aerators	✓	✓		
Low Flow Shower Fixtures	✓	✓		
Low Flow Toilet Fixtures	✓	✓		
Low Volume Irrigation	✓	✓		
Maintenance	✓	✓	✓	
Meter Calibration/Replacement			✓	
Night Watering	✓	✓		
Plumbing Incentive Program		✓		✓
Pre-Rinse/Commercial Kitchen Upgrades		✓		
Process Water Optimization		✓		
Public Education Handouts		✓	✓	✓
Public Workshops				✓
Rate Structure			✓	

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Table 9 - Summary of Deficit Mitigation Strategies

Measure	Residential	Com/ Indust/ Inst	Water Purveyor	Municipal
Revised Irrigation Ordinance				✓
School Conservation Programs			✓	✓
Submetering	✓	✓	✓	
Swimming Pool Covers	✓			
Turfgrass Selection				
Washing Machine Upgrade	✓	✓		
Water Bill Structure/Comparison	✓	✓	✓	
Water Conservation Programs		✓	✓	✓
Water Treatment Improvements			✓	
Waterless Restrooms		✓		
Well Optimization			✓	
Reuse and Reclamation				
Graywater Recharge	✓	✓		
Graywater Reuse for Irrigation	✓	✓		
Internal Infrastructure Graywater Reuse		✓		
Internal Infrastructure Stormwater Reuse		✓		
Storage				
Composting	✓	✓		
Install Geotextiles Under Plantings	✓	✓		
Rainwater Harvesting/Rainwater Cistern	✓	✓		
Water Storage Tank Management			✓	
Recharge				
Assisted Infiltration/Enhanced Recharge	✓	✓		✓
Building Interceptor Dykes, Swales and Berms	✓	✓		✓
Injection Wells		✓		
Modifications to Zoning				✓
Stormwater Ordinance				✓
Porous Paving	✓	✓		✓
Rainwater Harvesting/Rain Gardens	✓	✓		
Retrofit Existing Detention Basins		✓		✓

Com = Commercial; Indust = Industrial; Inst = Institutional

Evaluation and Ranking of Water Conservation Strategies

Evaluation

To determine the best mitigation strategies for this WUCMP, a simple qualitative ranking system was developed. This system considers seven attributes of each potential strategy from the perspective of a user in these subwatersheds. The seven attributes are:

1. *Feasibility* – Can the strategy be implemented by a specific type of user? Strategies that have a high ranking for Feasibility can be implemented relatively easily. Implementing a night watering program is considered a highly feasible deficit mitigation strategy.
2. *Effectiveness* – If the strategy is implemented by a specific type of user, will it create the desired effect? Strategies that have a high ranking for Effectiveness offer the best opportunity to directly reduce the NWA deficit. Example: Using a broom rather than a hose or power washer to clean a driveway is considered a highly effective deficit mitigation strategy.
3. *Resilience and Reliability* – Once the strategy is implemented, how susceptible is it to failure, and how much maintenance will it require to remain in operation? Strategies that have a high ranking for Resilience and Reliability are expected to be implemented consistently over long periods. Example: Installation of a graywater system is considered a highly resilient and reliable deficit mitigation strategy.
4. *Reduction Potential and Market Penetration* – Once the strategy is working, what regional reduction in deficit can be expected, based on the number of users likely to implement the strategy? Strategies that have high rankings for Reduction Potential and Market Penetration offer opportunity for implementation by the greatest number of stakeholders. Example: Installation of low-flow plumbing fixtures is highly ranked for reduction potential and market penetration.
5. *Administrative Complexity and Availability of Implementing Entities* – How difficult will it be to launch, monitor, and evaluate the effectiveness of the mitigation strategy? Strategies that are highly ranked for Administrative Complexity and Availability of Implementing Entities are simple to implement and can be implemented by existing entities. Examples: modifying a stormwater ordinance or implementing a new rate structure.
6. *Cost and Cost Effectiveness* – What is the efficiency of a mitigation strategy in terms of cost per unit of reduction? Strategies that are highly ranked for Cost and Cost Effectiveness offer the “biggest bang for the buck”. Examples: plumbing incentive programs and drought contingency plans.
7. *Schedule* – How long will it take to implement the mitigation strategy? Strategies that are highly ranked for Schedule can be implemented quickly. Example: public education handouts.

Each mitigation strategy was ranked for each of the seven attributes listed above. A value of 1, 2 or 3 was assigned based on the degree to which each strategy embodies each attribute. A ranking of 3 indicates:

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- Highly feasible
- Very effective
- Highly resilient and reliable
- High potential for deficit reduction and market penetration
- Simple strategy to administer; implementing entities available
- Short time required to implement

Scores for each strategy are listed in Tables 10 through 13 for residential, commercial / industrial / institutional, water purveyors, and municipalities, respectively.

The evaluation was conducted under two scenarios and it is anticipated that it will be repeated following stakeholder input to assign weights to each attribute. The following scenarios were evaluated:

- Equal weight – each of the seven attributes was weighted equally. This is analogous to simply summing the scores in each table.
- Weighted for consumptive/depletive use reduction – a weight of 50% was assigned to the C/D reduction attribute and all other attributes were weighted equally (8.3% each).

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Table 10 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Residential Users

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Avoid Overspray	3	2	1	2	1	3	3
Building and Pipe Insulation	3	2	2	1	1	2	2
Cleaning	3	3	1	2	1	2	2
Community Garden	3	2	2	1	1	2	1
Composting	3	2	2	1	1	3	3
Dishwasher Upgrade	3	2	3	2	1	2	2
Hot Water Heater Upgrade	3	2	3	2	1	2	2
Install Geotextiles Underneath Plantings	3	2	2	1	1	2	2
Irrigation Conservation	3	2	1	2	1	3	3
Irrigation System Design	3	2	3	1	1	2	2
Landscape Design	3	2	2	1	1	2	2
Leak Detection and Repair	1	1	1	1	1	1	1
Low Flow Faucets/Faucet Aerators	3	2	3	2	1	3	3
Low Flow Shower Fixtures	3	2	3	2	1	3	3
Low Flow Toilet Fixtures	3	2	3	2	1	2	3
Maintenance	3	2	2	1	1	2	3
Night Watering	3	2	2	2	1	3	3
Porous Paving	1	3	2	2	1	1	1
Rainwater Harvesting/Rain Barrels	3	3	2	1	1	2	2
Rainwater Harvesting/Rain Gardens	3	2	2	1	1	2	2
Submetering	1	1	2	1	1	1	1
Swimming Pool Covers	3	2	2	1	1	1	3
Washing Machine Upgrade	3	2	3	2	1	2	3
Water Bill Structure/Comparison	3	3	3	3	3	3	3

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Table 11 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial/Industrial/Institutional Users

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Avoid Overspray	3	2	1	2	2	3	3
Building and Pipe Insulation	3	2	2	1	2	2	2
Building Interceptor Dykes, Swales and Berms	1	2	2	2	2	2	2
Cleaning	3	3	2	2	2	2	2
Composting	2	1	1	1	2	2	3
Cooling System Upgrades	2	2	2	2	1	1	1
Dishwasher Upgrade	3	2	3	2	2	2	2
Graywater Systems	3	2	3	2	2	2	1
Heating System Upgrades	2	2	2	2	1	1	1
Hot Water Heater Upgrade	3	2	3	2	2	2	2
Install Geotextiles Underneath Plantings	3	2	2	1	2	2	2
Internal Infrastructure Graywater Reuse	1	2	2	2	1	1	1
Internal Infrastructure Stormwater Reuse	3	2	2	2	2	2	1
Irrigation Conservation	3	2	1	2	2	3	3
Irrigation System Design	3	3	3	3	2	2	3
Landscape Design	3	2	2	1	2	2	2
Leak Detection and Repair	2	2	2	1	2	1	1
Low Flow Faucets/Faucet Aerators	3	2	3	2	2	2	3
Low Flow Shower Fixtures	2	2	2	2	2	2	3
Low Flow Toilet Fixtures	3	2	3	2	2	2	3
Maintenance	3	2	2	1	2	2	3
Night Watering	3	2	2	2	2	3	3
Pre-Rinse Spray Valve and Commercial Kitchen Conservation	3	2	2	2	2	2	2
Public Education Handouts	3	2	1	1	1	3	3
Rainwater Harvesting/Rain Barrels	3	2	2	1	1	2	2

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Table 11 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial/Industrial/Institutional Users

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Rainwater Harvesting/Rain Gardens	3	2	2	1	2	2	2
Submetering	1	1	2	1	1	1	1
Washing Machine Upgrade	2	2	3	1	2	2	3
Water Bill Structure/Comparison	2	2	3	3	3	3	3
Water Conservation Programs	3	2	1	2	2	3	3
Water Treatment Improvements	2	2	1	1	1	1	1
Waterless Restroom	1	2	1	2	1	1	1
Assisted Infiltration/Enhanced Recharge	3	2	2	2	2	2	2
Porous Paving	2	2	2	1	1	1	1
Injection Wells	1	3	2	2	1	1	1
Equipment Condensation	3	1	2	1	3	3	3
Retrofit Existing Detention Basins	3	3	3	3	2	2	1

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Table 12 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Water Purveyors

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Water Bill Structure/Comparison	3	3	3	3	3	3	3
Rate Structure	3	3	3	3	3	3	3
Meter Calibration/Replacement	2	2	2	2	3	2	1
Drought Contingency Plans	2	2	2	3	3	3	3
Water Treatment Improvements	3	3	3	3	3	3	2
Hydrant Locks	2	1	2	1	3	1	1
Well Optimization	3	2	2	2	3	2	2
Public Education Handouts	2	1	1	1	3	2	1
School Conservation Programs	2	2	2	1	3	3	1
Irrigation Education	2	2	2	1	2	3	1
Water Conservation Programs	3	3	1	1	3	2	3
Leak Detection and Repair	3	3	3	3	3	3	3
Submetering	2	2	2	2	3	2	3
Equipment Condensation	3	1	2	1	3	3	3
Maintenance	3	3	2	2	2	3	3
Water Storage Tank Management	3	2	3	2	3	2	3

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Table 13 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Municipalities

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Assisted Infiltration/Enhanced Recharge	3	2	2	2	1	2	2
Building Interceptor Dykes, Swales and Berms	2	1	2	2	1	2	2
Community Garden	3	2	2	1	1	2	1
Drought Contingency Plans	2	2	2	1	1	3	3
Irrigation Education	3	2	1	2	1	3	3
Irrigation System Design	3	2	3	1	1	2	2
Landscape Incentive Program	3	2	2	1	1	1	3
Modifications to Zoning	1	1	3	3	3	3	3
Modify Stormwater Ordinance	3	2	3	3	3	3	3
Plumbing Incentive Program	3	2	2	1	1	3	2
Porous Paving	1	3	2	2	1	1	1
Public Education Handouts	3	2	1	1	1	3	3
Public Workshops	3	2	1	1	2	3	3
Retrofit Existing Detention Basins	3	3	3	3	2	2	1
Revised Irrigation Ordinance (Odd/even, rain sensor requirements, etc.)	3	2	3	3	1	2	3
School Conservation Programs	3	2	1	1	2	2	3
Water Conservation Programs	3	2	1	2	1	3	3

Ranking of Deficit Mitigation Strategies

Deficit mitigation strategies that are relevant to this subwatershed have been prioritized and the top 10 strategies for each water user category are listed in Tables 14 through 17. An evaluation program called EVAMIX was utilized to rank each strategy. EVAMIX is a well-tested multi-criteria evaluation program that is used to rank alternatives. The program takes raw data, both quantitative and qualitative, normalizes it and uses the data to compare alternatives while helping stakeholders understand which factors have greater or lesser impact on the outcome. This is done by using the scores that were assigned in Tables 13-15 and determining the *relative* weight of each of the categories or attributes. The weights for each attribute are relative to each other and the sum of the weights must equal 1.0 (100%). For example, if a stakeholder thought that feasibility was the most important attribute, perhaps they would assign a weight of 40% to that attribute and 10% to each of the others.

Table 14 - Ranked Mitigation Management Strategies for Residential Users

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Water Bill Structure/Comparison	Water Bill Structure/Comparison	1
2	Irrigation System Design	Irrigation System Design	2
3	Low Flow Faucets/Faucet Aerators	Low Flow Faucets/Faucet Aerators	3
3	Low Flow Shower Fixtures	Low Flow Shower Fixtures	3
5	Low Flow Toilet Fixtures	Low Flow Toilet Fixtures	5
5	Washing Machine Upgrade	Night Watering	5
7	Night Watering	Washing Machine Upgrade	5
8	Avoid Overspray	Avoid Overspray	8
8	Irrigation Conservation	Irrigation Conservation	8
10	Dishwasher Upgrade	Dishwasher Upgrade	10

**Table 15 - Ranked Mitigation Management Strategies for
Commercial/Industrial/Institutional Users**

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Irrigation System Design	Irrigation System Design	1
2	Water Bill Structure/Comparison	Water Bill Structure/Comparison	2
3	Retrofit Existing Detention Basins	Retrofit Existing Detention Basins	3
4	Low Flow Faucets/Faucet Aerators	Low Flow Faucets/Faucet Aerators	4
4	Low Flow Toilet Fixtures	Low Flow Toilet Fixtures	4
6	Night Watering	Night Watering	6
7	Cleaning	Cleaning	7
8	Dishwasher Upgrade	Dishwasher Upgrade	8
8	Hot Water Heater Upgrade	Hot Water Heater Upgrade	8
10	Water Conservation Programs	Water Conservation Programs	10

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Table 16 - Ranked Mitigation Management Strategies for Water Purveyors

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Leak Detection and Repair	Leak Detection and Repair	1
1	Rate Structure	Rate Structure	1
1	Water Bill Structure/Comparison	Water Bill Structure/Comparison	1
4	Water Treatment Improvements	Water Treatment Improvements	4
5	Water Storage Tank Management	Drought Contingency Plans	5
6	Maintenance	Water Storage Tank Management	6
7	Drought Contingency Plans	Maintenance	7
8	Equipment Condensation	Well Optimization	8
9	Water Conservation Programs	Submetering	9
10	Well Optimization	Meter Calibration/Replacement	10

Table 17 - Ranked Mitigation Management Strategies for Municipalities

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Stormwater Ordinance	Stormwater Ordinance	1
2	Retrofit Existing Detention Basins	Retrofit Existing Detention Basins	2
3	Modifications to Zoning	Modifications to Zoning	3
4	Revised Irrigation Ordinance (Odd/even, rain sensor requirements, etc.)	Revised Irrigation Ordinance (Odd/even, rain sensor requirements, etc.)	4
5	Public Workshops	Irrigation Education	5
6	Irrigation Education	Water Conservation Programs	5
6	Water Conservation Programs	Assisted Infiltration/Enhanced Recharge	7
8	School Conservation Programs	Porous Paving	8
9	Public Education Handouts	Building Interceptor Dykes, Swales and Berms	9
10	Plumbing Incentive Program	Public Workshops	10

Funding Opportunities

Public

Highlands Council Planning Grants

The Highlands Council will approve the WUCMP following an opportunity for formal public review and comment. Upon approval, the WUCMP will become a component of the Plan Conformance process for the affected municipalities. The Highlands Act provides for state funding to support planning efforts necessary to implement Plan Conformance. In the case of a WUCMP, state funding is available to address necessary modifications (if any) to the Highlands Area Land Use Ordinance, and implementation planning for other components. In addition, the municipality may request additional planning funds to develop mitigation strategies. The Highlands Council is not currently authorized to provide capital grants for project implementation, but the Highlands Council will work with the municipalities to identify and obtain funding from other state and federal agencies (see below) for such purposes.

State Program Grants

The following state agencies should be considered for state program grants:

- New Jersey Department of Agriculture (NJDA)
- New Jersey Department of Environmental Protection (NJDEP)
- New Jersey Department of Community Affairs (DCA)

The official website for the State of New Jersey provides links to various grant opportunities throughout the state. The following is a direct link to state grants by department or agency:

<http://www.nj.gov/nj/gov/njgov/grants.html>

In addition, water supply, wastewater and stormwater infrastructure improvements may be eligible for low-interest loans from the New Jersey Environmental Infrastructure Financing Program:

<http://www.njeit.org/>

The Small Cities Community Development Block Grant (CDBG) program offers funding for local needs for which no other source of funding is available.

<http://www.nj.gov/dca/divisions/dhcr/offices/cdbg.html>

Federal Program Grants

Federal funding is available for water conservation and water use technology. Grants are one way to obtain funding for a water conservation project. A searchable database of federal program grants can be accessed at www.grants.gov. For federal grants the following agencies and their components should be considered:

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- Environmental Protection Agency (EPA) – of note are:
 - The Catalog of Federal Funding Sources for Watershed Protection (<http://cfpub.epa.gov/fedfund/>)
 - Office of Wetlands, Oceans, and Watersheds – Watershed Funding (<http://water.epa.gov/aboutow/owow/funding.cfm>)
- United States Department of Agriculture (USDA)
- United States Department of Energy (USDOE)
- United States Department of the Interior (USDOI)
- United States Department of Housing and Urban Development (HUD) – including Community Development Block Grants (CDBG)
- USGS – including cooperative agreements

Grants may be available from multiple components of the agencies listed above, so when searching for grants, do not immediately rule out agencies with names different from those listed. Each grant in the Grants.gov database has a summary/description and eligibility requirements.

The Natural Resources Conservation Service (NRCS) is a notable component of the USDA to consider for funding.

Activities in planning for green building, including activities in the Leadership in Energy and Environmental Design (LEED) program, are supported by EPA through funding for governments, non-profit organizations, consumers and industries who are striving to conserve energy. The following website details some of the funding opportunities provided by EPA regarding green building:

<http://www.epa.gov/greenbuilding/tools/funding.htm>

Private Funding Sources

Development

Funding from development activities can be implemented through changes to construction codes and development review ordinances, including the Highlands Area Land Use Ordinance.

Commercial Entities

Cooperative events with local businesses can be used to raise funds or provide discounts to local stakeholders to promote water conservation.

Foundations

The following are some foundations that offer funding opportunities:

- National Fish and Wildlife Foundation (<http://www.nfwf.org/>)
- River Network (<http://www.rivernetwork.org/>)
- American Rivers (<http://www.amrivers.org/>)
- Center for Watershed Protection (<http://www.cwp.org/>)
- Trout Unlimited (<http://www.tu.org/>)

Other Non-Governmental Organizations

The American Water Works Association (AWWA) participates in grant and research programs for water conservation and technology. The following is a link to AWWA's website where current grant information may be found:

<http://www.awwa.org/>

The American Water Resources Association (AWRA) has information about water resources education, management and research.

<http://www.awra.org/>

Municipalities and Utilities

Municipal Capital Projects

Municipalities periodically repair, rehabilitate or replace municipal facilities. In municipal capital projects, incorporation of improved fixtures, irrigation methods, stormwater capture and recharge, and other methods for reducing water consumption and depletion can be highly cost-effective. Some water conservation methods have relatively short payback periods, especially those that reduce hot water use.

Utility Operations

Utilities also periodically repair, rehabilitate or replace their capital facilities, with most of the costs funded through user charges. These projects, when part of a planned preventive maintenance program, can reduce the long-term costs of operating the utility by minimizing the potential for emergency repairs. Utilities also may address constraints on water line service capacity by encouraging water conservation by customers. Such projects reduce both water losses and system stress.

Water Conservation, Deficit Reduction and Elimination Strategies

Note: Deficit Reduction Targets and Strategies will be established upon development of a full municipal WUCMP

Selected Strategies

Since this subwatershed is primarily residential and the Net Water Availability deficit is marginal, the selected strategies are focused around residential users and public water supply systems.

Water Bill Structure/Comparison

This strategy focuses on highlighting for the residents their usage as a function of historical patterns and other users. The goal of this strategy is take advantage of behavioral science findings that people respond to peer-pressure or normative behavior. The premise is that when water users better understand the behavior of their peer group, they are more likely to change their own behavior and respond in a positive manner.

Irrigation System Design

This strategy involves the promotion of intelligent irrigation system design for residential and commercial irrigation water use. Through the incorporation of scheduling techniques, efficient technology, and soil moisture sensors, the amount of water used for irrigation can be reduced.

Agricultural irrigation is not addressed under this strategy because no agricultural water use statistics are available for this subwatershed.

Leak Detection and Repair

The strategy involves the use of sonic or other methods to detect water escaping the distribution system. Leaks at stream crossings are among the most difficult to detect and repair.

Proactive programs for leak detection can reduce downtime for emergency repairs. Such programs should look to survey the entire system at least once every 5 years in a phased manner.

Rate Structure

This strategy entails the development of water utility rate structures that promote water conservation. Generally, these rate structures encourage customers to use less water while still providing affordable water, and informing the public about the real cost of this limited critical resource. Revenue from surcharge rates charged to high-use customers can be used to promote conservation through incentive and education programs

Stormwater Ordinance

This strategy involves developing a stormwater ordinance or improving an existing stormwater ordinance to promote recharge and/or infiltration within the subwatersheds as development occurs,

beyond typical minimum standards such as those contained in N.J.A.C. 7:8 et seq, N.J.A.C. 5:21 et seq. (Residential Site Improvement Standards), or the Highlands Area Land Use Ordinance..

Deficit Reduction Target

TBD upon development of a full municipal WUCMP

Water Conservation and Deficit Reduction Estimates

Water Bill/Structure Comparison

There is a population of approximately 2,130 persons served by a public water supply in the WUCMP area (based on 2010 Census data). Approximately half the users will have above average water usage and could potentially be targeted by the strategy. It is reasonable to assume a 1% reduction in water usage using this deficit mitigation strategy, but higher rates are possible.⁹

Average water withdrawal in the existing areas served by public water supply in this WUCMP area is as follows:

- United Water – Highland Lakes – 0.016 mgd

Using the 1% reduction rate indicated above, approximately 160 gallons per day can be conserved.

Irrigation System Design

Some experts estimate that up to 50 percent of commercial and residential irrigation water use goes to waste due to evaporation, wind, improper system design, or overwatering.¹⁰ This strategy is focused on the design of intelligent irrigation system that utilize current technologies such as irrigation controllers, soil moisture sensors, rain shut off switches, or efficient sprinkler heads.

As the basis for this strategy, the total amount of irrigated land in the subwatersheds was estimated using a GIS analysis. Using NJDEP's 2007 Land Use/Land Cover feature dataset, land use types associated with residential, commercial, and athletic field land uses were isolated for this subwatershed.

The total irrigated portion of the land use types indicated above was estimated to be 10% of the total pervious land area identified in the residential, commercial, and athletic field land use types.

The peak irrigation rate for residential, commercial, and athletic fields was estimated to be 8 gpm/acre. This is consistent with 1-inch of water per irrigation, occurring for 8 hours over a 7 day period.¹¹

⁹ Hoffman, Jeff, "Calculating Conservation: The Competitive Power of the Water Bill", The Aquifer, Vol 24, No. 4, Spring 2010.

¹⁰ Outdoor Water Use in the United States, Environmental Protection Agency, Water Sense – An EPA Partnership, Retrieved from < <http://www.epa.gov/WaterSense/pubs/outdoor.html> >.

¹¹ New Jersey Irrigation Guide (June 2005), United States Department of Agriculture, Natural Resources Conservation Service, Somerset, NJ, Chapter 6, Table NJ 6.7, page NJ6-15.

Water Use and Conservation Management Plan for HUC14 02020007040040

Based on the GIS analysis described above, the following table of acreage by land use type was developed:

Table 18 – Estimated Total Pervious Acres and Irrigated Acres by Land Use Type

County	Pervious Acres by Land Use Type			Total
	Residential	Commercial	Athletic Field	
Morris	467	5	-	472
Total Acres	467	5	-	472
Estimated Total Irrigated Acres*	47	0	-	47

*Estimated Total Irrigated Acres = Total Pervious Acres x 10%

Based on the total irrigated acreage and a peak irrigation rate of 8 gpm/acre, a total of 378 gpm peak irrigation is estimated. However, this rate is estimated to occur for a total of 8-hours over the course of a 7-day period. Using these boundary conditions, this equates to an average irrigation water usage of approximately 25,900 gallons per day.

We have conservatively estimated irrigation water usage can be reduced by 10% using this strategy. Using this estimate, approximately 2,590 gallons per day can be conserved.

Leak Detection and Repair

Estimates of leak detection and repair will be based on “non-revenue water” which describes water that has been produced and supplied to the distribution system by the water purveyor, but is not delivered to customers. Leaks (real loss) are one component of non-revenue water. Other components include unauthorized consumption, customer metering inaccuracies, overflows at storage tanks, leakage at service connections. Real water loss within distribution systems are typically 10%.¹² This is consistent with current estimates of distribution system in New Jersey.¹³

A conservative estimate of 10% can be applied to the reduction of real water loss volume as the potential savings in water use.¹⁴

Average water withdrawal in the existing areas served by public water supply in this WUCMP area is as follows:

¹² Lambert, Allan, Assessing non-revenue water and its components, Water Loss – IAP Task Force, Water21, August 2003, Issue 5.4, pp. 50-51.

¹³ Caroom, Eliot, (2012-05-12), “Water utilities cleared by state to make swifter repairs (and increases to bills)”, *The Star Ledger*. Retrieved from <http://www.nj.com/business/index.ssf/2012/05/water_utilities_cleared_by_sta.html>

¹⁴ Guidance Document, Water Leak Detection and Repair Program (August 2007), Georgia Environmental Protection Division, Watershed Protection Branch, Retrieved from <http://www1.gadnr.org/cws/Documents/Leak_Detection_and_Repair.pdf>

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- United Water – Highland Lakes – 0.016 mgd

Based on the assumptions indicated above, the real water loss is estimated at 10% or 1,600 gallons per day. Using the 1% reduction rate indicated above, approximately 160 gallons per day can be conserved.

Rate Structure

The relationship between water rates and water usage/conservation has been the subject of study for many years. The economics of this unique relationship have been explored in various studies, and it is recognized that even within the Highlands, different rate structures may be required.

However, for the purposes of estimating potential water conservation, it is reasonable to assume reductions in water usage of 1% assuming a rate increase of 10%.¹⁵

Average water withdrawal in the existing areas served by public water supply in this WUCMP area is as follows:

- United Water – Highland Lakes – 0.016 mgd

Given a 10% increase in rates, and the resulting 1% reduction in water use, approximately 160 gallons per day can be conserved.

Stormwater Ordinance

The premise of this deficit mitigation strategy is that baseflow could be enhanced by the construction of recharge and/or infiltration basins.

In keeping with current NJDEP guidance, this strategy is based on the infiltration facilitated by a design storm of 0.31 inches (one-quarter of the NJDEP stormwater quality design storm of 1.25 inches).¹⁶ For the purpose of this estimate, we are assuming 50% of the total rainfall is infiltrated and the basin is approximately 3 acres in size.

The above assumptions equate to 18,938 gallons of additional infiltration. Over a 90 day period, this equates to 210 gallons per day for an individual rainstorm. Larger basins or more frequent recharge will increase this estimate.

Summary of Savings Potential

Following is a summary table of the potential savings in water use estimated under this Plan:

¹⁵ American Water Works Association (AWWA). (2000). Principles of Water Rates, Fees, and Charges. *American Water Works Association Manual of Water Supply Rates, M1*. (Fifth Edition). Published by American Water Works Association.

¹⁶ Carleton, Glen B, Simulation of Groundwater Mounding Beneath Hypothetical Stormwater Infiltration Basins, Scientific Investigations Report 2010-5102, USGS, Reston, VA, 2010.

**Water Use and Conservation Management Plan for
HUC14 02020007040040**

Table 19 - Summary of Potential Water Use Reductions

Strategy	Potential Savings (gpd)
Water Bill/Structure Comparison	160
Irrigation System Design	2,590
Leak Detection and Repair	160
Rate Structure	160
Stormwater Ordinance*	210

*Note: this is on a per rainfall event basis.

The above table presents potential savings that are representative of withdrawals during the June-July-August period.

Selection of a combination of the above strategies should be considered as measures to help work toward achieving the Net Water Availability targets for this WUCMP area.

Monitoring

The recommended mitigation strategies selected to reduce the deficit in the subwatersheds must be evaluated periodically. A cursory annual review of each strategy will be conducted to determine the effectiveness of each strategy, with a more detailed biennial review by the Highlands Council that updates the Net Water Availability tables of this WUCMP. The review will include an analysis to see if the Net Water Availability deficit is likely to be achieved via the mitigation strategy. The same analysis techniques used in the initial Net Water Availability determination will be used to determine the current deficit or surplus within the subwatersheds.

For municipal plans, annual monitoring will be required. A monitoring form has been included here as Appendix B. This form will be made available online to facilitate efficient completion and submittal. It is anticipated that the form will be submitted to the Highlands Council on October 30th of each year, corresponding with submittal of water use forms to DEP. The monitoring period that will be reflected by the form will be October 1 through September 30 (although data will represent June through September of that particular year). One form will be submitted for each HUC14 subwatershed within the municipality. Appendix B includes an example subwatershed for Sparta Township.

Annual Water Use and Return Data

Monitoring of these subwatersheds is to begin with an annual review of water use data for the preceding year. This data can be obtained from the water purveyor, United Water.

The NJDEP well database, which identifies well systems by Public Water System Identification (PWSID) numbers, should also be monitored annually to see if any public, residential, commercial/industrial, irrigation, or any other well type has been constructed in the past year. Once the population is adjusted and new wells are identified, a re-evaluation of the water use in this watershed should be conducted and compared to the results of the initial determination.

USGS monitoring stations are a valuable source of data when available. Some are available within these subwatersheds. However, the suitability of each should be evaluated further to determine if they offer a viable means for continued monitoring of Deficit Mitigation Strategies. Therefore, any re-evaluation of Net Water Availability will be conducted by the Highlands Council using its regional methodology with incorporation of local data.

A re-evaluation of the septic system return for these subwatersheds should also be performed biennially. The re-evaluation will adjust the total number of septic systems to account for any new septic systems constructed in the subwatersheds. Identification of any public sanitary sewer service within the subwatersheds should also be included in the re-evaluation.

The existing ArcGIS database should be updated to show any new stormwater management basins as well as any new sewer discharge points (if applicable). After identification of new septic systems or

Water Use and Conservation Management Plan for HUC14 02020007040040

potential discharge points, a return calculation will be performed which will be compared with the initial study baseline data.

The re-evaluation will end with a calculation of the current deficit/surplus. As the implementation plan is adjusted the results for each biennial review should show a reduced or completely eliminated deficit with these subwatersheds.

Ongoing Monitoring

Public education efforts play a significant role in the success of implementing mitigation strategies. Before any strategies are eliminated or adjusted, a comparison of actual public efforts and projected public efforts should be made. This comparison can be made using the results of public surveys, which is discussed in detail in the Implementation section of this plan. A tabulation of the survey data should be conducted. Once tabulated, these data need to be analyzed statistically, because only a fraction of the population within the subwatersheds will respond to the survey. Initially, the participation for each mitigation strategy was estimated because the participation was unknown, and proven data were generally not available as to participation statistics. The results of the survey will provide a basis to estimate the actual participation rates for each strategy. These results may show that a particular mitigation strategy was unsuccessful primarily due to the lack of participation. Once comparisons are made and this analysis is completed, it will be clear where adjustments need to occur. The mitigation strategies shall be adjusted based upon the results of this annual analysis.

Implementation Plan

Annual Program Implementation Plan

If a deficit remains after an annual review is conducted several issues need to be addressed. It is expected that as the implementation plan is tested and fine-tuned, it will be refined throughout the process.

The annual review to refine the implementation plan for each subwatershed should include:

- Verification of implementation for each mitigation strategy
- Assessment of effectiveness for each mitigation strategy
- Verification of effectiveness for each mitigation strategy
- If proven non-effective, where is the process going wrong? / Where can improvements be made?
- Elimination/addition of strategies.
- Creation/Revisions of timeline to predict deficit reduction/elimination.

Overall, it is important that annual determinations/analysis/monitoring is conducted to verify the effectiveness of each implementation plan within the subwatersheds. A database that stores annual monitoring data should be kept beginning with the implementation of this plan and continued post deficit elimination to document continued compliance and ensure that the deficit does not reappear in the future. If monitoring is done efficiently and thoroughly, elimination of deficits should be a reasonably achievable task.

Strategies

The following deficit mitigation strategies have been chosen for implementation.

Water Bill Structure/Comparison

The implementation plan consists of coordinating with United Water to develop a customizable charts or tables to compare and contrast individual water usage based on subwatershed totals.

Irrigation System Design

The implementation plan for this strategy involves water usage data review with the water department and performance of a water audit on the largest irrigation water users in the subwatershed. Once the water audit is complete, a plan can be developed with the irrigation system owners to incorporate intelligent irrigation system design parameters and measure water conserved.

Leak Detection and Repair

The implementation plan for this strategy is a study by the local water utilities, potentially in concert with other stakeholders, to identify leaks within the subwatersheds, and repairs to eliminate any meaningful leaks found.

Draft Water Use and Conservation Management Plan for HUC14 02030103030010, HUC14 02030103030020, and HUC14 02030103030030

Estimates of quantities lost from the identified leaks should be kept for reference and for comparison with the results of water use reduction measurements.

Rate Structure

Implementation of a rate structure to promote water conservation will include determination of revenue requirements, costs of services, the marginal price of water, and future water demand targets. The responsible entity should evaluate different cost structures and implement the one best suited to the service area and its residents.

Education and engagement of customers and elected officials are highly recommended for all phases of this strategy.

Stormwater Ordinance

The implementation plan for this strategy involves research from municipal stakeholders to determine what elements are required for inclusion in the stormwater ordinance, or how the existing stormwater ordinance will be modified.

Schedule to Achieve Water Balance

It is anticipated that a full year will be required to facilitate implementation of the Water Bill. It is anticipated that a full year will be required for implementation of the Water Bill Structure/Comparison and Rate Structure strategies, and that it will be several years before significant reductions result from them. If a 10% rate increase is implemented, it is recommended that it be implemented over a period of several years.

The Irrigation System Design strategy will require several years to implement from education of the public and business community, through implementation of water conserving irrigation-based measures.

The leak study can be completed in phases over the first five years, and associated modest repairs can be performed under existing maintenance budgets. Larger or more widespread repairs may require several years to implement.

Development of the new or revised ordinances can be accomplished in a year, and savings can be evident in the first year after adoption.

The overall schedule is to mitigate the deficit in this WUCMP within 3-5 years.

Responsible Parties

Responsible parties will consist of homeowners within Highland Lakes region, Vernon Township, and United Water.

We recommend development of a committee representing the Highland Lakes community to monitor and promote progress at the municipal level.

Funding Commitments

TBD

Next Steps

To be determined by Stakeholders.

Appendix A

Background

Net water availability is defined as Ground Water Availability minus consumptive and depletive water uses. Following is a description of the different components that were used to derive the estimate of Re-Evaluated Net Water Availability in this Water Use and Conservation Management Plan (WUCMP).

Basis for Net Water Availability

The following columns of data have been provided in the WUCMP:

Year	Ag Ground Water Availability (mgd)	Non-Ag Ground Water Availability (mgd)	Total Non-Ag Consumptive Use (mgd)	Imported Septic Return (mgd)	Net Water Availability (mgd)	Surplus for Potential Use (mgd)
------	------------------------------------	--	------------------------------------	------------------------------	------------------------------	---------------------------------

The columns of data shown above are explained in the following sections.

Year

This column refers to the calendar year from which the data was obtained.

Ground Water Availability

Ground Water Availability is that portion of Ground Water Capacity that is available for human uses, absent other constraints. For the purpose of the WUCMP calculations, Ground Water Availability is divided into two components. They are:

Agricultural (Ag) Ground Water Availability

Agricultural (Ag) Ground Water Availability – Ag Ground Water Availability is not applicable in each watershed. This type of Ground Water Availability is used when the Conservation Zone covers a majority of the watershed. In this case, Ag Ground Water Availability is established and tracked separately to support sustainable agriculture.¹⁷

Non- Agricultural (Non-Ag) Ground Water Availability

Non-Agricultural (Non-Ag) Ground Water Availability is the predominant type of Ground Water Availability and is used as the basis for net water availability for most watersheds.

¹⁷ Highlands Council Technical Report, Water Resources Volume II Water Use and Availability” (Highlands Council, 2008), p. 123.

Consumptive/Depletive Uses

Consumptive and Depletive (Water) Use totals are derived from Ground Water Pumpage and Surface Water Withdrawals. These uses are divided into two categories: Consumptive and Depletive. These two types of water use are defined as follows:

- Consumptive Uses - That part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock or otherwise removed from the immediate water environment other than by transport through pipelines and other conveyances as potable water or wastewater.
- Depletive Uses - Those water uses that physically transfer water from one watershed to another through pipelines and other conveyances as potable water or wastewater, resulting in a loss of water to the originating watershed.

Total Non-Ag Consumptive Use

Non-Ag Consumptive Use is calculated as follows:

$$\begin{aligned} \text{Total Non-Ag Consumptive Use} = & [\text{Adjusted Consumptive Domestic Use}] + \\ & [\text{Consumptive Public Supply Use}] + \\ & [\text{Total Non-Ag Consumptive Use from Surface Water}] + \\ & [\text{Other Non-Ag Consumptive Use from Ground Water}] \end{aligned}$$

Adjusted Consumptive Domestic Use

Adjusted Consumptive Domestic Use is an estimate of the consumptive uses from areas within the watershed that are served by private residential ground water wells and are served by septic systems.

Adjusted Consumptive Domestic Use is based on the Highlands estimate of residential well pumpage, when reduced by that portion that may be served by public sewer.

Consumptive Public Supply Use

Consumptive Public Supply Use is based on the Public Potable Supply pumpage for all public potable water facilities in the watershed that get their raw water supplies from ground water. The cumulative (raw) pumpage for these facilities was multiplied by 0.9 to account for the observed impact of maximum month pumping on annual base (stream) flows. The resultant is referred to as Adjusted Public Potable Supply.

To calculate Consumptive Public Supply, the Adjusted Public Potable Supply is reduced by the following amounts:

- Septic Return from Public Supply - This value represents the non-consumptive portion of public supply use that is returned to the watershed through septic systems.
- September Wastewater Return to Surface Water – This value represents the cumulative discharges from wastewater treatment plants, where the discharge is located in the watershed.

Total Non-Ag Consumptive Use from Surface Water

Total Non-Ag Consumptive Surface Water Use is a measure of the cumulative consumptive uses from within the watershed where the source is taken from surface water.

This quantity often includes golf course irrigation.

Other Non-Ag Consumptive Use from Ground Water

Other Non-Ag Consumptive Uses include the following where the source is taken from ground water

- Golf course irrigation (where this use is distinguished from that supplied by surface water)
- Commercial facilities with metered usage (e.g. restaurants, businesses, and other typical non-residential uses)
- Industrial facilities with metered usage (e.g. manufacturing)
- Cooling water with metered usage
- Institutional facilities with metered usage (e.g. hospitals, schools)

Imported Septic Return

Imported Septic Return occurs when an existing area served by public potable water supply, and the same areas are also served by septic systems. In addition, Imported Septic Return only applies when the source of public potable water supply under comes from outside the watershed.

Net Water Availability

In most circumstances, Non-Ag Net Water Availability is referred to as simply Net Water Availability and is distinguished from Ag Net Water Availability.

(Non-Ag) Net Water Availability is the amount of Non-Ag Ground Water Availability remaining after deducting Total Non-Ag Consumptive Uses and adding Imported Septic Return.

Net Water Availability cannot exceed Ground Water Availability, whether it is Ag or Non-Ag.

When the watershed has been designated as a Conservation Zone, Ag Net Water Availability will be calculated.

Surplus for Potential Use

When Imported Septic Return is sufficiently large, the calculation of (Non-Ag) Net Water Availability can exceed Non-Ag Ground Water Availability. In such cases, (Non-Ag) Net Water Availability is set to Non-Ag Ground Water Availability and the remaining portion is allocated under Surplus for Potential Use.

Appendix B – Monitoring Form

Appendix B includes a sample Water Use and Conservation Management Monitoring Form. See “Monitoring” section (pg. A-37) for instructions.

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form

Sparta Township

Year:	2012	Prepared By:	
HUC14:	02040105040050	Title:	
Name:	Sparta Junction tribs	Date:	
Ground Water Availability (mgd):	0.1008		
Baseline Net Water Availability (mgd):	-0.6163		

Diversion / Recharge Inventory							
Owner	Type		No. of Wells / Intakes / Discharges	MGD ¹	Adjusted MGD	Total C/D Water Use (mgd)	Net Water Availability (NWA; mgd)
	Recharge or Withdrawal	GW or SW					
Wells / Intakes						0.8390	-0.7317
Domestic Supply (private wells)	Withdrawal	Ground Water	100	0.1418	0.1277		
Sparta Township	Withdrawal	Ground Water	8	1.2958	1.1662		
Diamond Sand and Gravel	Withdrawal	Ground Water	1	0.0051	0.0046		
Skyview Golf Club	Withdrawal	Ground Water	2	0.0084	0.0075		
Limecrest Quarry Developers/Crest Aggregates	Withdrawal	Ground Water	1	0.0000	0.0000		
Diamond Sand and Gravel	Withdrawal	Ground Water	1	0.0242	0.0217		
P Michelotti & Sons	Withdrawal	Ground Water	1	0.0000	0.0000		
Skyview Golf Club	Withdrawal	Surface Water	1	0.0030	0.0030		
Diamond Sand and Gravel	Withdrawal	Surface Water	1	0.0867	0.0867		
Limecrest Quarry Developers/Crest Aggregates	Withdrawal	Surface Water	3	0.0000	0.0000		
P Michelotti & Sons	Withdrawal	Surface Water	1	0.0000	0.0000		
Wastewater Discharge							
On-site Wastewater Disposal Systems (septic)	Recharge	Ground Water	100	0.3871	0.3937		

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form

Sparta Township

Year:	2012
HUC14:	02040105040050
Name:	Sparta Junction tribs
Ground Water Availability (mgd):	0.1008
Baseline Net Water Availability (mgd):	-0.6163

Prepared By:

Title:

Date:

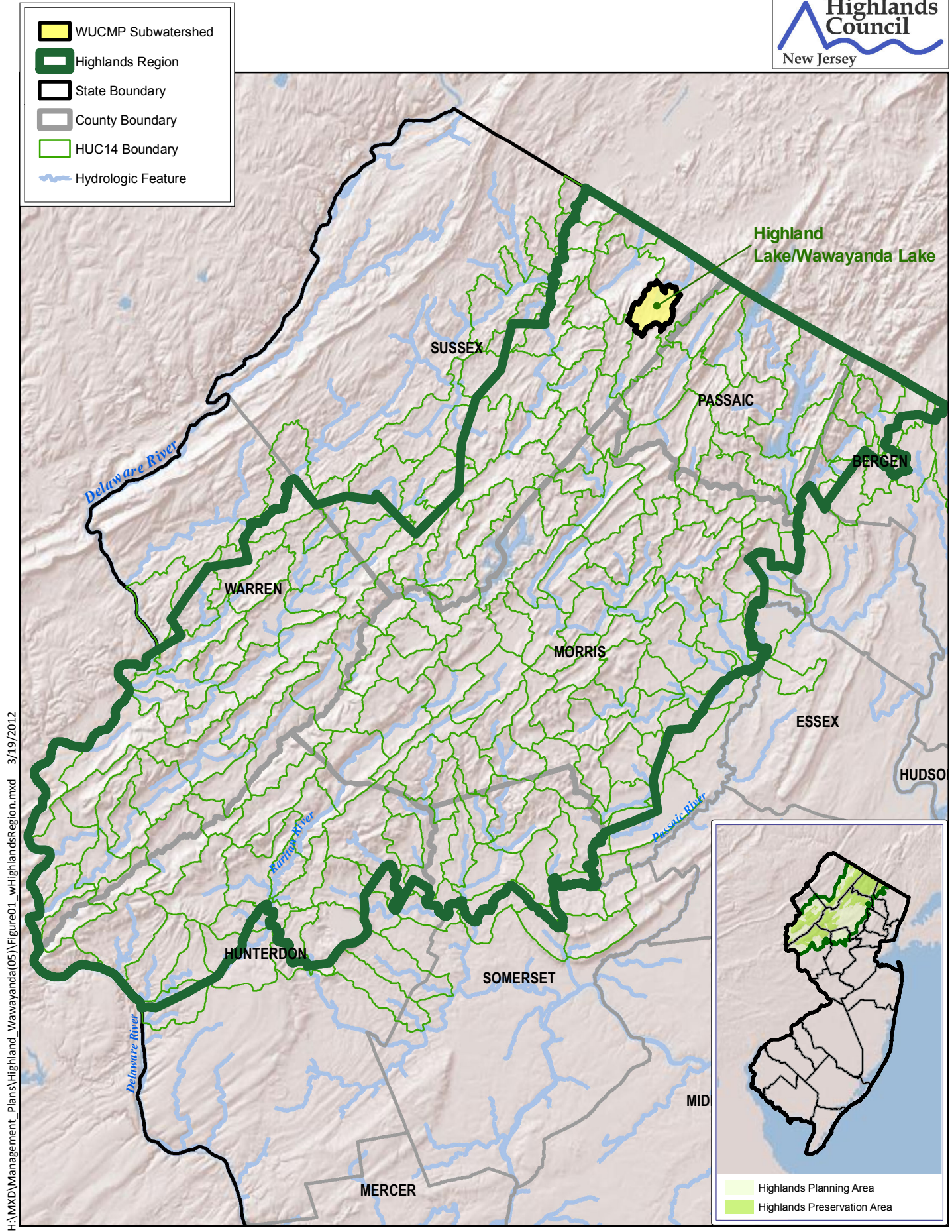
Mitigation Strategies

Owner	Type	Year Installed	Anticipated Benefit (gpd)	Adjustment Required to NWA? ² (Y/N) ²	Revised NWA (mgd)	Planned Mitigation Strategies for Next Year
					-0.7317117	
					-0.7317117	

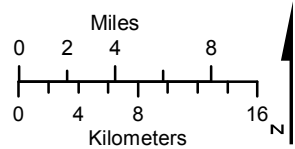
Monitoring Sites

Stream	Gage Location	Year Installed	Collection Frequency	Minimum September Flow of Record (cfs)	Minimum September Flow (cfs)

1. Maximum withdrawal from June, July or August and associated return for groundwater (must be consistent month within HUC). September withdrawal or return for surface water.
2. For mitigation strategies that are not directly related to water use (rate structures, water conservation structures). Stormwater BMPs are an example.
3. Use one table per HUC14.



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HUC14	Subwatershed Name
02020007040040	Highland Lake/Wawayanda Lake

Figure 1
Highlands Region and
WUCMP Location

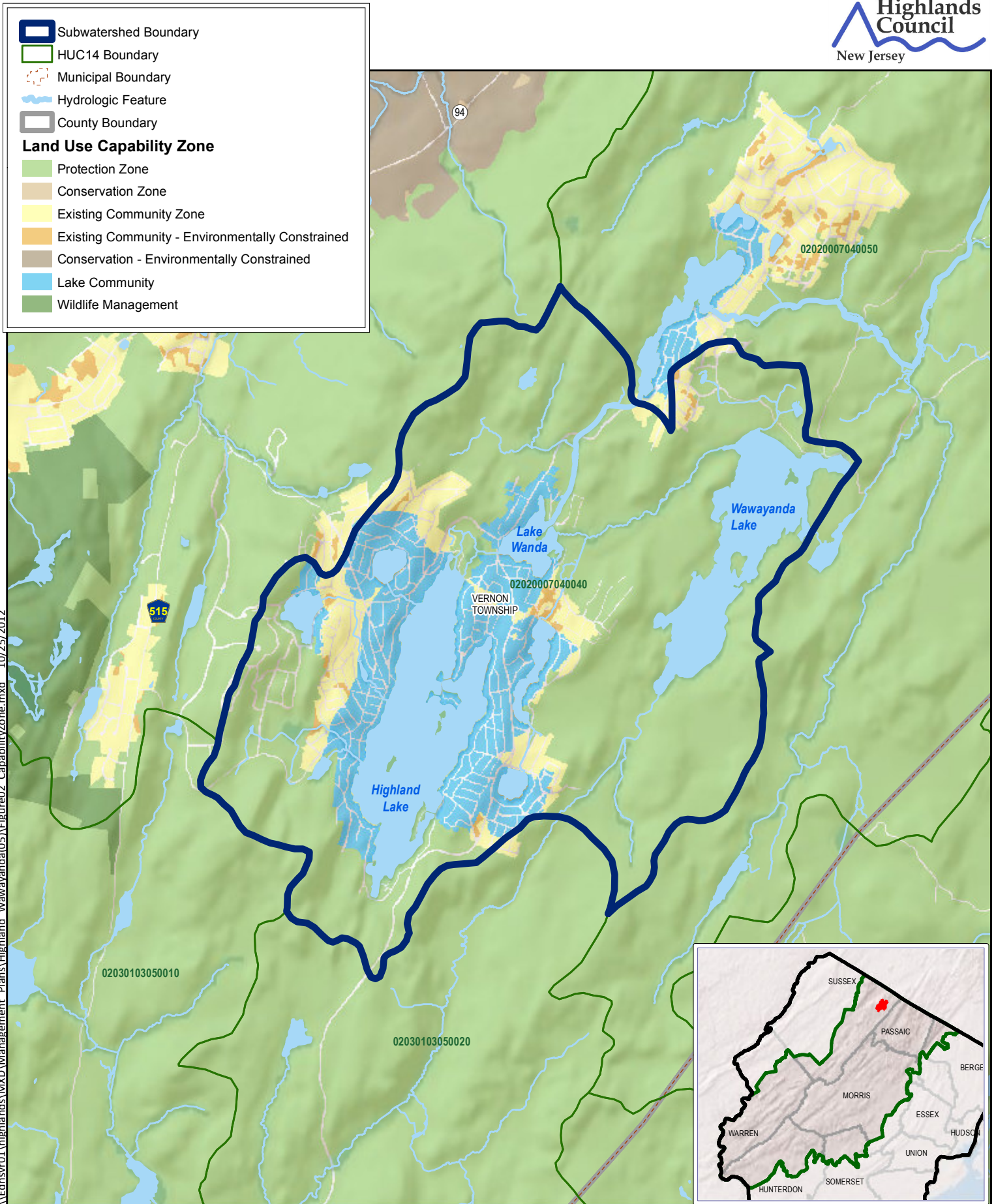


Figure 2
Land Use Capability Zone

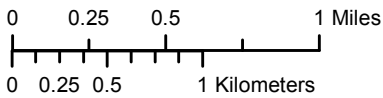
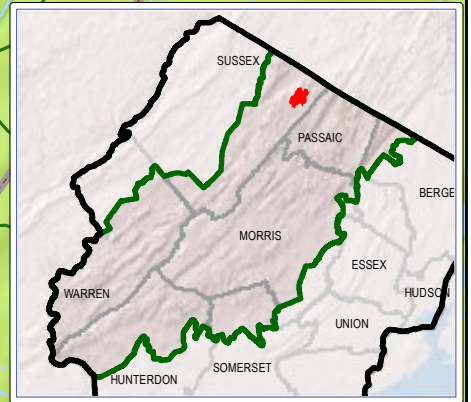
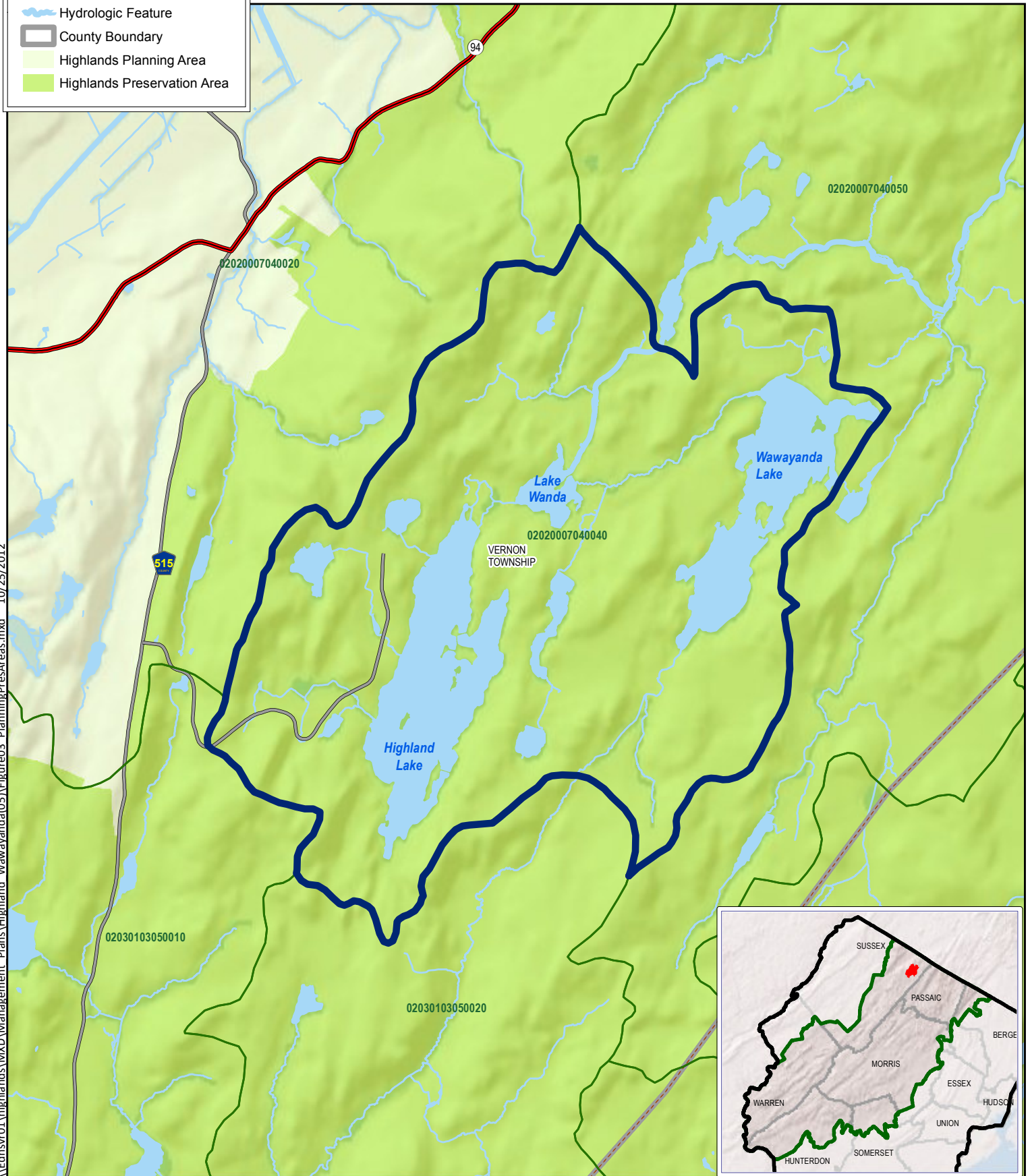
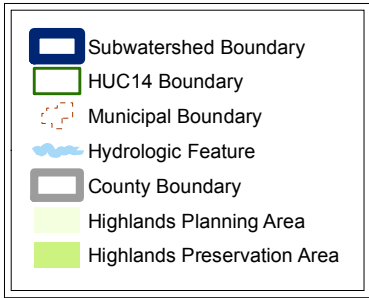










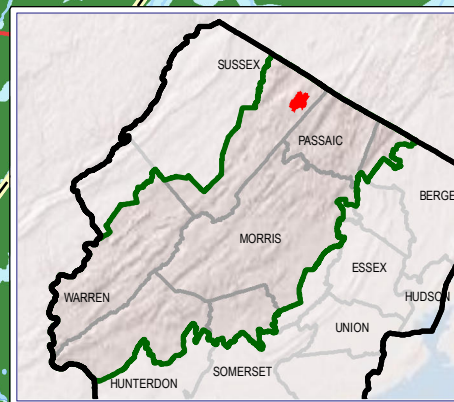
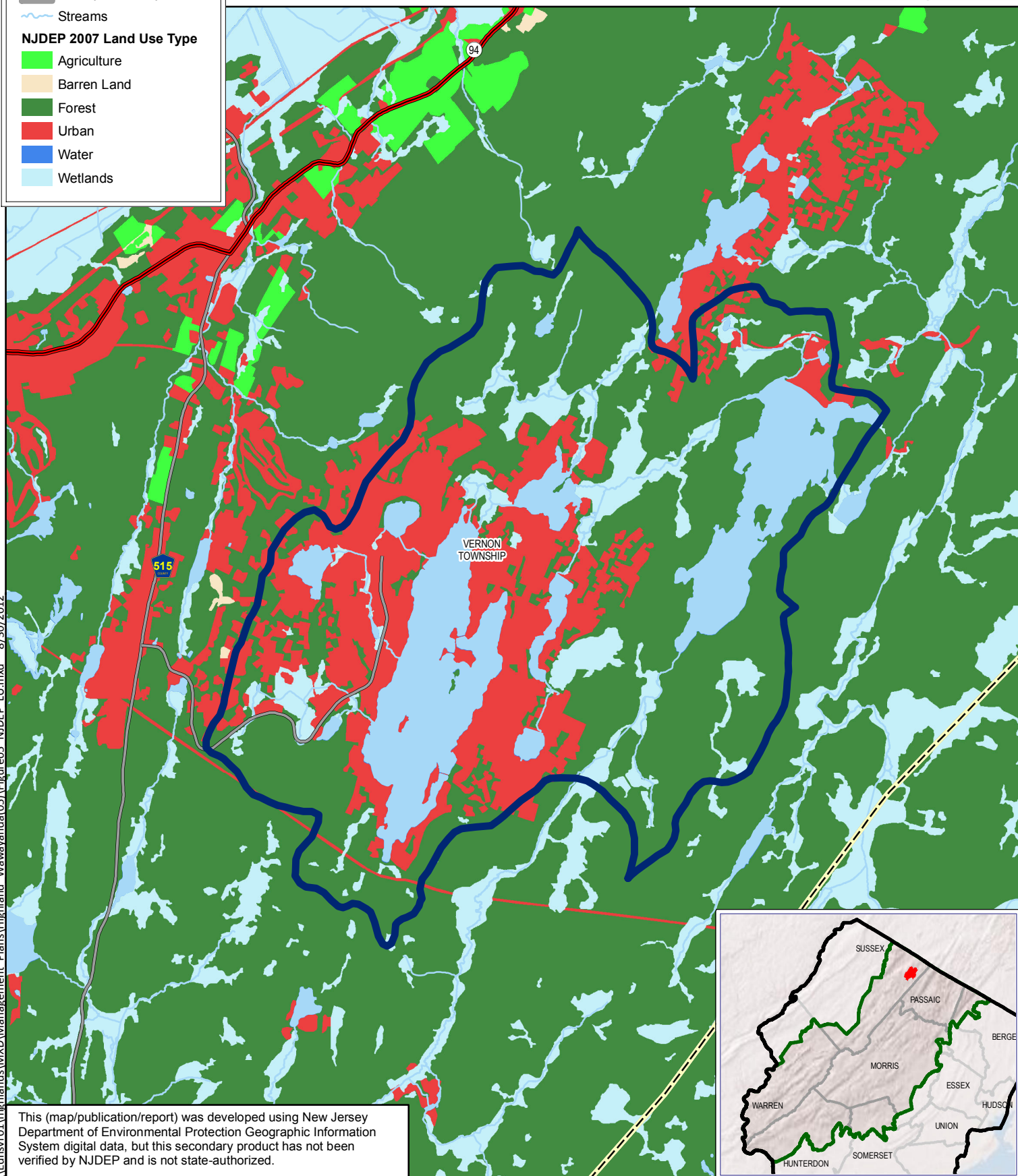


Figure 3
Planning and Preservation Areas

-  Subwatershed Boundary
-  Municipal Boundary
-  County Boundary
-  Streams
- NJDEP 2007 Land Use Type**
-  Agriculture
-  Barren Land
-  Forest
-  Urban
-  Water
-  Wetlands



This (map/publication/report) was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

0 0.25 0.5 1 Miles
0 0.25 0.5 1 Kilometers



Figure (
Land Use

\\Ednsrv01\highlands\MXD\Management Plans\Highland Wawayanda(05)\Figure05 NJDEP LU.mxd 8/30/2012

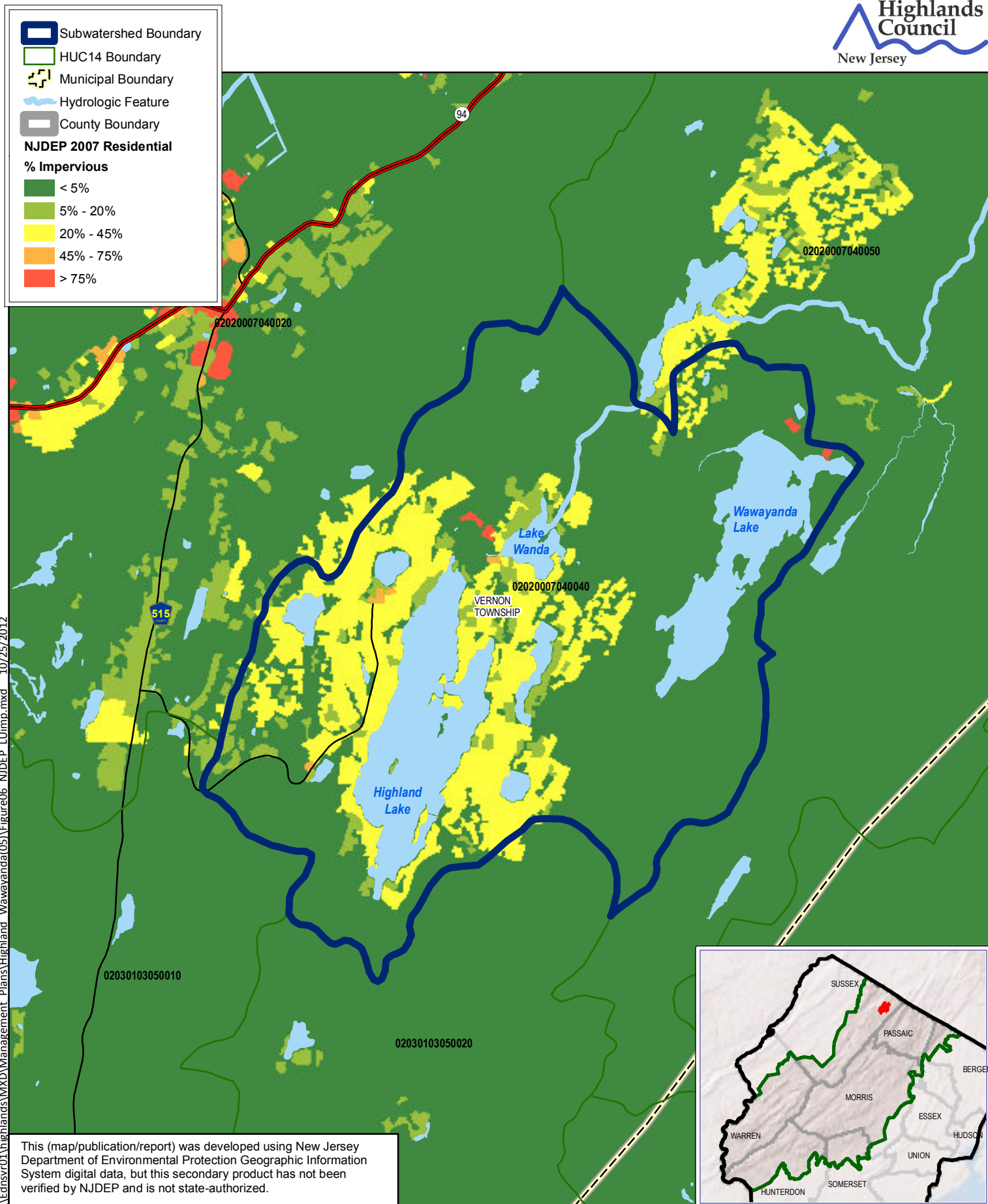




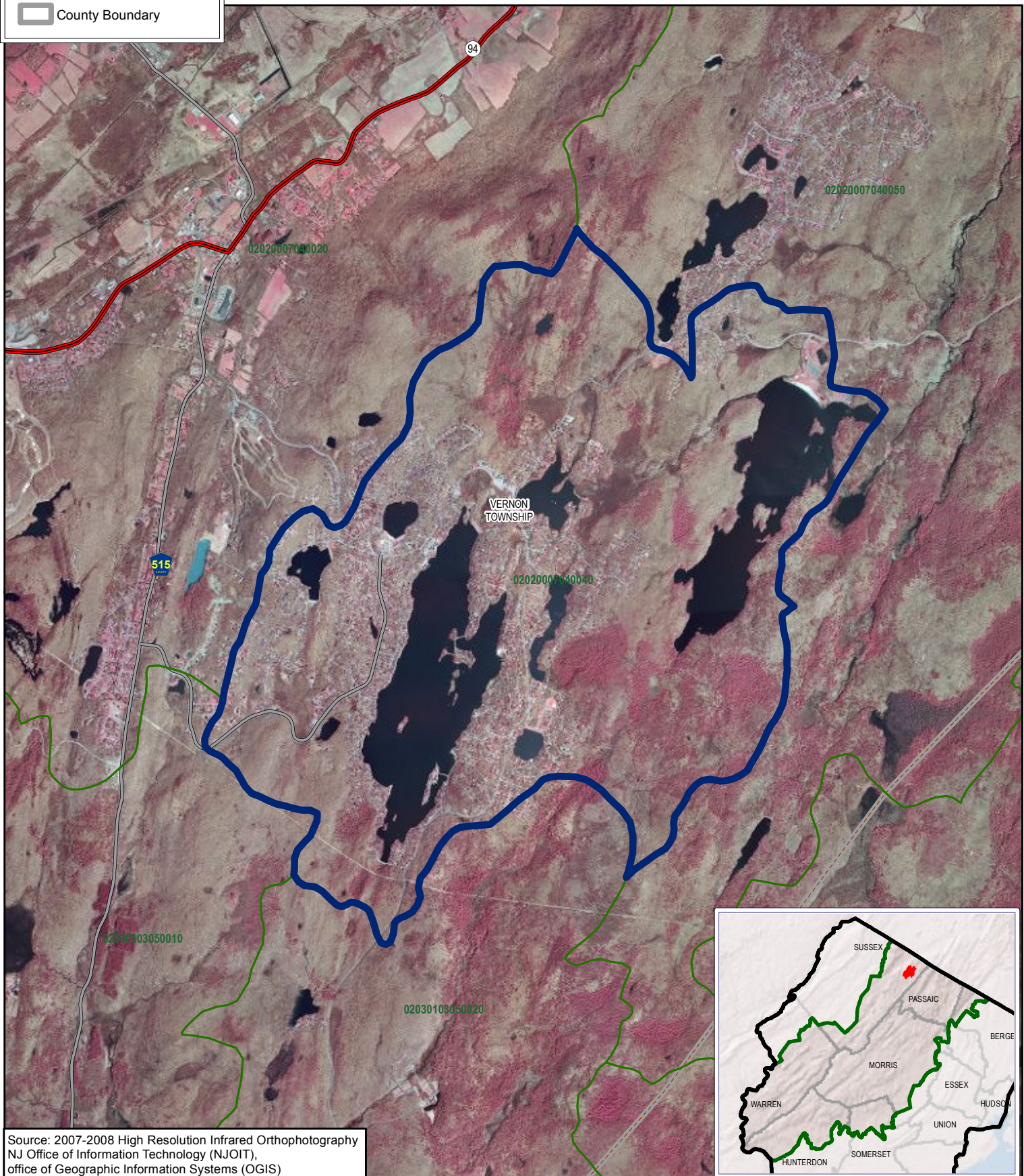


Figure)
Impervious Land Use

-  Subwatershed Boundary
-  HUC14 Boundary
-  Municipal Boundary
-  County Boundary

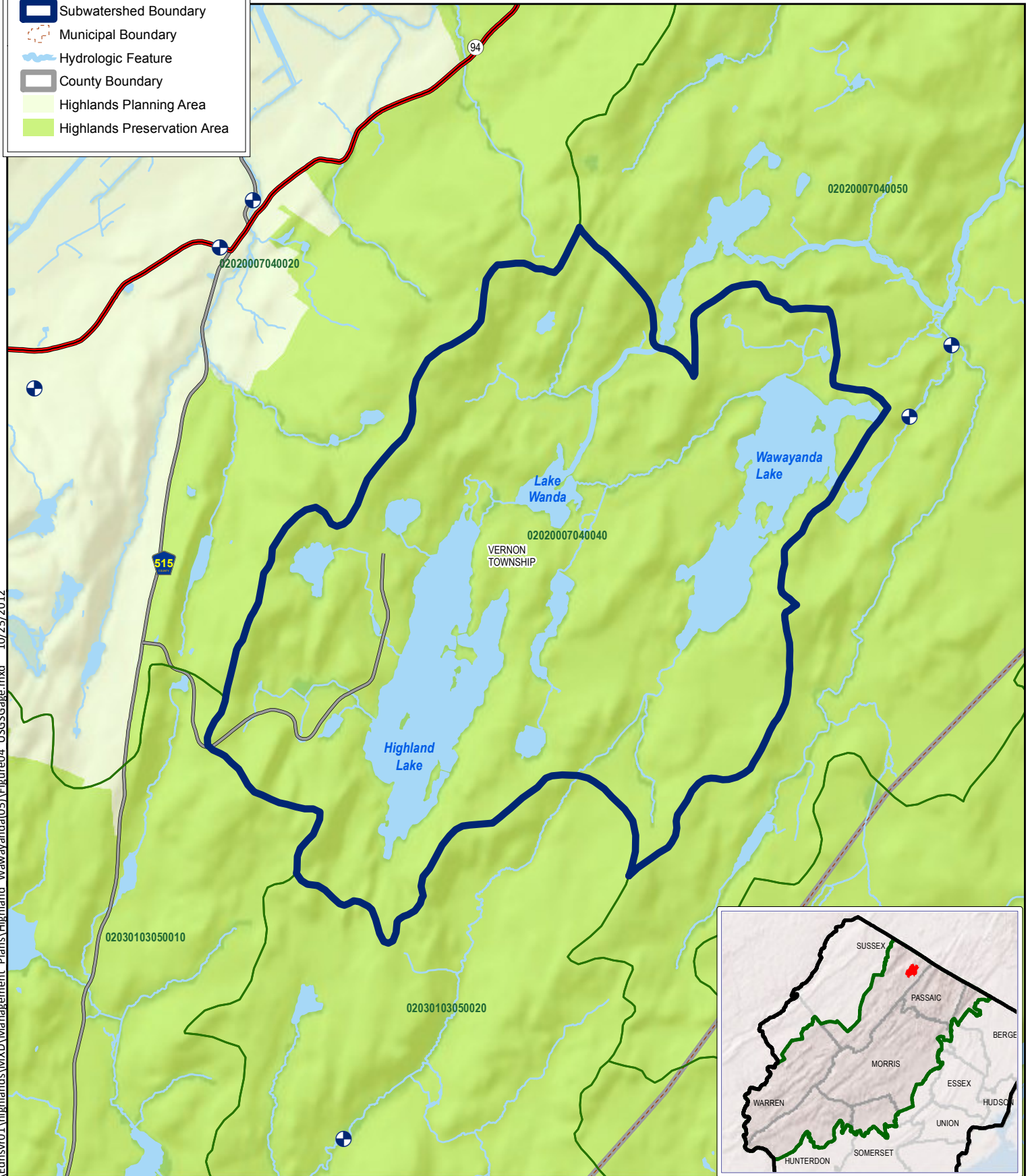
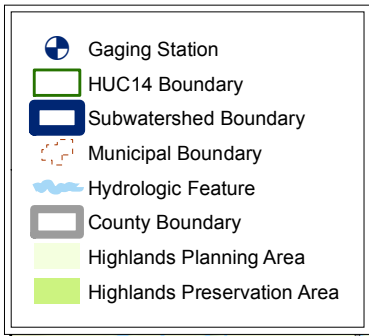


Source: 2007-2008 High Resolution Infrared Orthophotography
NJ Office of Information Technology (NJ OIT),
Office of Geographic Information Systems (OGIS)

0 0.25 0.5 1 Miles
0 0.25 0.5 1 Kilometers



Figure 6
2007-2008 Aerial



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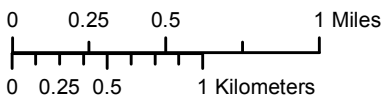


Figure 7
USGS Stream Gage Sites

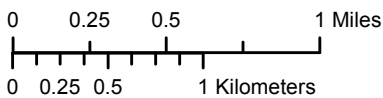
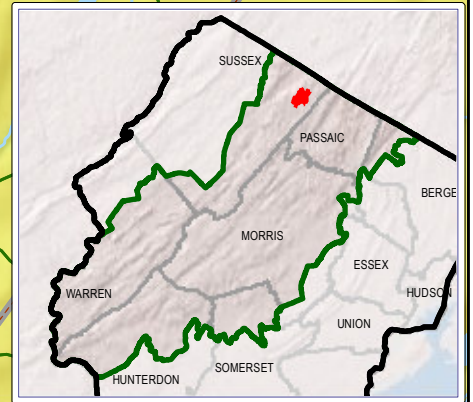
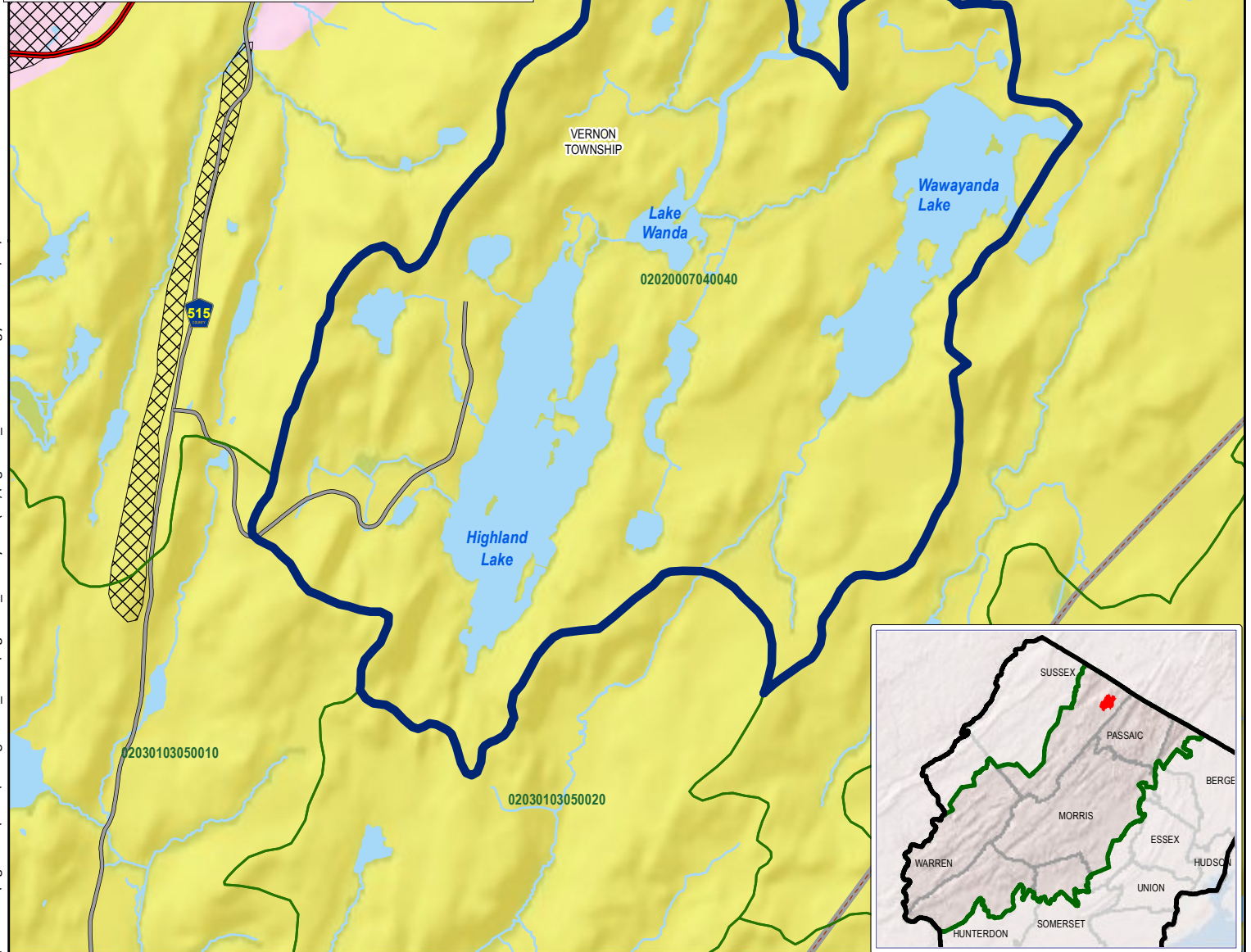
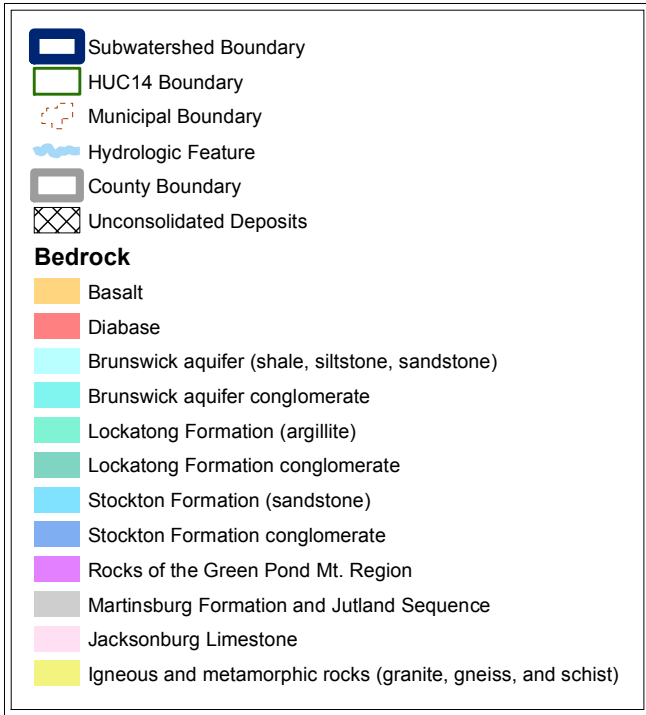


Figure 8
Bedrock Geology

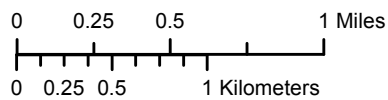
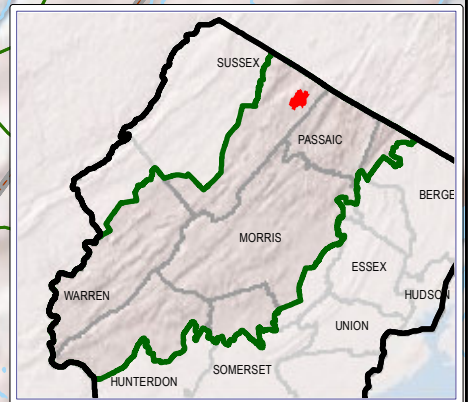
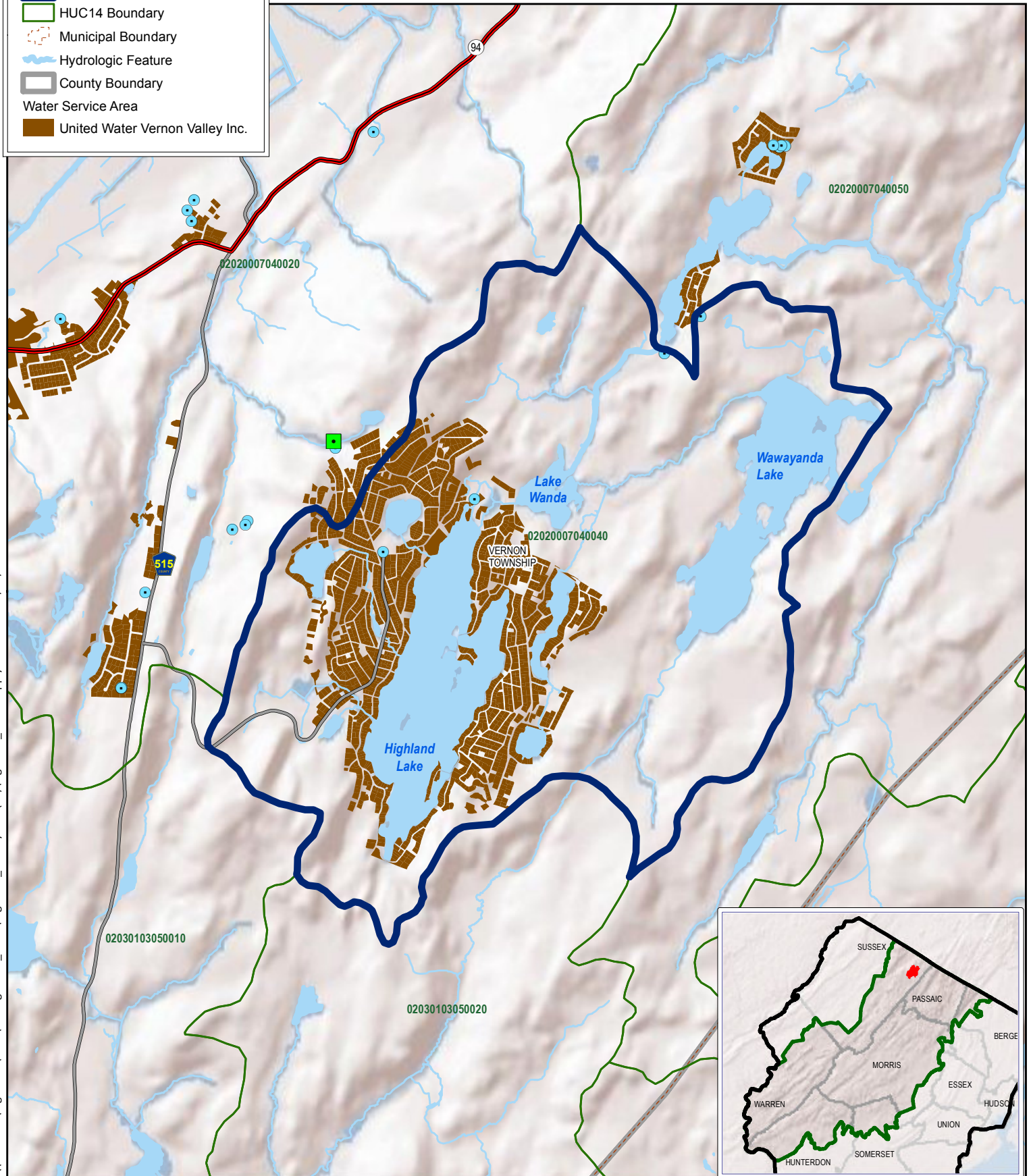
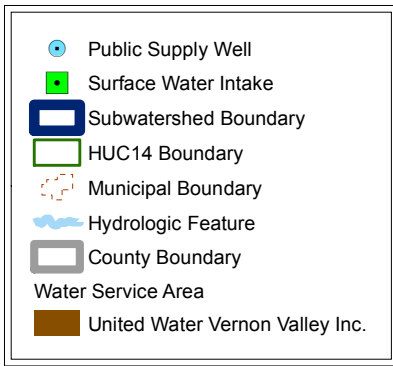


Figure 9
Public Supply Wells, Surface Water Intakes
and Water Service Areas

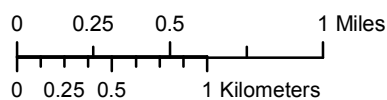
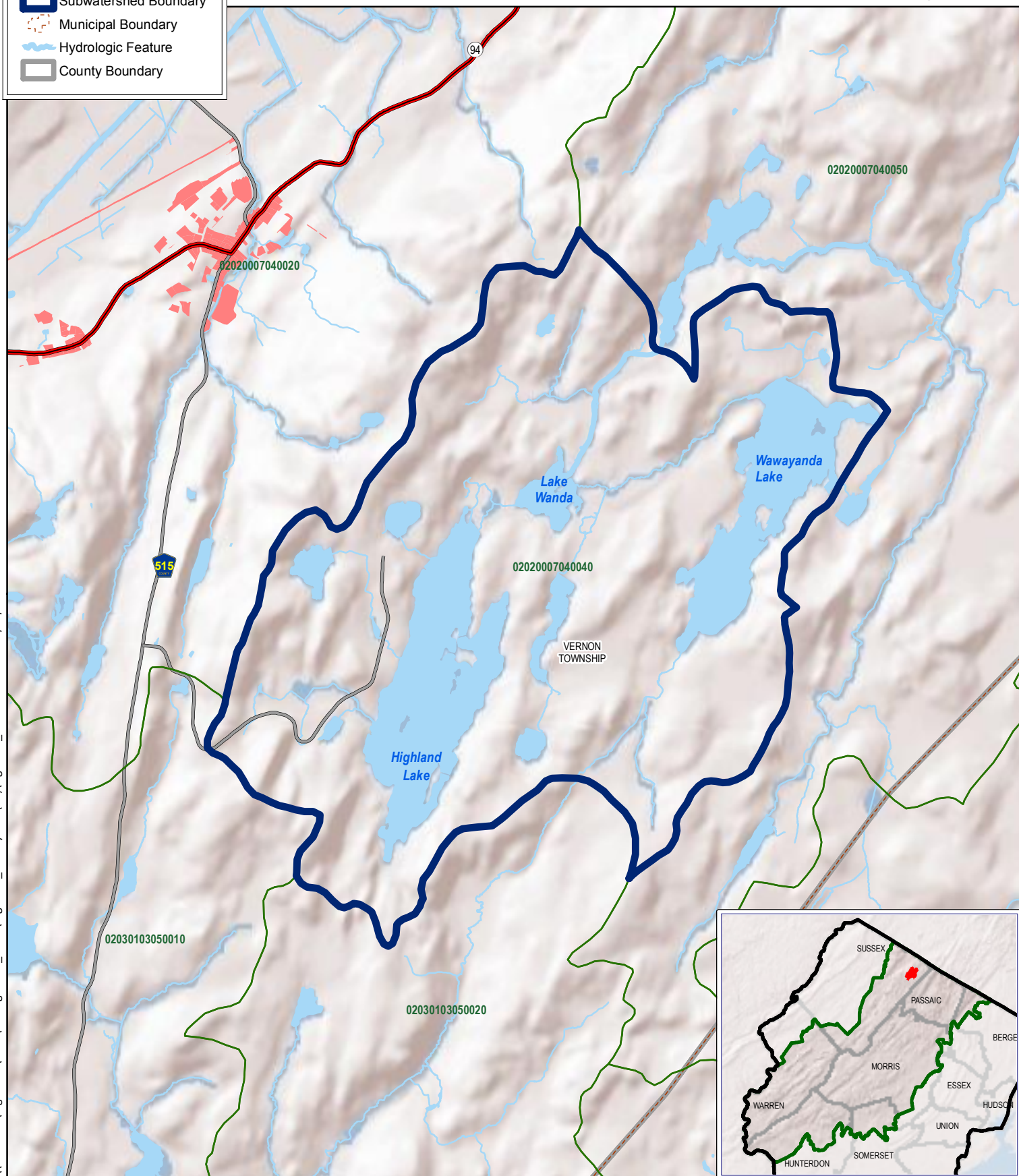
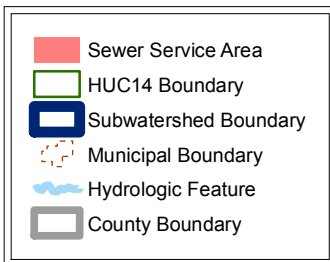


Figure 10
Sewer Service Areas
and NPDES Dischargers