Water Use and Conservation Management Plan for Denville Township

HUC14 02030103030090 Rockaway R (BM 534 brdg to 74d 33m 30s)
HUC14 02030103030120 Den Brook
HUC14 02030103030140 Rockaway R (Stony Brook to BM 534 brdg)

Prepared in Support of the Highlands Regional Master Plan: Water Use and Conservation Management Plan

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WATER USE AND CONSERVATION MANAGEMENT PLAN

for

HIGHLANDS REGIONAL MASTER PLAN CONFORMANCE

Denville Township
MORRIS COUNTY, NEW JERSEY

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Executive Summary

Introduction

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 municipalities throughout the Highlands region have been developing Water Use and Conservation Management Plans (WUCMPs) to conserve water within the 183 subwatersheds within the Highlands Region.

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 2000-2018 and has several refinements to the NWA computations.
- **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) have been identified.
- **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.

Municipal-based WUCMPs 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. In the case of Denville Township, the WUCMP includes three subwatersheds.

Summary

This WUCMP area covers the following HUC14 subwatersheds:

- 02030103030090: Rockaway River (BM 534 brdg to 74d 33m)
- 02030103030120: Den Brook
- 02030103030140: Rockaway River (Stony Brook to BM 534 brdg)

Although a total of nine HUC14 subwatersheds intersect Denville Township, the Township only has a significant portion of water withdrawals within these three subwatersheds. However, Denville Township is not solely responsible for mitigating deficits as surrounding municipalities also contribute.

Major water service providers included in planning area include:

- Town of Boonton Water Department
- Denville Township Water Department
- Mountain Lakes Water Department
- Rockaway Township Municipal Utility

Net Water Availability

The analysis of net water availability (NWA) for this planning area indicates the following variation in NWA between 2000 and 2018. All three HUC14s are in deficit at least for one year during the period although HUC14 02030103030120 has been in surplus since 2003.

Summary of Variation in Net Water Availability: 2000 - 2018

HUC	NWA Minimum (MGD)	NWA Maximum (MGD)	Published NWA (MGD) [1]
HUC14 02030103030090: Rockaway River (BM 534 brdg to 74d 33m)	-1.8195	-0.96	-0.9455
HUC14 02030103030120: Den Brook	-0.7446[2]	0.2724	0.0754
HUC14 02030103030140: Rockaway River (Stony Brook to BM 534 brdg)	-1.8981	-0.7765[3] / -1.2899	-2.0851

1. As published in the Highlands Regional Master Plan
2. Represents 2001. The years 2000-2002 are anomalous due to public community supply withdrawal from Denville Township (permit ID: 2500009808).
3. Represents the year 2000, which is an outlier within the time period.

Water Conservation and Deficit Reduction and Elimination Strategies

The following preliminary strategies have been identified for this planning area. These strategies are not prescriptive but serve as initial recommendations. Alternative strategies may be considered but should suit the needs and goals of this or future revisions of the WUCMP.

- Golf Course Water Use - develop best practices and implement strategic water use reducing measures.

- Irrigation (and Water) Conservation Programs – implement community outreach and educational programs in schools to promote water conservation.
- Leak Detection and Repair – implement programs to identify water system leaks and eliminate them.
- Water Bill Structure/Comparison – highlight historical use patterns for residential customers.
- Rate Structure – develop water utility rate structures that promote water conservation.

It should be noted that the Net Water Availability deficit in the HUC14 02030103030140 is large and measures listed above will not result in a complete elimination of the deficit. The deficit is due to significant withdrawals by Denville Township, Boonton Township and Mountain Lakes. The upstream HUC14 02030103030120 is in surplus of approximately 0.2 MGD. Shifting supply withdrawals to that HUC14 would help, but it would represent a costly solution for 0.2 MGD. Conservation measures should be implemented as a first step to alleviate the deficit in HUC14 02030103030140.

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 should be conducted to determine its effectiveness, and a more detailed review every five (5) years 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. Establishing an implementation plan is critical to the WUCMP's success. Although elimination of any deficits does not have a specific timeline, progressing towards deficit reduction is the intent of this WUCMP and the Highlands Council of New Jersey will ask for a periodic review of the implementation of this Plan (on the order of 5 years).

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 groundwater 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 (WUCMPs) specific to municipalities is intended to address the requirements of this objective in a practical way that is applicable to each municipality.

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 (NWA) for each HUC14 subwatershed.[2] 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 Plan updates the calculations of Net Water Availability within Denville Township and offers recommended strategies to help alleviate any deficits that exist.

Water Use and Conservation Management Plan (WUCMP) Goals and Policy Overview

Net Water Availability is total available groundwater minus consumptive and depletive water uses. NWA 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:

[1] Highlands Regional Master Plan, (Highlands Council, 2008), p. 159.
[2] Highlands Regional Master Plan, (Highlands Council, 2008), p. 160, Policy 2B2.

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:

- 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:

- **Identification of water sources and uses** – Denville Township uses groundwater for potable water supply as well as irrigation (including agricultural). Surface water withdrawals are reported for agricultural and golf course irrigation although the golf irrigation may be from a groundwater fed pond.
- **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 2000-2018.
- **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

There are nine HUC14 subwatersheds that intersect Denville Township (Denville), although the Township has a significant impact to NWA in only three of these nine HUC14s. Therefore, the focus of this WUCMP is within the following HUC14s (**Figure 1**):

- 02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)
- 02030103030120: Den Brook
- 02030103030140: Rockaway River (Stony Brook to BM 534 brdg)

Denville has a direct influence on NWA in that one or more major supply wells are located both within the municipal boundary of Denville Township and within the focused HUC14s. Denville also owns and operates a wellfield in Randolph Township. Other surrounding HUC14s have withdrawals from adjacent municipalities that are more significant than simply domestic pumping so management of the water resource within those HUC14s would likely be the responsibility of those neighboring municipalities.

The six other HUC14s that intersect Denville Township do not have any significant water withdrawals within Denville and only a relatively small area of those HUC14s exist within Denville's municipal boundaries. Therefore, Denville Township would have a very minimal impact to the NWA of those HUC14s[3]. However, that's not to say that water use and conservation does not apply within those HUC14s, but that the only applicable conservation measures would be limited to domestic supply (low flow fixtures and/or irrigation limitations, for example) within Denville Township. These HUC14s have most of their area and water withdrawals outside of the Denville Township in surrounding municipalities (Boonton Township, Mountain Lakes Borough, Parsippany-Troy Hills, Randolph Township, Rockaway Township and Borough and Morris Township). Denville Township is responsible for managing only their portion of the water resources within the HUC14s, which is addressed herein.

[3] For more details refer to Technical Memo "Revised Net Water Availability for Denville Township: Initial Results & Assumptions, February 2019.

WUCMP Area Characteristics

Background

Denville Township is in Morris County, New Jersey. It covers an area of 12.56 square miles and has a population of approximately 16,735 people (2016 estimate). The area included in this WUCMP consists of three subwatersheds designated by Hydrologic Unit Code (HUC14) as follows:

- 02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)
- 02030103030120: Den Brook
- 02030103030140: Rockaway River (Stony Brook to BM 534 brdg)

The land use within Denville Township is mostly urban but includes a large amount of forested land and small areas of agricultural land.

Land Use Capability/Land Cover

Land Use Capability Zones

The Highlands Region is classified into three Land Use Capability Zones, of which Denville Township has area within two:

- **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.
    - Denville has approximately 1,377 acres within the Protection Zone (approx. 18.8% of the total area of the township).
- **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 three sub-zones: Existing Community, Existing Community Environmentally-Constrained, and Lake Community.
    - Denville has approximately 5,952 acres within the Existing Community Zone (approx. 81.2% of the total area of the township).
- **Conservation Zone** - Areas that have significant agriculture along with wooded and environmental areas which should be preserved to the extent possible. This zone has one sub-zone, Conservation Environmentally-Constrained. Conservation Environmentally-Constrained areas have significant environmental features that should be preserved and protected from non-agricultural development.
    - Denville has no area within the Conservation Zone.

Figure 2 shows the Land Use Capability Zone map for Denville Township.

Preservation and Planning Areas

In addition to Land Use Capability Zones, the Highlands Region is also subdivided into Preservation and Planning Areas. Preservation Areas are critical to water resource protection. A summary of the goals for both the Preservation and Planning Areas is shown in **Table 1**. The Township is to 99% within the Highlands Planning Area. Only a very small area of approximately 5.5 acres is within the Highlands Preservation Area, along the northwest township boundary. **Figure 3** shows the delineation of the Planning and Preservation Areas in the vicinity of this WUCMP.

Table 1 - Region-wide goals for the Preservation and Planning Areas (from Highlands Council, 2008)

Goals Specific to Preservation Area	Goals Specific to Planning Area
Preserve extensive and, to the maximum extent possible, contiguous areas of land in its natural state, thereby ensuring the continuation of Highlands environment which contains the unique and significant natural, scenic, and other resources representative of the Highlands Region	Preserve to the maximum extent possible any environmentally sensitive lands and other lands needed for recreation and conservation purposes
Protect the natural, scenic, and other resources of the Highlands Region, including, but not limited to, contiguous forests, wetlands, vegetated stream corridors, steep slopes, and critical habitat for fauna and flora	Protect and maintain the essential character of the Highlands environment
Promote compatible agricultural, horticultural, recreational, and cultural uses and opportunities within the framework of protecting the Highlands environment	Promote the continuation and expansion of agricultural, horticultural, recreational, and cultural uses and opportunities
Prohibit or limit, to the maximum extent possible, construction or development which is incompatible with preservation of this unique area	Encourage, consistent with the State Development and Redevelopment Plan and smart growth strategies and principles, appropriate patterns of compatible residential, commercial, and industrial development, redevelopment, and economic growth, in or adjacent to areas already utilized for such purposes; discourage piecemeal, scattered, and inappropriate development, in order to accommodate local and regional growth and economic development in an orderly way while protecting the Highlands environment from the individual and cumulative adverse impacts thereof
	Promote a sound, balanced transportation system that is consistent with smart growth strategies and principles and which preserves mobility in the Highlands Region

Land Use/Zoning

Land use/land cover data representing 2015 conditions are obtained from the New Jersey Department of Environmental Protection (NJDEP). Based on 2015 conditions, the land use / land cover within the Township is primarily comprised of urban (61%), forest land (27%), wetlands (7%) and water (4%). **Figure 4** depicts the land use types within the Township. The Township includes a golf courses and farm that contribute to the consumptive uses described in a subsequent section.

NJDEP 2012 impervious surface data are shown on **Figure 5**. Township wide, there is approximately 8% impervious cover (water and wetlands are excluded). Impervious cover is 9% (HUC14 02030103030090), 7% (HUC14 02030103030120) and 4% (HUC14 02030103030140) respectively for the three (3) subwatersheds that intersect Denville Township and are part of the WUCMP area (excluding water and wetlands).

Major Hydrologic Features

The study area includes several surface water bodies (**Figure 6**). In total Denville has 11 named bodies of water within the Township limits. There are four major residential lake communities: Cedar Lake, Indian Lake, Rock Ridge and Arrowhead Lake. Another important hydrologic feature within the study area is the Rockaway River, a major tributary to the Passaic River that runs through the northern part of the Township. The Passaic is a major river joining the Hackensack River at the northern end of Newark Bay. Smaller tributaries to the Rockaway River are also present (for example Beaver Brook) as are other smaller streams and creeks (for example Den Brook, Silver Brook). Two active USGS stream gauges that measures streamflow along the Rockaway River is located within the study area (USGS Gage 1379845 and 1380100).

Geology and Soil Properties

Denville Township is located within the Highlands Physiographic Province, which consists of igneous and metamorphic rocks in a series of ridges and valleys including Jacksonburg Limestone. The Highlands Physiographic Province is separated from the neighboring Piedmont Province by crystalline rocks that are in contact with significantly younger sedimentary and igneous rocks. (**Figure 7**). Overlying the bedrock are surficial glacially deposited sediments such as glaciofluvial terraces, which are comprised of sand and gravel. Denville community water supply wells are screened within these deposits.

Soils within the area are shown on **Figure 8**. Approximately 66% of the Township consists of ten different soil types shown in **Table 2**. The majority of the soils are classified as being within hydrologic group B, which are generally comprised of 10 to 20% clay and a saturated hydraulic conductivity of 1.42 to 5.67 inches per hour[4]. Soils within the C and D group are less permeable with saturated hydraulic conductivities of 0.14 to 1.42 inches per hour and less than or equal to 0.14 inches per hour, respectively. In general, the majority of the soil drains well within the Township.

[4] United States Department of Agricultural (USDA), Natural Resources Conservation Service (NRCS). 2007. Part 630 Hydrology National Engineering Handbook, Chapter 7: Hydrologic Soil Groups.

Table 2 - Primary Soil Types within Denville Township

Soil Symbol	Description	Percent of Township	Hydrologic Group
RobCb	Rockaway sandy loam, 8 to 15 percent slopes, very stony	12%	C
PauCc	Parker-Gladstone complex, 0 to 15 percent slopes, extremely stony	11%	B
PauDc	Parker-Gladstone complex, 15 to 25 percent slopes, extremely stony	8%	B
RksB	Riverhead gravelly sandy loam, 3 to 8 percent slopes	6%	B
NerC	Netcong gravelly sandy loam, 8 to 15 percent slopes	6%	A
NerB	Netcong gravelly sandy loam, 3 to 8 percent slopes	5%	A
RkgBc	Ridgebury stony loam, New Jersey Highlands, 0 to 8 percent slopes, extremely stony	5%	D
RobDc	Rockaway sandy loam, 15 to 25 percent slopes, extremely stony	4%	C
HcuAt	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	3%	B/D
USROCC	Urban land-Rockaway complex, 3 to 15 percent slopes	3%	C

Identification of Water Sources and Uses

Water System Profile

Description

Denville Township's potable supply is from five community water supply wells owned and operated by the Denville Township Water Department. Public supply wells from two other service providers exist within the WUCMP area (the Boonton Town Water Department and the Mountain Lakes Water Department), but service areas of both providers are outside Denville Township boundaries. In addition to the community supply wells owned and operated by Denville, the Denville Water Department purchases water directly from Morris County Municipal Utilities Authority (MUA) which serves the south side of the township. The source of the MUA water is also groundwater, although it originates outside of the township. Homes and businesses outside of the public water service areas are served by privately owned (domestic, or non-community) groundwater wells.

In addition to the water systems mentioned above, groundwater and surface water withdrawals for golf course irrigation and groundwater withdrawals for irrigation related to agricultural land and commercial properties are also present in the Township.

Facilities

Community public water supply wells for all three water systems mentioned above are shown on **Figure 9** along with the existing areas served, as obtained from the New Jersey Highlands Council.

Service Areas

The service area within the Denville Township is:

- Denville Township Water Department – serves the population within Denville Township, but also serves a small area within the South of Boonton Township. Only a very small portion of the service area exists within HUC14 02030103030090.

Service areas adjacent to the study area and outside of the Denville Township boundary are:

- Mountain Lakes Water Department – a small portion of this distribution system extends within HUC14 02030103030140. Public supply wells operated by this service provider are located within the Denville Township.
- Boonton Town Water Department - a portion of this distribution system extends within HUC14 02030103030140.
- Randolph Township Water Department - a large portion of this distribution system extends within HUC14 02030103030120, but no public supply wells operated by this provider are located within Denville nor the HUC14.
- Rockaway Borough Water Department - a small portion of this distribution system extends within HUC14 02030103030140, but largely within HUC14 02030103030090.

- Rockaway Township Water Department – largely within HUC14 02030103030090.
- Parsippany-Troy Hills Water Department - a small portion of this distribution system extends within HUC14 02030103030120
- Dover Water Department – This system is within HUC14 02030103030090.

These service areas can be seen in **Figure 9**.

Allocation and Firm Capacity

Allocation and capacity information for existing public groundwater wells within Denville Township is shown in **Table 3.** 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 or intakes. There may be wells or intakes outside of the particular HUC14 or WUCMP area that are included within the water system, and thus the allocation and firm capacity. The Boonton Water Department does not have supply wells directly in Denville Township but within the Denville Water Department Service Area and has been included in the table below. It should be noted that Denville's permitted allocation includes purchased water from Morris County MUA.

Table 3 – Capacity Information for Public Groundwater Wells in HUC14 02030103030140[5]

PWSID	Firm Capacity	Allocation		Peak Demand			Remaining Firm Capacity
	Daily (MGD)	Monthly Limit (MGM)	Yearly Limit (MGY)	Daily (MGD)	Monthly (MGM)	Yearly (MGY)	Daily (MGD)
Denville Township Water Department							
1408001	4.456	101.800	924.000	2.824	86.802	816.226	1.632
Mountain Lakes Water Department							
1425001	1.076	30.000	285.000	0.991	28.304	231.767	0.085
Boonton Town Water Department							
1401001	3.348	61.700	575.000	1.651	48.530	320.135	1.697
1401002	0.300	9.000	108.000	0.091	2.739	23.794	0.209

[5] Reference: https://www.state.nj.us/cgi-bin/dep/watersupply/pwsproc.pl (last updated as of 12/17/2019)

Remaining Capacity

If remaining firm capacity is listed as a negative number, then a water supply deficit exists for that water system. All data provided in **Table 3** and below is as of December 17, 2019 as accessed through NJDEP's Division of Water Supply and Geoscience.

Denville Township Water Department

The total peak daily demand for this system was 2.824 MGD which occurred in August 2015.

The Remaining Firm Capacity of this system is 1.632 MGD.

Mountain Lakes Water Department

The total peak daily demand for this system was 0.991 MGD which occurred in August 2015.

The Remaining Firm Capacity of this system is 0.085 MGD.

Boonton Water Department

The total peak daily demand for these systems was 1.651 MGD and 0.091 MGD, respectively, which occurred in September 2015.

The Remaining Firm Capacity of these systems is 1.697 MGD and 0.209 MGD, respectively.

Wastewater Management

Description

Much of the Denville Township is served by public sewer through the Rockaway Valley Regional Sewerage Authority (RVSRA). There are also a few parcels within the study area which are not served by public water but are served by RVSRA. A small portion in the southeast of Denville is served by the Parsippany-Troy Hills Sanitary Sewer Authority. Both utilities discharge treated sanitary effluent to the Rockaway River, well outside the Township. Therefore, groundwater withdrawals that serve the sewer customer base within Denville are considered depletive.

The Sewer Service Area is shown in **Figure 10**. The remaining areas within the WUCMP area are served by individual subsurface sewage disposal (septic systems).

Facilities

There are no treated sanitary effluent dischargers within the Denville Township. As mentioned above, both utilities (RVSRA and Parsippany-Troy Hills Sanitary Sewer Authority) discharge treated sanitary effluent to the Rockaway River, outside of the study area.

Only one discharger (Sunoco) discharged small return flows of generally less than 0.0004 MGD into surface waters during the years 2000-2010, with no reported returns thereafter. This discharger is no longer active.

Stakeholders

Potential Stakeholders within the HUC14 include the following:

- Municipal governments and water utilities of Denville, Boonton, Mountain Lakes and Randolph Township.
- Residents of Denville Township
- Rockaway Valley Regional Sewerage Authority, Parsippany-Troy Hills Sewer Authority; and
- Other commercial and agricultural users, such as Independence Plating Corp. and Hamilton Farms.
- Rockaway River Country Club (Country Club and Golf course facility)

The stakeholders presented above represent the current main water users within the Township, for which reported user/ withdrawal information exists. However, Denville Township is responsible for including any additional stakeholders and inform all stakeholders of the plan and ways in which each of them can conserve water.

Analysis of Net Water Availability

Introduction

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

On a municipal basis, Net Water Availability is calculated for subwatersheds that are either entirely within the municipality where the municipality has significant (non-domestic) withdrawals in a portion of the subwatershed. For subwatersheds that are within a particular municipality that only has domestic water withdrawals, but another municipality has more significant withdrawals (public supply wells, for example), the onus of Net Water Availability will be assigned to the municipality with the more significant withdrawals. For subwatersheds that intersect Denville Township and have significant withdrawals from adjacent municipalities, the only impact to NWA are from domestic withdrawals and public supply (Mountain Lakes and Boonton Water Department).

Net Water Availability has been calculated for HUC14s intersecting Denville from 2000 through 2018 and results are documented within this chapter.

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 has been 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. The 7Q10 has been used throughout the industry to quantify passing flow requirements and 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.[6]

Low Flow Margin is used to calculate Groundwater Capacity, or the natural ability of the watershed to support base flow. Groundwater 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.

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[6] Highlands Council Technical Report, Water Resources Volume II Water Use and Availability" (Highlands Council, 2008), p. 46.

Groundwater 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.

Groundwater Availability

Groundwater Availability is that portion of Groundwater Capacity that is available for human uses, absent other constraints[7]. The following threshold values were established by the Highlands Council (**Table 4**):

Table 4 - Groundwater Availability Thresholds as Percentage of Groundwater Capacity

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

The subwatersheds addressed by this WUCMP are within the Existing Community Zone, so according to the rules established in the Highlands RMP and Technical Report Vol. II, Groundwater Capacity is multiplied by 20% to arrive at Groundwater Availability. Low Flow Margins, Groundwater Capacity and Groundwater Availability for the three (3) subwatersheds covering Denville are presented below in **Table 5**.

Table 5 - Low Flow Margin, Groundwater Capacity and Availability

HUC14 Description	Low Flow Margin (MGD)	Groundwater Capacity (MGD)	Groundwater Availability (MGD)
02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)	1.0598	1.081	0.2162
02030103030120: Den Brook	1.48	1.51	0.3015
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	0.82	0.84	0.1671

Net Water Availability

Calculation of Net Water Availability

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

[7] Highlands Council Technical Report, Water Resources Volume II Water Use and Availability" (Highlands Council, 2008), p. 121.

NWA was originally calculated using maximum water withdrawals from 2003, which represented the most recently available compiled and checked data for use in the RMP. The NWA values for the subwatersheds in the Highlands Council Technical Report Water Resources Volume II Water Use and Availability (2008) for this WUCMP area are presented below in **Table 6**.

Table 6 - Published Net Water Availability (Highlands Regional Master Plan, 2008)

HUC14 Description	Net Water Availability (MGD)
02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)	-0.9455
02030103030120: Den Brook;	0.0754
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	-2.0851

It should be noted that for HUC14s in surplus that are upstream of HUC14s in deficit, the RMP assigns an additional constraint to ensure flow to the downstream HUC14 in deficit. That constraint is to allow for existing consumptive and depletive uses[8] plus 5% of the Low Flow Margin (but to remain within groundwater availability). It should be noted that the original NWA value for HUC14 02030103030120 in the RMP is based on an additional upstream flow restriction. Without the additional restriction, the NWA of HUC14 02030103030120 would increase to 0.2741 MGD, or an additional 198,700 gallons per day. While the premise of additional restrictions is logical and may be appropriate on a regional basis, this restriction is not applied for the NWA revisions for Denville. This is justified by the fact that the upstream HUC14 is in surplus and the downstream HUC14 in deficit are both within Denville Township and within the same HUC14 subwatershed.

As part of the WUCMP, updates to the NWA calculation were performed for these subwatersheds to adjust for the following:

- Partitioning potable demands into groundwater-based demands vs. augmented surface-based demands;
- Incorporation of additional years of water diversion data (obtained from NJDEP);
- Incorporation of additional years of wastewater discharge data;
- Calculating NWA for the entire subwatershed and allocating responsibility of deficit mitigation by consumptive use;
- Assessment of additional wastewater returns beyond Highlands Domestic Sewerage Facilities (HDSFs); and
- Selection of specific maximum diversions months to coincide with LFM target months
- Remove upstream flow restriction for HUC14 030

[8] Consumptive/ depletive uses are defined as water that is lost within the subwatersheds and is not returned as recharge or as discharge to a stream within the subwatersheds.

Water Supply

Public Community Supply

Following is a summary of Public Community and Non-Community Supply withdrawals within these subwatersheds for the period 2000-2018 (**Table 7**):

Table 7 – Groundwater Supply Withdrawals

HUC/Water Purveyor	Category	Withdrawals[1]	
		Peak Summer Month	Peak Withdrawal (MGD)
HUC14 02030103030120: Den Brook			
Denville Township Water Department	Potable Supply	July 2001	1.130
HUC14 02030103030140: Rockaway R (Stony Brook to BM 534 brdg)			
Denville Township Water Department	Potable Supply	July 2004	1.269
St. Francis Health Resort	Potable Supply	June 2001	0.025
Saint Clare's Hospital, Inc.	Potable Supply	June 2001	0.120
Boonton Town Water Department	Potable Supply	August 2007	0.895
Mountain Lakes Water Department	Potable Supply	August 2002	0.563
HUC14 02030103030090 - Rockaway R (BM 534 brdg to 74d 33m 30s)			
Denville Township Water Department	Potable Supply	June 2005	1.413
Rockaway Borough Water Department	Potable Supply	August 2013	1.147
Rockaway Township Water Department	Potable Supply	June 2005	0.235

1. These represent maximum withdrawals by purveyor for the months of June, July, August from 2000-2018. The months shown don't necessarily match the month where the maximum pumping occurs within the HUC14 as this table is public supply only (irrigation, commercial, etc., not represented here).
2. MGD = million gallons per day

Domestic Well Groundwater Usage

Domestic Well Groundwater Usage is an estimate of private well withdrawals within the subwatersheds for areas not served by the public supply. Domestic withdrawals were updated for each watershed by utilizing the domestic withdrawals in the New Jersey Department of Environmental Protection (NJDEP) / New Jersey Geological Survey (NJGS) Water Transfer Model (WTM). The values for domestic withdrawals represent the average July values from 2000 to 2015. Values used in the RMP were calculated based on population estimates for the subwatersheds from the 2000 Census, multiplied by a factor of 100 gallons per person per day. Values in the WTM were utilized instead in order to apportion the domestic usage by municipality, which is not included in the RMP. Domestic Groundwater Usage is summarized below in **Table 8**:

Table 8 - Domestic Groundwater Usage

HUC 14	Domestic Groundwater Usage (MGD)
02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)	0.0723 / 0.0036
02030103030120: Den Brook	0.1152 / 0.0345
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	0.0656 / 0.0266
TOTAL	**0.1808 / 0.0611**

1. Withdrawals represent total domestic withdrawals within the entire subwatershed / Denville
2. MGD = million gallons per day

Golf Course Irrigation

Golf course irrigation within these subwatersheds is summarized below in **Table 9**.

Table 9 - Irrigation Water Usage for Golf Course

HUC 14	Owner	Water Source	Peak Summer Month	Peak Withdrawal (MGD)
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	Rockaway River Country Club	Groundwater	August 2005	0.117
		Surface Water	September 2005	0.095

Other Irrigation

Withdrawals for other irrigation within these subwatersheds is summarized below in **Table 10**.

Table 10 – Other Irrigation Water Usage

HUC	Owner	Water Source	Peak Summer Month	Peak Withdrawal (MGD)
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	Independence Plating Corp.	Groundwater	June 2008	0.104
02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)	Townsquare Village Homeowners	Groundwater	July 2012	0.013

Agricultural

Water usage for Agricultural irrigation within these subwatersheds is summarized below in **Table 11**.

Table 11 - Water Usage for Agricultural Use

HUC	Owner	Water Source	Peak Summer Month	Peak Withdrawal (MGD)
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	Tourne Valley Farm[1]	Surface Water	September 2000	0.014
	Hamilton Farms	Groundwater	June 2007 & June 2008	0.033

1. The two (2) wells contributing from this user within this HUC14 only has data until 2003 and is assumed to be out of service and the location of the well is not included on the figures.

Consumptive/Depletive Uses

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.

Consumptive water uses such as irrigation are further adjusted using consumptive use coefficients. Consumptive use coefficients reflect the percentage of the consumptive use that is lost and is not returned to the aquifer.[9] For irrigation, most of the water is lost to evapotranspiration and therefore the consumptive use is high (consumptive use coefficient of 0.9, or 90% of the water is not returned). Conversely, much of the water used for power generation or industrial purposes is returned to the aquifer or watershed so the consumptive use is low (consumptive use coefficients of 0.01 to 0.1).

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 sewered 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.

Further it should be noted, that groundwater models used in support of the Highlands Regional Net Water Availability analysis show that the impact on September stream flows of

[9] Highlands Council Technical Report, "Water Resources Volume II Water Use and Availability" (Highlands Council, 2008), p. 119.

consumptive/depletive (C/D) groundwater use during the summer is not 1:1, but roughly 1:0.9.[10] In other words, 1 gallon of C/D water use is calculated to reduce Groundwater Availability in September by 0.9 gallons. Therefore, groundwater 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.

Groundwater uses within the subwatersheds are predominantly for potable use, through domestic groundwater and public community supply, with public community supply use far exceeding that of domestic groundwater. However, groundwater use for golf course irrigation is also prevalent. There are also surface water withdrawals relating to irrigation of golf courses (e.g. those associated with Rockaway River Country Club) reported within the subwatersheds.

Net Water Availability is calculated for each subwatershed based on the maximum total groundwater withdrawals for the months of June, July and August for each year. For surface water withdrawals, the month of September is always used.

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 2000-2018, 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.

Consumptive use from public supply accounts for water that is not returned to the subwatershed. So, for instances where a system has a treated wastewater return to a surface water, that return directly offsets the consumptive use. If instead of the individual wastewater treatment plant the sewage is transported outside of that particular subwatershed, instead of offsetting consumptive public supply, that flow becomes depletive.

Most of Denville Township is sewered and served by Rockaway Valley Regional Sewerage Authority. A relatively small area in the southeast portion of the township is served by the Parsippany-Troy Hills Sanitary Sewer Utility. Both utilities discharge treated sanitary effluent to the Rockaway River, well outside the study area. Therefore, groundwater withdrawals that serve the sewer customer base within Denville is considered depletive.

[10] Highlands Council Technical Report, "Water Resources Volume II Water Use and Availability" (Highlands Council, 2008), p. 116.

Net Water Availability is shown on **Tables 14, 15** and **16**. A general summary for each of the subwatersheds is described below.

HUC14 02030103030120 was published in the RMP as having a surplus of 0.0754 MGD (75,400 gallons per day[11]). This HUC14 also extends into Randolph Township, although there are no active community public supply wells within the HUC14, so distributing responsibility for deficit reduction is solely based on consumptive use for domestic pumping in Randolph and Denville.

Based on this revised analysis, the entire HUC14 averages a surplus of 117,800 gallons per day or up to 272,300 gallons per day when not including 2000-2002 in the analysis. The increase in the surplus is due to the incorporation of septic return from a portion of the Denville Water Department distribution system as well as the shutdown of one of its supply wells in 2002. Furthermore, as mentioned above, this HUC14 had an upstream constraint of consumptive/depletive uses plus 5% of the Low Flow Margin which has not been assigned in this analysis. Should the additional constraint be applied, the NWA drops to a deficit of 16,400 gallons per day when considering 2000-2002, or a surplus of 107,200 gallons per day otherwise.

Denville accounts for 28% of the C/D use within this HUC14 from domestic withdrawals.

HUC14 02030103030140 – Rockaway R (Stony Brook to BM 534 brdg) was published in the RMP as having a deficit of 2.085 MGD (2,085,000 gallons per day). This HUC is divided mainly in Denville Township, but also intersects Boonton Township, Mountain Lakes Borough and Rockaway Borough. As a result of this new evaluation, the HUC14 averages a deficit of 1.53 MGD. The largest average water withdrawal occurs from the potable supply wells from the three municipalities. Denville accounts for 59% of the C/D use within this subwatershed and therefore is responsible for managing 59% of the deficit.

As mentioned earlier, wastewater returns for this HUC14 are from one (1) surface water discharger (Permit Number: NJG010988; Sunoco S/S 7-1027), but available databases (Water Transfer Model) only include data through March 2011. This discharger is not included in Highlands databases. It is assumed to be no longer active.

HUC14 02030103030090 - Rockaway R (BM 534 brdg to 74d 33m 30s) was published in the RMP as having a deficit of 0.9455 MGD (945,500 gallons per day). As a result of this new evaluation, the HUC14 averages a deficit of 1.29 MGD. The areas served by public supply are sewered by RVRSA and discharged out of the study area. Although only a very small portion of the Denville water distribution is outside of the Township (serving the industrial facility in Rockaway Township), the two water supply wells owned and operated by the Denville Water Department (located in Randolph Township) account for approximately 50% of the total consumptive use of the HUC14. Therefore, although most of this HUC14 is outside of Denville Township, Denville accounts for 50% of the deficit.

[11] Value includes upstream constraint of consumptive/depletive uses plus 5% LFM

Although NWA was not calculated for the remaining six subwatersheds that intersect Denville Township, the average July domestic withdrawals have been summarized for each, for use in NWA calculations by neighboring municipalities (**Table 12**).

Table 12 - Average Domestic Withdrawals (July 2000-2015) within Denville Township for HUC14s Outside NWA Analysis

HUC14	Name	Domestic Withdrawals (MGD)
02030103020080	Troy Brook (above Reynolds Ave)	0.022
02030103030080	Mill Brook (Morris Co)	0.06
02030103030110	Beaver Brook (Morris County)	0.358
02030103030130	Stony Brook (Boonton)	0.003
02030103030150	Rockaway R (Boonton dam to Stony Brook)	0.03
02030103020030	Greystone / Watnong Mtn tribs	0.254

MGD = million gallons per day

Refer to the Appendix for a further definition of terms.

Summary of Significant Causes of Deficit

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

Table 13 - Summary of NWA Results

HUC14	NWA Minimum (MGD)	NWA Maximum (MGD)
02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)	-1.820	-0.960
02030103030120: Den Brook	-0.745	0.272
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	-1.898	-0.777

MGD = million gallons per day

Significant causes of the deficits noted above include:

- **HUC 14 02030103030090:** The driver behind the deficit in this HUC14 is community public supply pumpage from Denville, Rockaway Borough and Rockaway Township water departments.
- **HUC 14 02030103030120:** The only recent reported use within this HUC14 is from domestic supply.
- **HUC 14 02030103030140:** The driver behind the deficit in this HUC14 is community public supply pumpage from Denville, Mountain Lakes and Boonton water departments.

Characterization of Deficit

The deficit in this WUCMP area varies from a surplus to extreme deficit (>1 MGD). HUC14 02030103030120 has had a stable surplus since the inactivity of public supply withdrawal beginning in 2003. HUC14 02030103030140 has been in a consistent deficit throughout 2000-2006 years and is showing a slight upward trend over the last 10 years. The HUC14, in deficit should be prioritized for the implementation of water conservation and management measures. Water conservation approaches are discussed below.

Table 14 - Re-evaluated New Water Availability HUC14 02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)

Year	Non-Ag Groundwater Availability (MGD)	Wastewater Return (MGD)	Consumptive Domestic Use (MGD)	Consumptive Public Supply (MGD)	Total Non-Ag Consumptive Use (MGD)[1]	Total Ag Consumptive Use (MGD)[1]	Non-Ag Net Water Availability (MGD)[2]
Published	**0.2162**	**0.0000**	**0.0150**	**1.1113**	**1.150**	**0.0000**	**-0.9455**
2000	0.2162	0.0000	0.0189	1.2366	1.271	0.0000	-1.0549
2001	0.2162	0.0000	0.0189	1.4843	1.521	0.0000	-1.3050
2002	0.2162	0.0000	0.0189	1.2873	1.321	0.0000	-1.1044
2003	0.2162	0.0000	0.0189	1.3520	1.380	0.0000	-1.1638
2004	0.2162	0.0000	0.0189	1.3096	1.335	0.0000	-1.1184
2005	0.2162	0.0000	0.0189	2.0016	2.031	0.0000	-1.8153
2006	0.2162	0.0000	0.0189	1.8138	1.852	0.0000	-1.6357
2007	0.2162	0.0000	0.0189	1.9629	2.036	0.0000	-1.8195
2008	0.2162	0.0000	0.0189	1.3250	1.395	0.0000	-1.1791
2009	0.2162	0.0000	0.0189	1.2291	1.264	0.0000	-1.0481
2010	0.2162	0.0000	0.0189	1.2602	1.299	0.0000	-1.0825
2011	0.2162	0.0000	0.0189	1.2160	1.252	0.0000	-1.0361
2012	0.2162	0.0000	0.0189	1.5961	1.641	0.0000	-1.4244
2013	0.2162	0.0000	0.0189	1.6272	1.669	0.0000	-1.4525
2014	0.2162	0.0000	0.0189	1.6336	1.674	0.0000	-1.4577
2015	0.2162	0.0000	0.0189	1.4482	1.478	0.0000	-1.2621
2016	0.2162	0.0000	0.0189	1.1359	1.176	0.0000	-0.9600
2017	0.2162	0.0000	0.0189	1.8202	1.854	0.0000	-1.6380
2018	0.2162	0.0000	0.0189	1.2507	1.280	0.0000	-1.0642

[1] [Adjusted Consumptive Domestic Use] + [Consumptive Public Supply Use] + [Total Non-Ag Consumptive Use from Surface Water] + [Other Non-Ag Consumptive Use from Groundwater].
[2] [Non-Ag Groundwater Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return]

Table 15 - Re-evaluated New Water Availability HUC14 02030103030120: Den Brook

Year	Non-Ag Groundwater Availability (MGD)	Wastewater Return (MGD)	Consumptive Domestic Use (MGD)	Consumptive Public Supply (MGD)	Total Non-Ag Consumptive Use (MGD)[1]	Total Ag Consumptive Use (MGD)[1]	Non-Ag Net Water Availability (MGD)[2]
Published	**0.3015**	**0.0000**	**0.0275**	**0.0000**	**0.0275**	**0.0000**	**0.0754**
2000	0.3015	0.0000	0.0301	0.9158	0.9458	0.0000	-0.6443
2001	0.3015	0.0000	0.0301	1.0161	1.0462	0.0000	-0.7446
2002	0.3015	0.0000	0.0301	1.0002	1.0303	0.0000	-0.7288
2003	0.3015	0.0000	0.0301	-0.0008	0.0292	0.0000	0.2723
2004	0.3015	0.0000	0.0301	-0.0009	0.0292	0.0000	0.2724
2005	0.3015	0.0000	0.0301	-0.0007	0.0294	0.0000	0.2722
2006	0.3015	0.0000	0.0301	-0.0008	0.0292	0.0000	0.2723
2007	0.3015	0.0000	0.0301	-0.0008	0.0292	0.0000	0.2723
2008	0.3015	0.0000	0.0301	-0.0009	0.0292	0.0000	0.2723
2009	0.3015	0.0000	0.0301	-0.0008	0.0293	0.0000	0.2723
2010	0.3015	0.0000	0.0301	-0.0008	0.0292	0.0000	0.2723
2011	0.3015	0.0000	0.0301	-0.0008	0.0293	0.0000	0.2722
2012	0.3015	0.0000	0.0301	-0.0007	0.0293	0.0000	0.2722
2013	0.3015	0.0000	0.0301	-0.0007	0.0294	0.0000	0.2721
2014	0.3015	0.0000	0.0301	-0.0007	0.0293	0.0000	0.2722
2015	0.3015	0.0000	0.0301	-0.0009	0.0292	0.0000	0.2723
2016	0.3015	0.0000	0.0301	-0.0007	0.0293	0.0000	0.2722
2017	0.3015	0.0000	0.0301	-0.0007	0.0293	0.0000	0.2722
2018	0.3015	0.0000	0.0301	-0.0008	0.0293	0.0000	0.2723

[1] [Adjusted Consumptive Domestic Use] + [Consumptive Public Supply Use] + [Total Non-Ag Consumptive Use from Surface Water] + [Other Non-Ag Consumptive Use from Groundwater].
[2] [Non-Ag Groundwater Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return]

Table 16 - Re-evaluated New Water Availability HUC14 02030103030140: Rockaway R (Stony Brook to BM 534 brdg)

Year	Non-Ag Groundwater Availability (MGD)	Wastewater Return (MGD)	Consumptive Domestic Use (MGD)	Consumptive Public Supply (MGD)	Total Non-Ag Consumptive Use (MGD)[1]	Total Ag Consumptive Use (MGD)[1]	Non-Ag Net Water Availability (MGD)[2]
Published	**0.1671**	**NA**	**0.0149**	**1.9036**	**2.1216**	**0.2613**	**-2.0851**
2000	0.1671	0.0004	0.0171	0.8334	0.944	0.013	-0.7765
2001	0.1671	0.0002	0.0171	1.4892	1.546	0.003	-1.3786
2002	0.1671	0.0003	0.0171	1.5689	1.695	0.001	-1.5280
2003	0.1671	0.0003	0.0171	1.7144	1.829	0.000	-1.6624
2004	0.1671	0.0000	0.0171	1.5374	1.638	0.000	-1.4709
2005	0.1671	0.0001	0.0171	1.7064	1.959	0.012	-1.7919
2006	0.1671	0.0003	0.0171	1.6402	1.792	0.018	-1.6248
2007	0.1671	0.0001	0.0171	1.8546	2.005	0.008	-1.8377
2008	0.1671	0.0002	0.0171	1.8882	2.065	0.013	-1.8981
2009	0.1671	0.0001	0.0171	1.4496	1.569	0.013	-1.4016
2010	0.1671	0.0000	0.0171	1.7102	1.852	0.013	-1.6847
2011	0.1671	0.0000	0.0171	1.6428	1.767	0.012	-1.5995
2012	0.1671	0.0000	0.0171	1.5836	1.719	0.012	-1.5524
2013	0.1671	0.0000	0.0171	1.3330	1.457	0.021	-1.2899
2014	0.1671	0.0000	0.0171	1.5187	1.664	0.013	-1.4973
2015	0.1671	0.0000	0.0171	1.6225	1.778	0.013	-1.6112
2016	0.1671	0.0000	0.0171	1.5709	1.688	0.022	-1.5213
2017	0.1671	0.0000	0.0171	1.4818	1.585	0.018	-1.4178
2018	0.1671	0.0000	0.0171	1.5715	1.694	0.000	-1.5271

[1] [Adjusted Consumptive Domestic Use] + [Consumptive Public Supply Use] + [Total Non-Ag Consumptive Use from Surface Water] + [Other Non-Ag Consumptive Use from Groundwater].
[2] [Non-Ag Groundwater Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return]

Anticipated Impacts of Climate Change to Net Water Availability

Background

The Northeast region of the United States, along with the rest of the world, is expected to experience a range of changes that will influence the quantity and quality of water supplies, including modified stream flows, increased sea level rise and storm surges, increased extreme precipitation events, and increased water temperatures. As a result, federal agencies and state, county, and local governments in the region have begun developing and integrating climate change adaptation policies into their environmental programs including water resource management and planning.

In 2019, New Jersey established[12] the Interagency Council on Climate Change. One of the goals of the Council is to develop short- and long-term action plans that will promote the long-term mitigation, adaptation, and resilience of New Jersey's economy, communities, infrastructure, and natural resources. In addition to these coordinated efforts, the Interagency Council will support the development and implementation of the Climate Change Resilience Strategy that will guide and inform State actions to address the impacts of climate change.

Given the importance of the Highlands Region as an essential source of drinking water to more than one-half of the State's population, the region plays a crucial role in the promotion of long-term water resource security (*NJDEP 2017a, RMP 2008*). Thus, it is important to start considering the impacts of a changing climate to the Highland's HUC14 subwatersheds and consequently in the Municipal Water Use and Conservation Management Plans (WUCMPs).

In this context, the purpose of this section is to provide a summary of expected changes in atmospheric (temperature, precipitation) and hydrological conditions (snowfall, drought, groundwater, streamflow) for New Jersey and the Highlands Region including a qualitative assessment of potential impacts to groundwater recharge and availability.

Changing Climate Conditions in the New Jersey

Since the end of the 1800s, New Jersey has experienced a 3.5°F (1.9°C) increase in the State's average temperature (*NJDEP 2020a*). This warming trend is expected to continue with annual average temperature increases of 4.1 to 5.7°F (2.3°C to 3.2°C) by 2050 (*Horton et al. 2015*). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation. Heat waves are also expected to impact larger areas, with more frequency and longer durations (*Lyon et al. 2019*).

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[12] Executive Order 89, New Jersey. October 2010. https://nj.gov/infobank/eo/056murphy/pdf/EO-89.pdf

It is projected that by the middle of the 21st century 70% of summers could be hotter than the warmest summer experienced to date (*Runkle et al. 2017*).

Temperature changes are different across the different climate divisions of New Jersey as shown in **Table 17**. The Highlands Region is located in Division 1, which shows the highest increases in winter temperatures between 1895 and 2019 (*Office of NJ State Climatologist, 2020*).

Table 17 - Annual and Seasonal Increases in Air Temperatures (in °F) Over the Period 1895 to 2019 (NJDEP 2020a, modified).[13]

Spatial extent	Annual	Winter	Spring	Summer	Fall
Statewide	1.9	3.5	3.0	3.1	3.0
Division 1 North	2.0	3.6	3.1	3.0	3.1
Division 2 South	1.9	3.4	2.9	3.1	2.8
Division 3 Coast	2.2	4.0	3.6	3.6	3.5

As temperatures increase, the atmosphere can hold more water vapor leading to a greater potential for precipitation. New Jersey's annual rainfall averages approximately 46 inches per year (*Office of NJ State Climatologist, 2020*). However, this average varies across the state due to physiographical differences in the inland and coastal areas (*Agel et al. 2015, Runkle et al. 2017*). The north to central portion (including the Highlands) of the state averages 49 inches of precipitation annually while the coastal and southern regions average 44 and 45 inches, respectively (*Office of the New Jersey State Climatologist 2020*). Overall, New Jersey is becoming wetter in recent decades. In the northern part of the State, the average precipitation increased over five inches when comparing long-term averages between 1895-1970 and 1971-2000 (*NJDEP 2020b*). And over the last 10 years, the annual rainfall has slightly increased by 7.9%. However, the changes in precipitation have not been be uniform across seasons with small increases in Winter and Spring, small decreases in summer and larger increases in the Fall (*NJDEP 2020a, USGCRP 2017).* Assessing long-term and short-term trends on an annual and seasonal basis is important for projecting future precipitation and also account for common seasonal and interannual variability associated with rainfall.

In the future, depending on the emission scenario, annual precipitation in New Jersey could increase between 4% to 11% by 2050 (*Horton et al. 2015*). Rainfall increases are projected to differ across seasons with higher increases in the amount of precipitation occurring in winter and spring followed by more moderate increases in the fall. Projected change in precipitation for summer and fall are small compared to natural variation (*USGCRP 2017).* Summer precipitation projections show a range of

[13] The change in temperature was determined form the linear slope of the entire period of record. www.climate.rutgers.edu/stateclim_v1/monthlydata/index.php

results in the literature between no to small increases in rainfall (*Fan et al. 2014, Demaria et al. 2016, USGCRP 2017*).

While average rainfall totals will increase, changing atmospheric conditions are expected to especially exacerbate the intensity of heavy rainfall events as a warmer atmosphere has the potential to produce more intense and frequent storms (*NJDEP 2020a, USGCRP 2017*). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. As Earth continues to warm, increased frequency and intensity of heavy precipitation will become more likely. For example, the U.S. National Climate Assessment (*USGCRP 2017)* notes that the Northeast United States has already seen "a greater increase in extreme precipitation than any other region" with a roughly 55 percent increase in intense storms between 1958 and 2010, defined as the heaviest 1 percent of precipitation events (**Figure 11**).

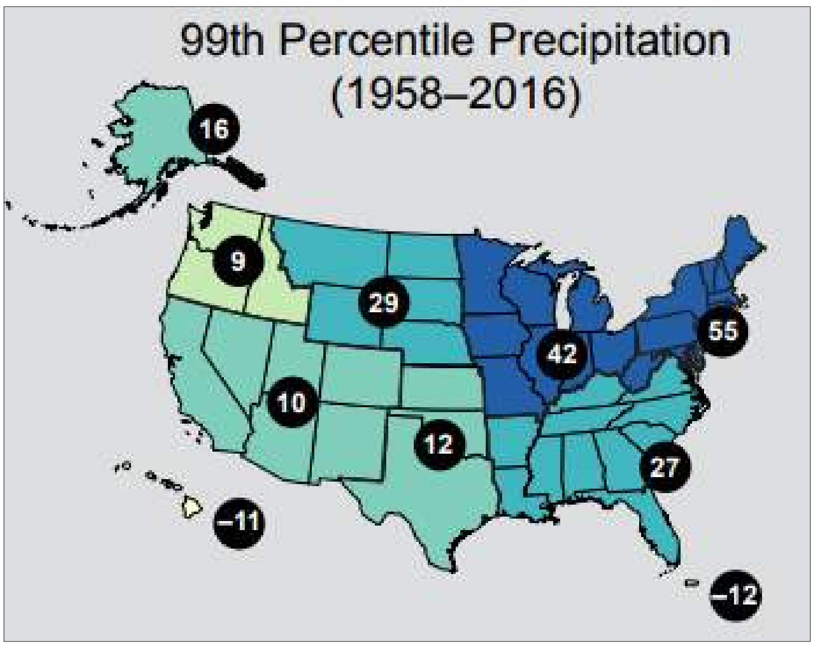

Figure 11 - Annual amount of precipitation falling in daily events that exceed the 99th percentile of all non-zero precipitation days

The changes in climate will have an impact on the water cycle, including the quantity and quality of New Jersey's ground and surface waters.

A general overview of water supply in the Highlands Region and impacts of climate change to Region's water resources is presented below. A detailed overview on the effects of changing precipitation patterns (frequent, intense rainfall with extended dry periods) to groundwater recharge and availability relevant to WUCMPs are provided in the next section.

Water Quantity

Water supply within the Highlands Region is primarily sourced from groundwater although reservoir storage is prevalent. Reservoirs primarily serve large populations outside of the region, but smaller reservoirs also serve municipalities within the Highlands. Aquifer recharge plays a crucial role in the Highlands Region. Recharge replenishes the aquifer for groundwater supply wells and allows for base flow to streams and reservoirs. The majority of groundwater recharge occurs during the non-growing season (typically May through October) where evapotranspiration is low. Runoff is also an important mechanism, although can also be detrimental in areas with high connected impervious cover. In those areas, streams can become flashy and cause excessive erosion of their stream channels. Intense runoff has some benefit as it can quickly replenish reservoirs, although will also introduce a higher pollutant load (sediment, metals, nutrients) as discussed below. Pervious runoff (runoff that occurs when the storage capacity of the soil is exceeded) occurs under natural conditions and is preferable to impervious surface runoff.

As temperatures increase and the growing season lengthens, there will be greater demand for water for irrigation use (e.g., crop, golf course, and outdoor residential), putting more stress on the water supply. Water demands peak in warm weather and these peaks occur at the same time that natural resources are typically most limited. Higher temperatures will also lead to more evapotranspiration (the release of moisture from open water and soils by evaporation and from plants by transpiration) and reduced soil moisture, amplified by warmer and drier conditions over an extended growing season (*USGCRP 2017*). As increased evapotranspiration rates will result in drier soils it can have different effects on runoff generation. An increase of runoff is expected during larger higher intensity storms (limited capacity to absorb water rapidly), whereas reduction of runoff is likely during smaller storm. Increases in evapotranspiration can be significant in New Jersey where evapotranspiration presents a large portion of the total hydrologic equation (*Rutgers 2016).*

On the other hand, increasing rainfall also provides opportunities for greater water supply, in particular rainfall which occurs during periods when groundwater infiltration and aquifer recharge can occur. More heavy rainfall is also expected to generate more runoff as high intensity rainfall can overwhelm the capacity of soil and add to runoff generated by impervious cover. Runoff increases can help to fill lakes, reservoirs and streams in summer and fall during rain events.

Water Quality

It should be noted that higher temperatures and more rainfall will also have an impact to water quality, both to surface and groundwater. Increases in extreme rainfall will increase runoff and increase potential to impair water quality through erosion, increased turbidity, nutrient loading and pathogens in waterways (*NJDEP 2020a*). Further, concerns also include a potential to stimulate harmful algal blooms and potential for contamination from the mobilization of microbial pathogens, pesticides, and fertilizers rich in nitrogen and phosphorus from agricultural areas *(Sinha et al. 2017, Ho et al. 2019 Hamilton and Helsel 1995, USGS 2012).*

These runoff-related water quality impacts do not have an impact to groundwater or net water availability and is not a focus of the WUCMP (which is based on low flow statistics that generally reflect periods of base flow only). However, it is important to point out that climatic changes may stress the water treatment processes required by the Safe Drinking Water Act or limit use for other non-potable uses.

Potential Impacts of Climate Change to Groundwater Availability

For the purpose of this WUCMP, a qualitative assessment of the impacts of climate change to groundwater availability[14] and water use was conducted based on information provided in the literature and scientific resources specific to New Jersey. Impacts to groundwater availability and water uses may ultimately impact Net Water Availability, which could affect Denville Township's strategies and planning to conserve and preserve water in the future.

Evaluating the impacts of climate change to a watershed and groundwater is complex and depends on different climatic and non-climatic factors such as land use and aquifer characteristics. A more detailed hydrological/geohydrological assessment which includes updated analysis of streamflow records, local climate projections and non-climatic factors is needed to quantitatively assess impacts to groundwater availability in response to changing climate.

Groundwater Availability

Low flow statistics derived from base flow are used in the Highlands Regional Master Plan (*RMP 2008b*) to determine groundwater capacity[15] which ultimately leads to the determination of Ground Water Availability. Base flow, under natural conditions, is the amount of stream flow discharging from the surface aquifer, which is controlled by the amount of water recharging the groundwater by precipitation and the infiltration capacity of the soil. Base flow in a natural stream system is essentially equal to total ground water recharge of the surface aquifer minus any vertical recharge of underlying aquifers (*RMP 2008b*).

Based on the information provided in the previous section, climate change will likely affect groundwater recharge and thus base flow in the following ways:

- More rainfall in the winter & spring season will increase groundwater recharge. Typically, rainfall in the non-growing season contributes a large fraction of annual recharge compared to the growing season rainfall. Further, warmer winter temperatures will result in longer

[14] It is that portion of the Ground Water Capacity of a subwatershed that can be provided for human use without harm to other ground water users, aquatic ecosystems or downstream users.

[15] The natural ability of a subwatershed to support stream flow over time, during dry weather climatic condition. In the specific context of water availability calculations by subwatershed, it is the Low Flow Margin derived from the September median flow minus the 7Q10 value for that portion of each HUC14 within the Highlands Region

periods where the ground is not frozen, providing additional potential for recharge. Thus, above average precipitation and temperatures in both seasons may result in higher groundwater recharge, which supports long-term stream flow and increases the amount of water available for use during the summer months.

- Declining snow fall and less snowpack due to warmer temperatures can reduce snowmelt recharge to groundwater in the Spring causing earlier in the year winter-spring flows. This may lead to higher winter flows but lower spring flows, with potential impacts to base flows in the summer as in some regions snow melt flow provides a large fraction of water to sustain base flows during the summer. *(Hodgkins and Dudley 2006, Hayhoe et al. 2007).*
- An increase in intense precipitation events will likely increase runoff (precipitation that moves immediately across the land surface into surface waters) which will lead to higher short duration streamflow spikes and three-day peak flows (*Demaria et al. 2016)*. However, increased rainfall intensity will reduce the amount of water able to infiltrate into the soil, as most soils have a limited capacity to absorb water rapidly, resulting in more runoff with negative impacts to groundwater recharge.
- As mentioned above, rainfall during summer months is expected to experience little to no increase in the future. This in combination with increasing temperatures will increase evapotranspiration rates. Higher evapotranspiration rates will affect soil moisture storage and increase moisture deficits potentially decreasing recharge (*Demaria et al. 2016)*. Further, increasing evapotranspiration rates and soil moisture could even offset runoff increases due to more rain (*USGCRP 2017*).
- Lastly, warmer temperatures and shifting precipitation patterns will likely change groundwater recharge patterns and thus impact the magnitude and duration of summer-fall low flows (*Demaria 2016, USGCRP 2017).*

Water Use

It is expected that drier summers and warmer temperatures will increase water use in the watersheds:

- As temperatures increase and thus the growing season lengthens, there will be greater demand for water for irrigation use (e.g., crop, nursery, golf course, and outdoor residential). This will be potentially exacerbated due to in an increase evapotranspiration and corresponding short-term soil moisture deficits which may become more frequent during summer, early fall. (*Hayhoe et al. 2007*).
- Water demand peaks are also expected to increase in warm weather, and even more so during heat waves. Demand peaks typically occur at the same time that natural resources are already most limited. This may be somewhat offset by increased recharge during the winter months.
- The increase water demand will have a negative effect on base flow and may result in higher Net Water Availability (NWA) deficits or reduction in NWA surpluses.

Summary

Annual total flows (base flow and runoff) have increased due the increases in rainfall in the North-East US (*Hayhoe et al. 2007*). However, future changes in seasonal rainfall patterns and increasing temperatures as presented above suggest that despite the projected increased in precipitation, seasonal low flow conditions will still prevail in the watersheds as evapotranspiration and water demand increases during the warm months. Further, the length of the low-flow season (typically May through October) is projected to increase resulting in greater potential for more frequent and prolonged droughts and lower streamflow during the warmest months of the year.

The results of the literature review suggest that the possible changes in climatic conditions could have a negative impact on groundwater recharge and base flow during the summer months. If true, higher water use during these periods is further expected to decrease surpluses and increase deficits in Net Water Availability. As Net Water Availability accounts for water usage during the summer months only, the water use component of NWA will increase, therefore increasing deficits and eroding any potential surplus. Increased recharge in the winter months will help with overall aquifer storage and can increase the availability of water for increased usage in the summer, but if the magnitude of increased usage is equivalent to the additional recharge, the benefit of any additional recharge to the low-flow margin will be limited and groundwater availability will remain essentially the same. Thus, it is recommended that municipalities keep developing and implementing the strategies identified in their WUCMPs as they need to adapt to less water availability during the warmer months.

Climate change science and projections are a complex and dynamic field. While some generalizations can be made, it is important to consider the complex interaction of the groundwater system to climatic and non-climatic factors. Climate change impacts to stream flows and groundwater capacity should be incorporated into the Monitoring and Implementation Phases of the Water Use and Conservation Management Plan and reflected in any subsequent updates.

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Water Conservation/Deficit Mitigation Strategies

The following table summarizes the water use management techniques and mitigation strategies to protect against future deficits that this WUCMP could use to reduce and/or eliminate the water deficit in this subwatershed.

Table 18 - Summary of Conservation and Deficit Mitigation Strategies

Measure	Res	Comm/ Indust	Water Purveyor	Golf	Ag	Mun
Water Use Reduction						
Avoid Overspray	✓	✓		✓	✓	
Building and Pipe Insulation	✓	✓				
Community Garden	✓					
Cooling System Upgrades		✓				
Crop and Soil Selection					✓	
Dishwasher Upgrade	✓					
Drought Contingency Plans			✓			✓
Equipment Condensation		✓	✓			
Heating System Upgrades		✓				
Hot Water Heater Upgrade	✓	✓				
Hydrant Locks			✓			
Install Smart Meters			✓			
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		✓				✓

Table 18 - Summary of Conservation and Deficit Mitigation Strategies

Measure	Res	Comm/ Indust	Water Purveyor	Golf	Ag	Mun
Public Education Handouts		✓	✓			✓
Public Workshops						✓
Rate Structure			✓			
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 Restroom				✓		
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		✓				
Modify Stormwater Ordinance						✓
Porous Paving	✓	✓				✓
Rainwater Harvesting/Rain Gardens	✓	✓				
Retrofit Existing Detention Basins		✓				✓

Res = Residential; Comm= Commercial; Indust = Industrial; Ag = Agricultural; Mun = Municipal

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:

- 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 19** through **24** for residential, commercial / industrial / institutional, water purveyors, golf courses, 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).

Table 19 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Residential Users

Measure	Feasibility	Effectiveness	Resilient /Reliable	Reduction Potential	Complexity	Cost	Schedule
Assisted Infiltration/Enhanced Recharge	3	2	2	2	1	2	2
Avoid Overspray	3	2	1	2	2	3	3
Building and Pipe Insulation	3	2	2	1	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
Composting	3	2	2	1	3	3	3
Dishwasher Upgrade	3	2	3	2	2	2	2
Graywater Reuse for Irrigation	3	2	3	2	1	1	1
Graywater Recharge	3	2	3	2	1	1	1
Hot Water Heater Upgrade	3	2	3	2	2	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	3	3	2	2	2	3
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
Low Volume Irrigation	2	2	3	1	1	2	3
Maintenance	3	2	2	1	1	2	3
Night Watering	3	2	2	2	3	3	3
Porous Paving	1	3	2	2	1	1	1
Rainwater Harvesting/Rainwater Cistern	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	2	1	3
Washing Machine Upgrade	3	2	3	2	2	2	3

Table 19 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Residential Users

Measure	Feasibility	Effectiveness	Resilient /Reliable	Reduction Potential	Complexity	Cost	Schedule
Water Bill Structure/Comparison	3	3	3	3	3	3	3

Table 20 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial and Industrial Users

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Assisted Infiltration/Enhanced Recharge	3	2	2	2	1	2	2
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
Composting	2	1	1	1	2	2	3
Cooling System Upgrades	2	2	2	2	1	1	1
Equipment Condensation	3	1	2	1	3	3	3
Graywater Reuse for Irrigation	3	2	3	2	1	1	1
Graywater Recharge	3	2	3	2	1	1	1
Heating System Upgrades	2	2	2	2	1	1	1
Hot Water Heater Upgrade	3	2	3	2	2	2	2
Injection Wells	1	3	2	2	1	1	1
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 Toilet Fixtures	3	2	3	2	2	2	3
Low Volume Irrigation	2	2	3	1	1	2	3
Maintenance	3	2	2	1	2	2	3
Night Watering	3	2	2	2	2	3	3
Plumbing Incentive Program	3	2	2	1	1	3	2
Porous Paving	2	2	2	1	1	1	1

Table 20 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial and Industrial Users

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Public Education Handouts	3	2	1	1	1	3	3
Rainwater Harvesting/Rainwater Cistern	3	2	2	1	1	2	2
Rainwater Harvesting/Rain Gardens	3	2	2	1	2	2	2
Retrofit Existing Detention Basins	3	3	3	3	2	2	1
Submetering	1	1	2	1	1	1	1
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

Table 21 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Water Purveyors

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

Table 22 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Golf Courses

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Assisted Infiltration/Enhanced Recharge	3	2	2	2	2	2	2
Avoid Overspray	3	2	1	2	2	3	3
Building Interceptor Dykes, Swales and Berms	1	2	2	2	2	2	2
Composting	1	1	1	1	2	2	3
Graywater Reuse for Irrigation	3	2	3	2	1	1	1
Graywater Recharge	3	2	3	2	1	1	1
Install Geotextiles Under Plantings	3	2	2	1	1	2	2
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	1	2	2
Leak Detection and Repair	2	2	2	1	3	2	2
Low Flow Faucets/Faucet Aerators	3	2	3	1	1	3	3
Low Volume Irrigation	2	2	3	1	1	2	3
Maintenance	3	2	2	1	2	3	3
Night Watering	2	2	2	2	2	3	3
Turfgrass Selection	3	2	3	2	3	2	3
Water Conservation Programs	3	2	1	2	2	3	3
Waterless Restroom	1	2	1	2	1	1	1

Table 23 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Agriculture

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Avoid Overspray	3	2	1	2	2	3	3
Composting	1	1	1	1	2	2	3
Crop and Soil Selection	1	2	1	2	1	3	3
Irrigation Conservation	3	2	1	2	2	3	3
Irrigation System Design	2	2	3	1	2	2	2
Leak Detection and Repair	2	2	2	1	3	2	2
Maintenance	3	2	2	1	2	3	3
Night Watering	2	2	2	2	2	3	3
Water Conservation Programs	3	2	1	2	2	3	3

Table 24 - 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 Conservation	3	2	2	2	2	2	2
Irrigation Education	3	2	1	2	1	3	3
Irrigation System Design	3	3	3	2	2	2	3
Landscape Incentive Program	3	2	2	1	1	1	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

A subset of ten deficit mitigation strategies that are relevant to the Denville Township have been ranked and the top ten strategies for each water user category are listed in **Tables 24** through **29**. 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 process uses the scores that were assigned in **Tables 18** through **23** 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 25 - 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	Washing Machine Upgrade	5
7	Night Watering	Night Watering	7
8	Avoid Overspray	Avoid Overspray	8
8	Irrigation Conservation	Irrigation Conservation	8
10	Dishwasher Upgrade	Dishwasher Upgrade	10

Table 26 - 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	Retrofit Existing Detention Basins	Retrofit Existing Detention Basins	2
3	Night Watering	Night Watering	3
4	Avoid Overspray	Avoid Overspray	4
4	Irrigation Conservation	Irrigation Conservation	4
4	Water Conservation Programs	Water Conservation Programs	4
7	Install Geotextiles Underneath Plantings	Assisted Infiltration/Enhanced Recharge	7
7	Landscape Design	Building Interceptor Dykes, Swales and Berms	8
7	Rainwater Harvesting/Rain Gardens	Graywater Reuse for Irrigation	9
10	Assisted Infiltration/Enhanced Recharge	Graywater Recharge	9

Table 27 - 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	Drought Contingency Plans	Water Storage Tank Management	6
7	Equipment Condensation	Well Optimization	7
8	Water Conservation Programs	Submetering	8
9	Well Optimization	Install Smart Meters	9
10	Submetering	Meter Calibration/Replacement	10

Table 28 - Ranked Mitigation Management Strategies for Golf Courses

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Irrigation System Design	Irrigation System Design	1
2	Turfgrass Selection	Turfgrass Selection	2
3	Avoid Overspray	Avoid Overspray	3
3	Irrigation Conservation	Irrigation Conservation	3
3	Water Conservation Programs	Water Conservation Programs	3
6	Night Watering	Night Watering	6
7	Maintenance	Assisted Infiltration/Enhanced Recharge	7
8	Low Flow Faucets/Faucet Aerators	Building Interceptor Dykes, Swales and Berms	8
9	Assisted Infiltration/Enhanced Recharge	Graywater Reuse for Irrigation	9
10	Low Volume Irrigation	Graywater Recharge	9

Table 29 - Ranked Mitigation Management Strategies for Municipalities

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

Table 30 - Ranked Mitigation Management Strategies for Agricultural Users

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Night Watering	Night Watering	1
2	Avoid Overspray	Avoid Overspray	2
2	Irrigation Conservation	Irrigation Conservation	2
2	Water Conservation Programs	Water Conservation Programs	2
5	Maintenance	Crop and Soil Selection	5
6	Leak Detection and Repair	Maintenance	6
7	Crop and Soil Selection	Leak Detection and Repair	7
8	Irrigation System Design	Irrigation System Design	8
9	Composting	Composting	9

Funding Opportunities

Public Funding Sources

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. 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 Infrastructure Bank (NJIB)
- 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

Financial Assistance through the Natural Resources Conservation Service of New Jersey can be found here:

https://www.nrcs.usda.gov/wps/portal/nrcs/main/nj/programs/financial/

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

https://www.njib.gov/

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:

- Environmental Protection Agency (EPA) – of note are:
    - The Catalog of Federal Funding Sources for Watershed Protection (https://www.epa.gov/waterdata/catalog-federal-funding)
  - 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 (https://www.nfwf.org/)
- River Network (http://www.rivernetwork.org/)
- American Rivers (https://www.americanrivers.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

Selected Strategies

As mentioned above, the upstream HUC14 020301030120 in surplus and the downstream HUC14 020301030140 in deficit are both located within the Denville Township. This provides an opportunity for Denville to shift some of its water uses to the upstream HUC14 in surplus. A relocation of water uses could be considered as a strategy as the main driver behind the NWA deficit are public supply wells from the Denville Water Department. However, as the surplus in HUC14 020301030120 is very minor while the deficit in HUC14 020301030140 exceeds 1 MGD, shifting water usage will not amount to any significant alleviation of the deficit.

Conservation efforts could be targeted toward public supply for HUC14 02030103030090 and 020301030140 as well as for golf course irrigation in HUC14 020301030140. Thus, the strategies below focus on irrigation as well as residential and water purveyors. Irrigation by commercial, residential and agricultural users as well as municipal usage which are the drivers of the deficit within HUC14 020301030090 and 020301030140. Note that domestic water supply has significantly more water used for irrigation and outdoor summer activities. Therefore, conservation strategies should focus on irrigation and/or offsetting the water used for irrigation. Retrofitting stormwater infrastructure to infiltration based is also encouraged and should be further evaluated during implementation.

The following selected strategies are provided as initial recommendations targeting deficit reductions in HUC14 02030103030090 and 020301030140. Additional strategies should be added and/or replaced as appropriate.

Irrigation (and Water) Conservation Programs

Community outreach for water conservation programs can go a long way towards water conservation. Implementing water conservation educational programs in schools, starting in elementary schools can be a cost effective and efficient approach to inform the public on water conservation.

Golf Course Water Use

Cooperative efforts with NJDEP and the golf course (Rockaway River Country Club) in HUC14 02030103030140 should be developed to reduce water use and provide alternative water sources such as high flow skimming to help address the deficit in this subwatershed. However, it should be noted that while golf course conservation approaches are encouraged, it is only a small fraction of the consumptive use in the watershed and is a lower priority than efforts to address conservation from community public supply.

Conservation at golf courses should generally include the development of 1) new grass varieties that use less water or can tolerate poor quality water; 2) new technologies that improve the efficiency of the irrigation system; 3) "best management practices" in golf course maintenance that result in less water use; 4) alternative water sources that reduce or eliminate the use of potable water; 5) golf course design concepts that minimize the area maintained with grasses that require considerable use of water; and 6) programs that educate golf course superintendents and other water users about opportunities for ongoing water conservation.[16]

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.

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. Denville Township has been implementing a leak detection program in an effort to reduce unaccounted for water loss.

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 to 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.

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.

[16] Snow, James T. (USGA Green Section National Director), “Water Right - Conserving Our Water Preserving Our Environment” (2001), International Turf Producers Foundation, Case Study 7, page 48. Retrieved from
< http://www.usga.org/course_care/articles/environment/water/Water-Conservation-on-Golf-Courses/>

Water Conservation and Deficit Reduction Target

As mentioned earlier, subwatersheds do not follow political boundaries and to establish a target for watershed management and water conservation on a municipal basis, the contribution of each municipality to a particular subwatershed's deficit is required. The target for this WUCMP is to reduce the Net Water Availability deficit for HUC14 02030103030140 and 02030103030090 and ensure sufficient supply during severe droughts and to provide a buffer for potential future needs.

Denville Township accounts for 50% of the C/D use within HUC14 02030103030090 and 59% of the C/D use within HUC14 02030103030140 and therefore is responsible for managing 50% and 59% of the deficit, respectively. Collaboration with other municipalities (Boonton, Randolph, Mountain Lakes) to reduce the deficits within these HUC14s will expedite deficit management.

HUC14 02030103030120 is entirely in surplus as only domestic supply is predominant. The Highlands Council policy is to permit such surpluses to be made available for downstream deficit reduction. Accordingly, the surplus evident in HUC14 02030103030120 can be used to offset the deficit in HUC14 02030103030140. However, because the deficit in HUC14 02030103030140 is so large, the deficit in this HUC will remain in the severe category even after the upstream surplus is considered.

Water Conservation and Deficit Reduction Estimates

Golf Course Water Use

There are a variety of options available to golf courses that can be implemented to achieve a reduction in water use. Due to the quantity of water used, even small reductions in water use can offer meaningful reductions in water use.

The potential water use reduction potential at golf courses has been estimated to be 26%.[17] However, this seems an aggressive goal for the purpose of the WUCMP. Reduction potential at golf courses has been set at 10% to be consistent with other strategies listed above.

Based on available data, the average water withdrawals for Rockaway River Country Club between June – September is approximately 0.16 MGD.

Based on the 10% reduction indicated above, approximately 16,000 gallons per day can be conserved for Denville Township using this mitigation strategy.

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[17] Gleick, Peter H, et al, Waste Not, Want Not: The Potential for Urban Water Conservation in California (Nov 2003), Commercial Water Use and Potential Savings: Appendix E, Pacific Institute for Studies in Development, Environment, and Security, p. 7. Retrieved < http://www.pacinst.org/reports/urban_usage/appendix_e.pdf>.

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.[18] This strategy is focused on the design of intelligent irrigation systems 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 of interest was estimated using a GIS analysis. Using NJDEP's 2015 Land Use/Land Cover feature dataset, land use types associated with residential, commercial, and recreational land uses were isolated.

The total irrigated portion of the land use types indicated above was assumed to be 50% of the total pervious land area identified in the residential and recreational 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.[19]

Based on the GIS analysis described above, the following table of acreage by land use type is shown in **Table 30** for parcels within the Denville Water Department distribution area. This is for the "URBAN" land use type and does not include stormwater basins and "other urban or built-up land". In addition, other HUC14s outside of this study area are included as water conservation measures within those HUC14s will benefit water supply withdrawals and subsequently HUC14 02030103030090 and 02030103030140.

Table 31 – Estimated Total Pervious Acres and Irrigated Acres by Land Use Type

HUC14	Pervious Acres by Land Use Type			Total
	Residential	Commercial & Industrial	Recreational	
02030103030090: Rockaway R (BM 534 brdg to 74d 33m 30s)	20.1	9.1	3.4	32.6
02030103030120: Den Brook	663.0	21.9	18.5	703.5
02030103030140: Rockaway R (Stony Brook to BM 534 brdg)	413.0	30.9	29.0	472.9
Other HUC14s[1]	257.9	11.6	3.5	273.1
Estimated Total Irrigated Acres[2]	677.1	36.8	27.2	741.0

1. Within the Denville Water Department service area, but outside the three HUC14s in this WUCMP
2. Estimated Total Irrigated Acres = Total Pervious Acres x 50%

[18] 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 >.

[19] 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.

Based on the total irrigated acreage and a peak irrigation rate of 8 gpm/acre, a total of 5,928 gpm peak irrigation is estimated in Denville. 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, and assuming an irrigation period of five months (May-September), this equates to an average irrigation water usage of approximately 406,500 gallons per day.

Irrigation water usage can be reduced by 10% using this strategy (conservative estimate), resulting in the following conservation totals from each subwatershed (raw/consumptive in gpd):

- HUC14 02030103030090: 893/804
- HUC14 02030103030120: 19,295/17,366
- HUC14 02030103030140: 12,971/11,694

Based on the above, approximately 31,500 gpd can be conserved for Denville Township using this mitigation strategy.

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%.[20] This is consistent with current estimates of distribution system in New Jersey.[21]

A conservative estimate of 10% can be applied to the reduction of real water loss volume as the potential savings in water use.[22]

Average water withdrawal by the Denville Water Department during June through August is 1.82 MGD. Based on the assumptions indicated above, the real water loss is estimated at 10% or 182,000 gallons per day. Using the 10% reduction rate indicated above, approximately 18,200 gallons per day can be conserved using this mitigation strategy.

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

[21] 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>

[22] 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>

Water Bill/Structure Comparison

There are an estimated 16,735 persons in the water service areas within the Denville Township area (based on 2016 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.[23]

Average water withdrawal in the existing areas served by public water supply in this WUCMP area is 1.82 MGD from the Denville Water Department. Using the 1% reduction rate indicated above, approximately 18,200 gallons per day can be conserved using this mitigation strategy.

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%.[24]

Using the 1% reduction rate indicated above, approximately 18,200 gallons per day can be conserved using this mitigation strategy.

Summary of Savings Potential

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

Table 32 - Summary of Potential Water Use Reductions

Strategy	Potential Savings (gpd)
Golf Course Water Use	16,000
Irrigation System Design	31,500
Leak Detection and Repair	18,200
Water Bill/ Structure Comparison	18,200
Rate Structure	18,200
Total	**102,100**

The above table presents potential savings that are representative of withdrawals during the June-July-August period. The total savings potential is 102,100 gpd.

As mentioned earlier a total of 1,530,250 gpd has to be mitigated in order to eliminate the total deficit for HUC14 02030103030140. Denville's contribution to this would be 59%, or 902,852 gpd.

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

[24] 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.

However, the saving potential for Denville Township is more realistically within the range of 12% of this total. Complete elimination of the deficit by using the conservation strategies listed above in the short-term is not feasible. However, simple measures described above can alleviate more than 10% of the portion of the deficit in this HUC14 for which Denville Township is responsible.

Monitoring and Annual Water Use and Return Data

The mitigation strategies selected to reduce the deficit in the subwatershed must be evaluated periodically. A cursory annual review of each strategy will be conducted to determine its effectiveness and a more detailed review will every five years update the Net Water Availability tables of this WUCMP. The biennial review will include an analysis of the likelihood of achieving the target reduction in the Net Water Availability deficit via the mitigation strategy. The same analytical techniques used in the initial Net Water Availability determination will be used to determine the future deficit or surplus within the subwatershed.

Annual Water Use and Return Data

Each year, a review will be conducted of water use data for these watersheds for the preceding year. This data can be obtained from the water purveyor (Denville Water Department, Boonton Town Water and Mountain Lakes Water Department).

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 other category of well has been constructed in the preceding year. Once the population is adjusted and new wells are identified, water use in these watersheds should be re-calculated and compared to the results of the initial calculation.

USGS stream gauges and monitoring stations are present within these subwatersheds and may be a valuable source of data. Each gauge and station should be evaluated to determine if it offers a viable means for monitoring Deficit Mitigation Strategies.

A re-evaluation of septic system returns for these subwatersheds should be performed biennially. The re-evaluation should update the total number of septic systems and identify any new or expanded public sanitary sewer service within the subwatersheds.

The existing ArcGIS database should be updated to show any new stormwater management basins where enhanced recharge has been implemented and any new sewer discharge points. After identification of new water return systems such as these, a new water return calculation will be performed and compared with the baseline calculation.

The re-evaluation will end with a calculation of the current deficit/surplus. As the WUCMP is implemented and adjusted, the results of each biennial review should show a reduced deficit or a surplus.

Stakeholder Participation and Ongoing Monitoring

Public education plays a significant role in the success of deficit 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 or inquiries to utilities and municipalities regarding their participation. The survey data should be tabulated and analyzed statistically. Statistical analysis is necessary because only a fraction of the population will respond to the survey. In preparation of this plan, an initial participation rate for each mitigation strategy was assumed. The results of the survey will provide a basis for estimating the actual participation rate for each strategy. These results may show that a mitigation strategy was unsuccessful primarily due to low participation. In that case, other strategies should be considered that may be more effective.

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 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/revision of timeline to achieve deficit reduction/elimination.

Overall, it is important that annual determinations/analysis/monitoring be conducted to verify the effectiveness of the implementation plan. A database that stores annual monitoring data should be kept, beginning with implementation of this plan, and continuing after deficit elimination, to document continued compliance and ensure that a deficit does not become apparent. If monitoring is efficient and thorough, elimination of deficits should be reasonably achievable.

Strategies

The following deficit mitigation strategies have been chosen for implementation and additional strategies will be added as the program progresses.

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.

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

Water Bill Structure/Comparison

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

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.

Schedule to Achieve Water Balance

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

The leak study has already been implemented and is an ongoing program. Larger or more widespread repairs may require several years to implement.

It is anticipated that at least 2 years 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.

Responsible parties for maintaining the water balance will consist of the following:

- Homeowners and businesses within Denville Township
- Denville municipal government and water utility
- Agriculture/ farms (i.e. Hamilton Farm)
- Business and commercial (i.e. Independence Plating Corp.)
- Golf courses (Rockaway River Country Club)

It is recommended that a committee be established to monitor and promote progress at the municipal level.

Funding Commitments

TBD

Next Steps

To be determined by Stakeholders.

Appendix A - Definitions

Background

Net water availability is defined as Groundwater 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 Groundwater Availability (MGD)	Non-Ag Groundwater Availability (MGD)	Total Non-Ag Consumptive Use (MGD)	Imported Septic Return (MGD)	Non-Ag 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.

Groundwater Availability

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

Agricultural (Ag) Groundwater Availability

Agricultural (Ag) Groundwater Availability – Ag Groundwater Availability is not applicable in each watershed. This type of Groundwater Availability is used when the Conservation Zone covers a majority of the watershed. In this case, Ag Groundwater Availability is established and tracked separately to support sustainable agriculture.[25]

[25] Highlands Council Technical Report, Water Resources Volume II Water Use and Availability" (Highlands Council, 2008), p. 123.

Non- Agricultural (Non-Ag) Groundwater Availability

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

Consumptive/Depletive Uses

Consumptive and Depletive (Water) Use totals are derived from Groundwater 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 the calculated as follows:

Total Non-Ag Consumptive Use = [Adjusted Consumptive Domestic Use] +
[Consumptive Public Supply Use] +
[Total Non-Ag Consumptive Use from Surface Water]+
[Other Non- Ag Consumptive Use from Groundwater]

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 Groundwater 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 Groundwater. 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 Groundwater

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

- 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 Groundwater Availability remaining after deducting Total Non-Ag Consumptive Uses and adding Imported Septic Return.

Net Water Availability cannot exceed Groundwater 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 Groundwater Availability. In such cases, (Non-Ag) Net Water Availability is set to Non-Ag Groundwater Availability and the remaining portion is allocated under Surplus for Potential Use.

Appendix B

WUCMP Monitoring Form Template

Appendix B includes a sample Water Use and Conservation Management Monitoring Form.

Municipal Water Use and Conservation Management Plan
Denville Township

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form

Year:		**Prepared By:**	
HUC14:			
Name:		**Title:**	
Groundwater Availability (MGD):			
Baseline Net Water Availability (MGD):		**Date:**	

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							
Wastewater Discharge							
Mitigation Strategies							

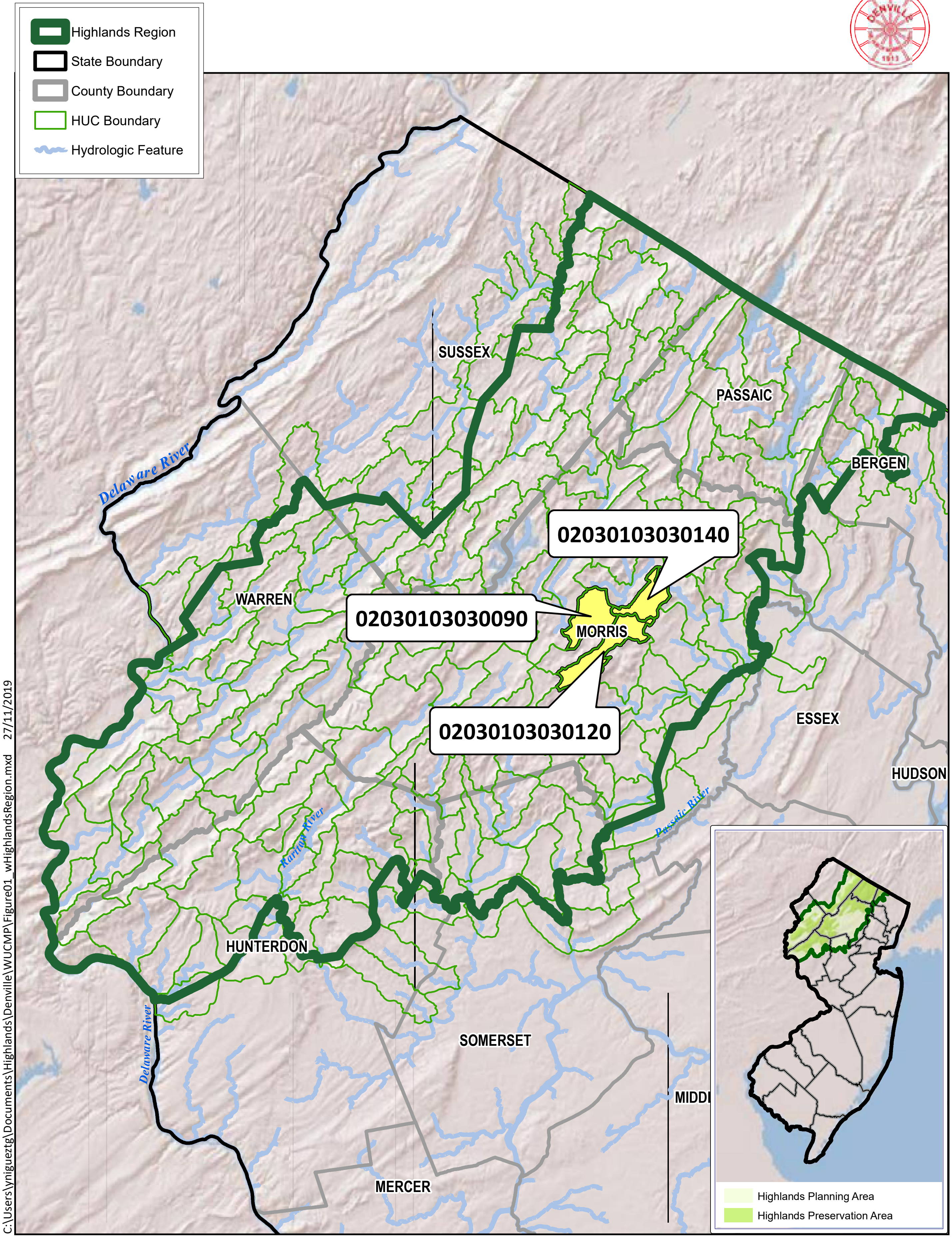
Municipal Water Use and Conservation Management Plan
Denville Township

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form

Year:		**Prepared By:**	
HUC14:			
Name:		**Title:**	
Groundwater Availability (MGD):			
Baseline Net Water Availability (MGD):		**Date:**	

Owner	**Type**	**Year Installed**	**Anticipated Benefit (gpd)**	**Adjustment Required to NWA? (Y/N)[2]**	**Revised NWA (MGD)**	**Planned Mitigation Strategies for Next Year**
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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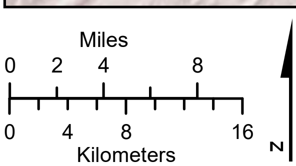

HUC14	Subwatershed Name
02030103030090	Rockaway R (BM 534 brdg to 74d 33m 30s)
02030103030120	Den Brook
02030103030140	Rockaway River (Stony Brook to BM 534 brdg)

Figure 1
Highlands Region and WUCMP Location

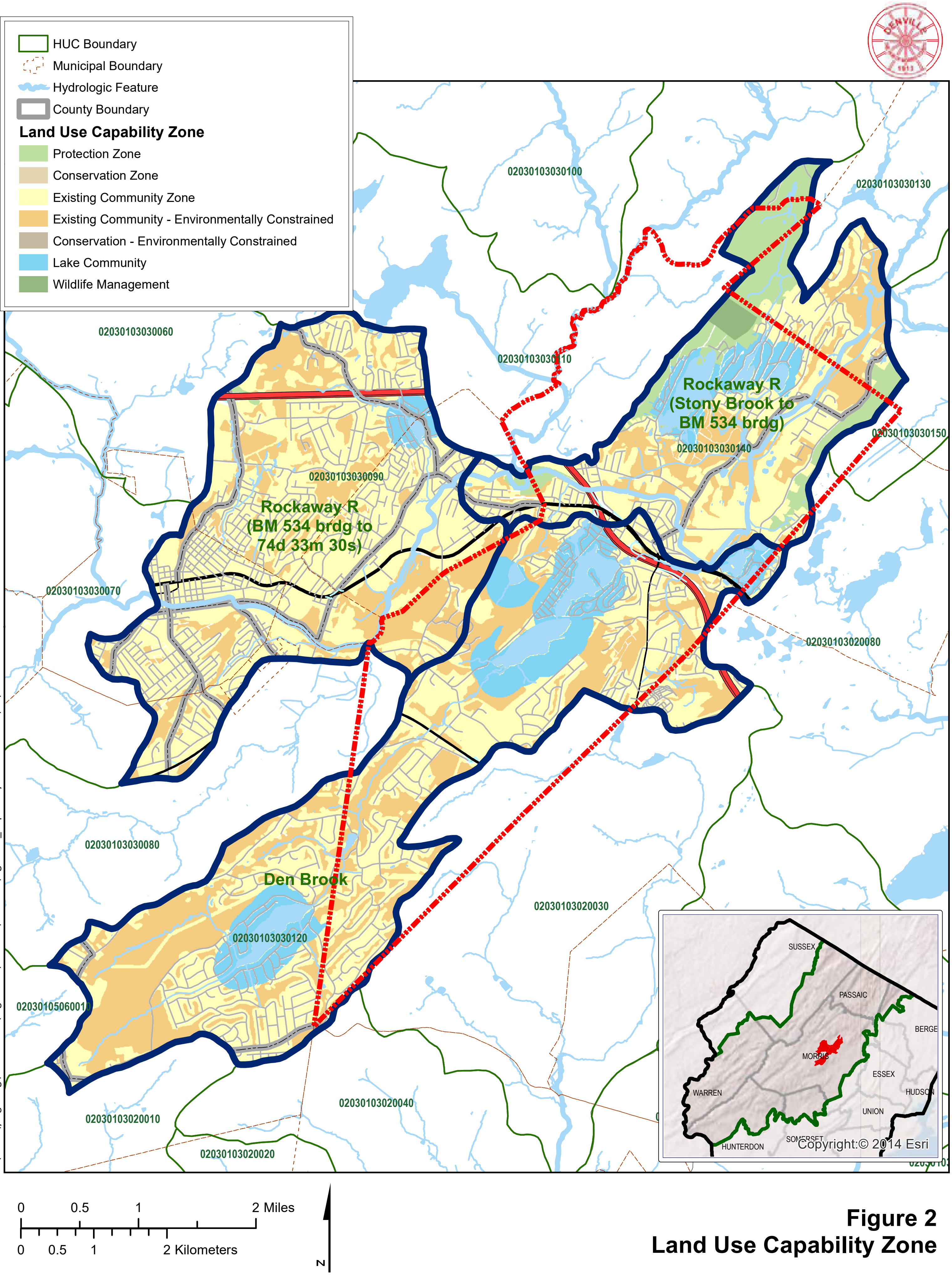

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Figure 2
Land Use Capability Zone

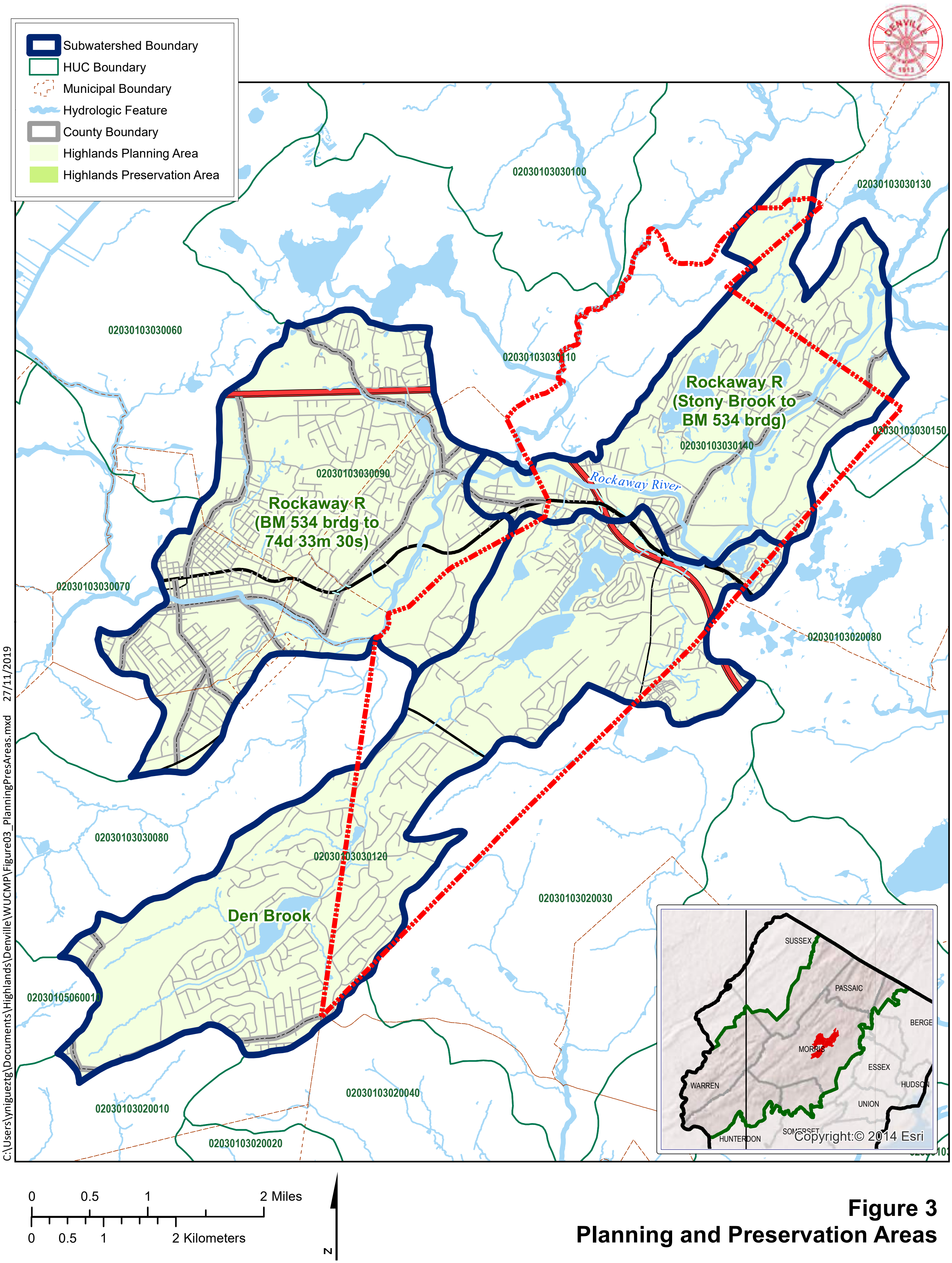
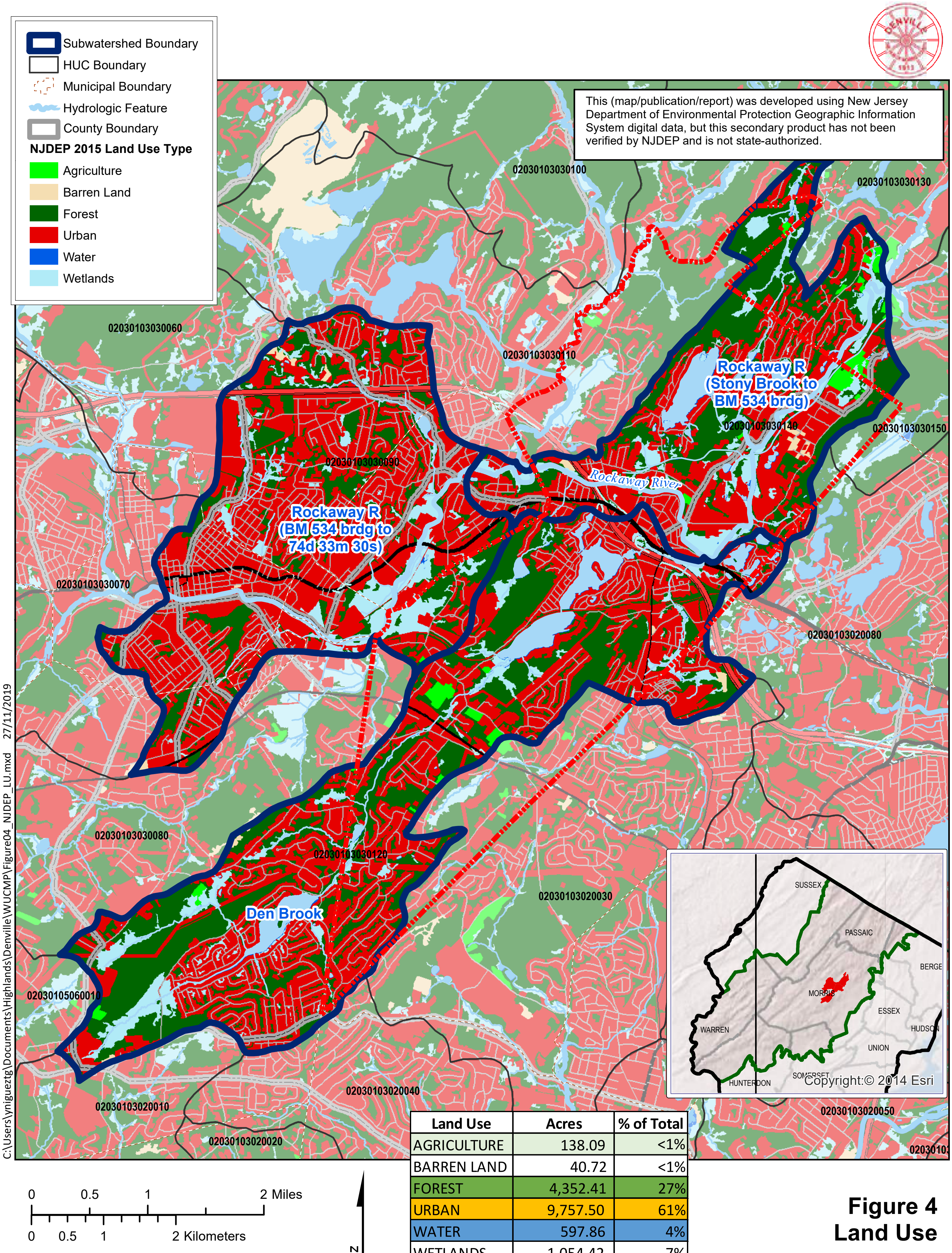
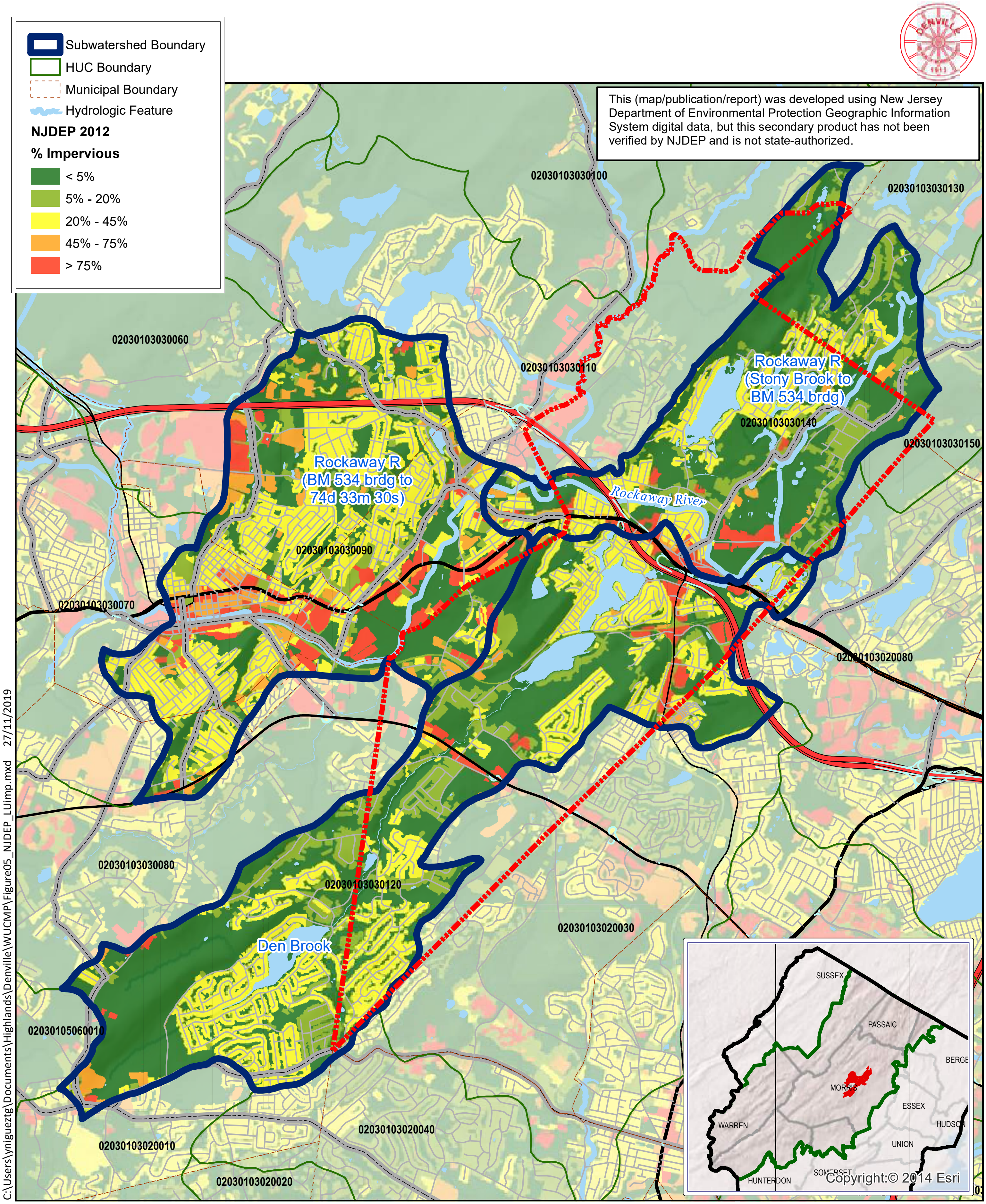


Figure 3
Planning and Preservation Areas



Land Use	Acres	% of Total
AGRICULTURE	138.09	<1%
BARREN LAND	40.72	<1%
FOREST	4,352.41	27%
URBAN	9,757.50	61%
WATER	597.86	4%
WETLANDS	1,054.42	7%

Figure 4
Land Use



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0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

N

HUC14	Subwatershed Name	% Impervious
02030103030090	Rockaway R (BM 534 brdg to 74d 33m 30s)	9%
02030103030120	Den Brook	7%
02030103030140	Rockaway River (Stony Brook to BM 534 brdg)	4%

Figure 5
Impervious Cover

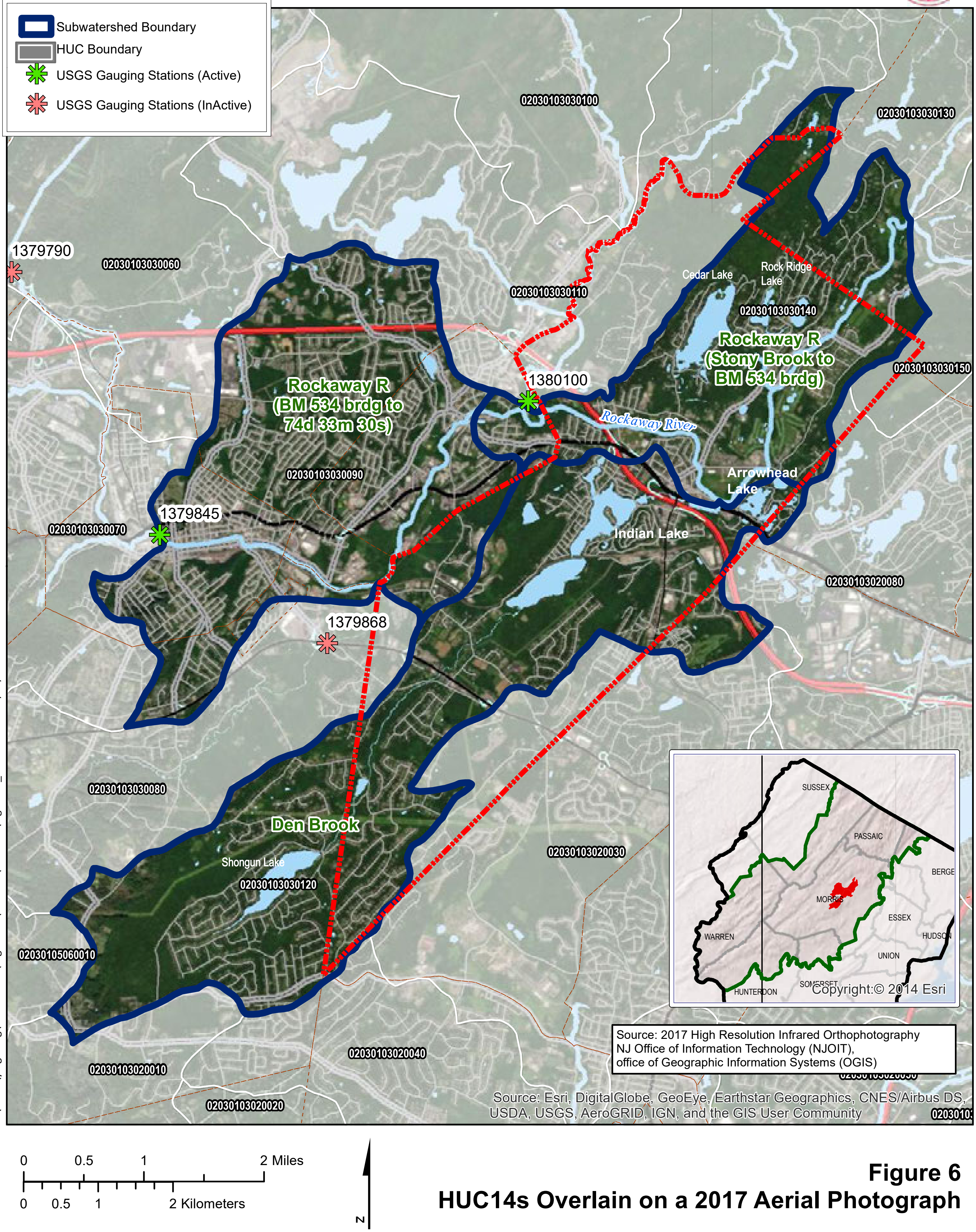

Figure 6
HUC14s Overlain on a 2017 Aerial Photograph

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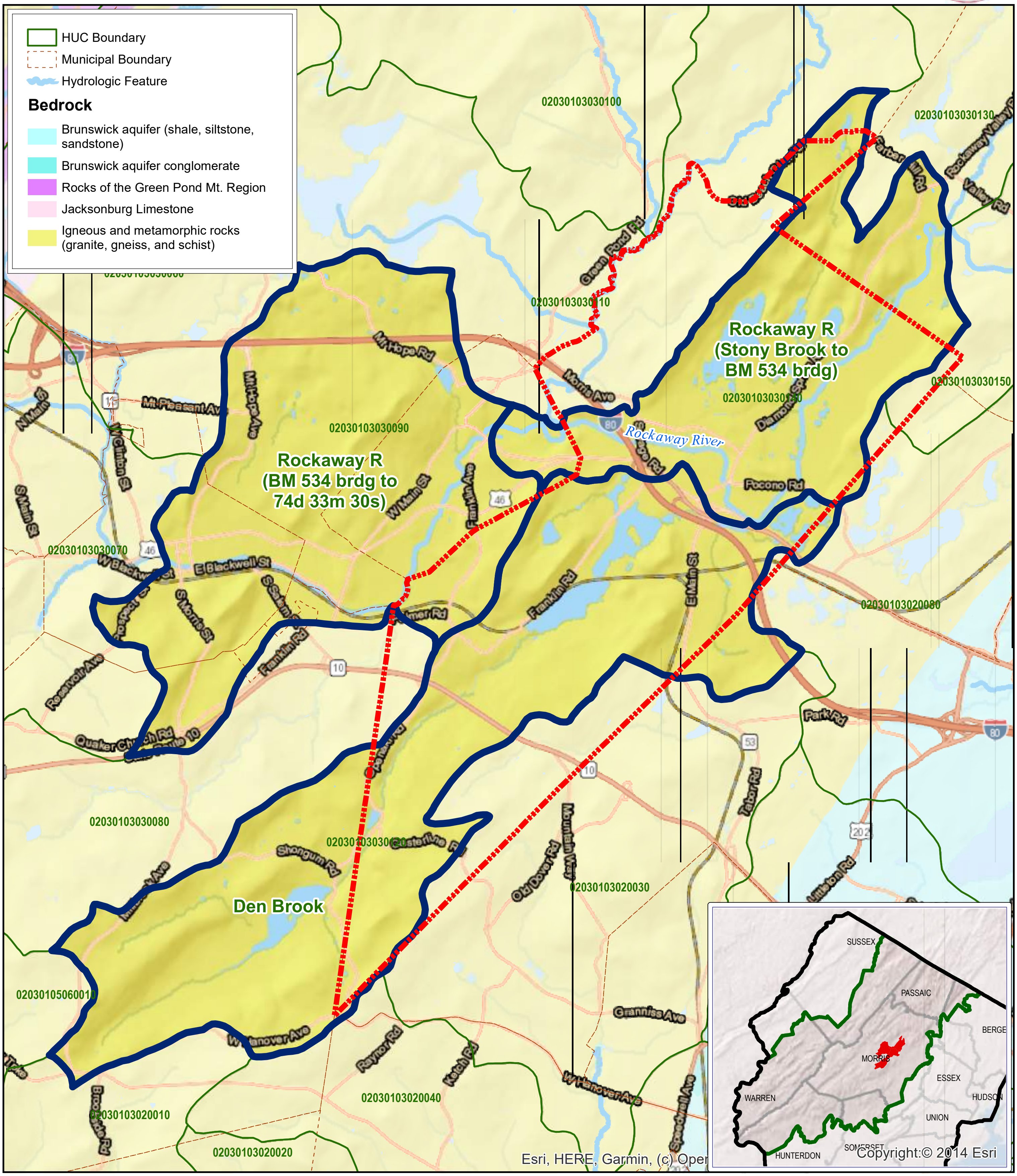

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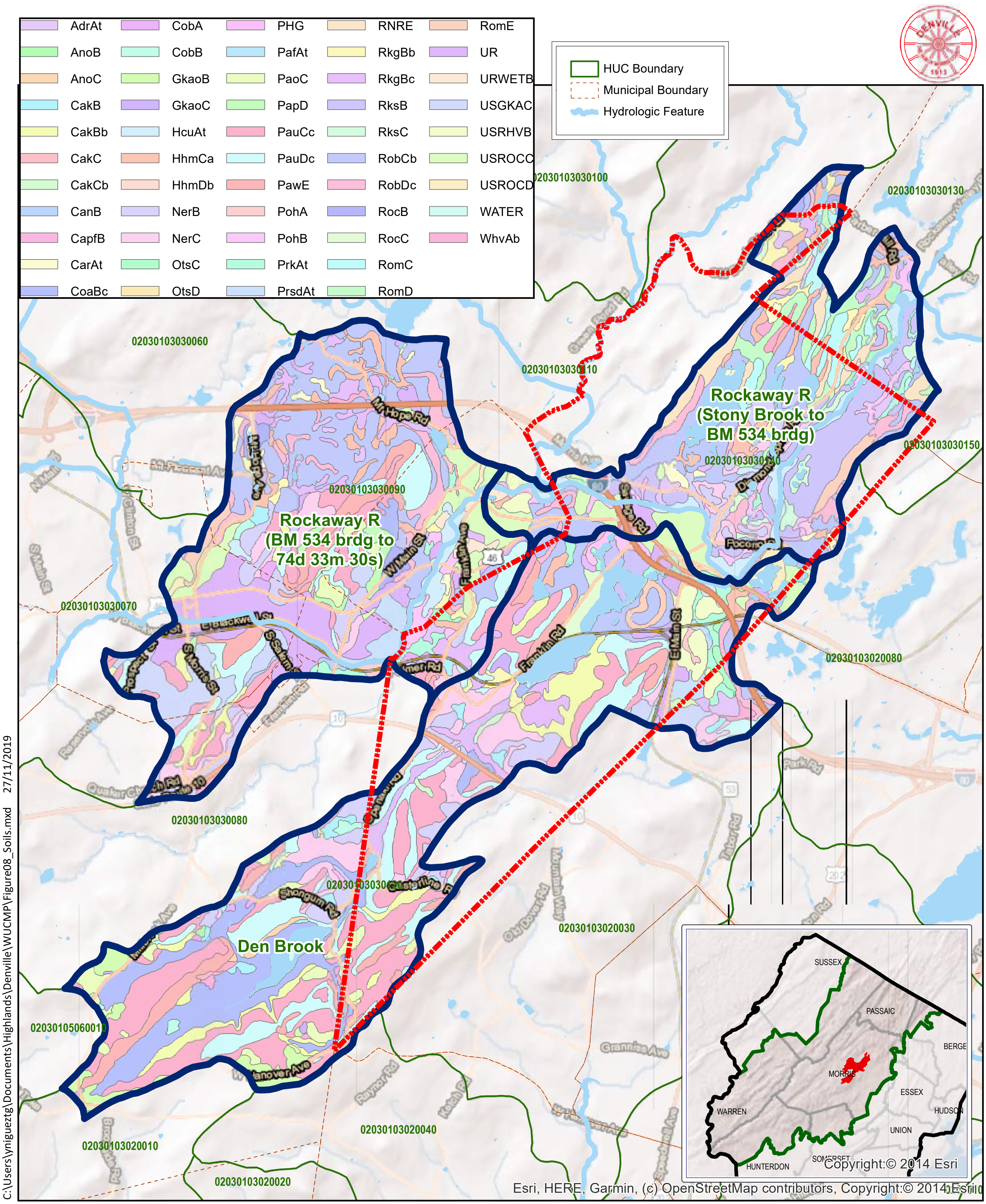
Figure 7
Bedrock Geology



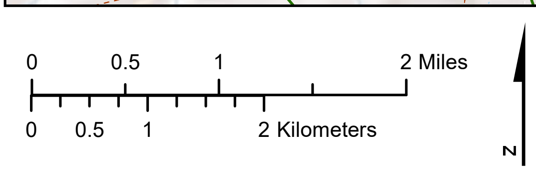


Figure 8
Soil Types

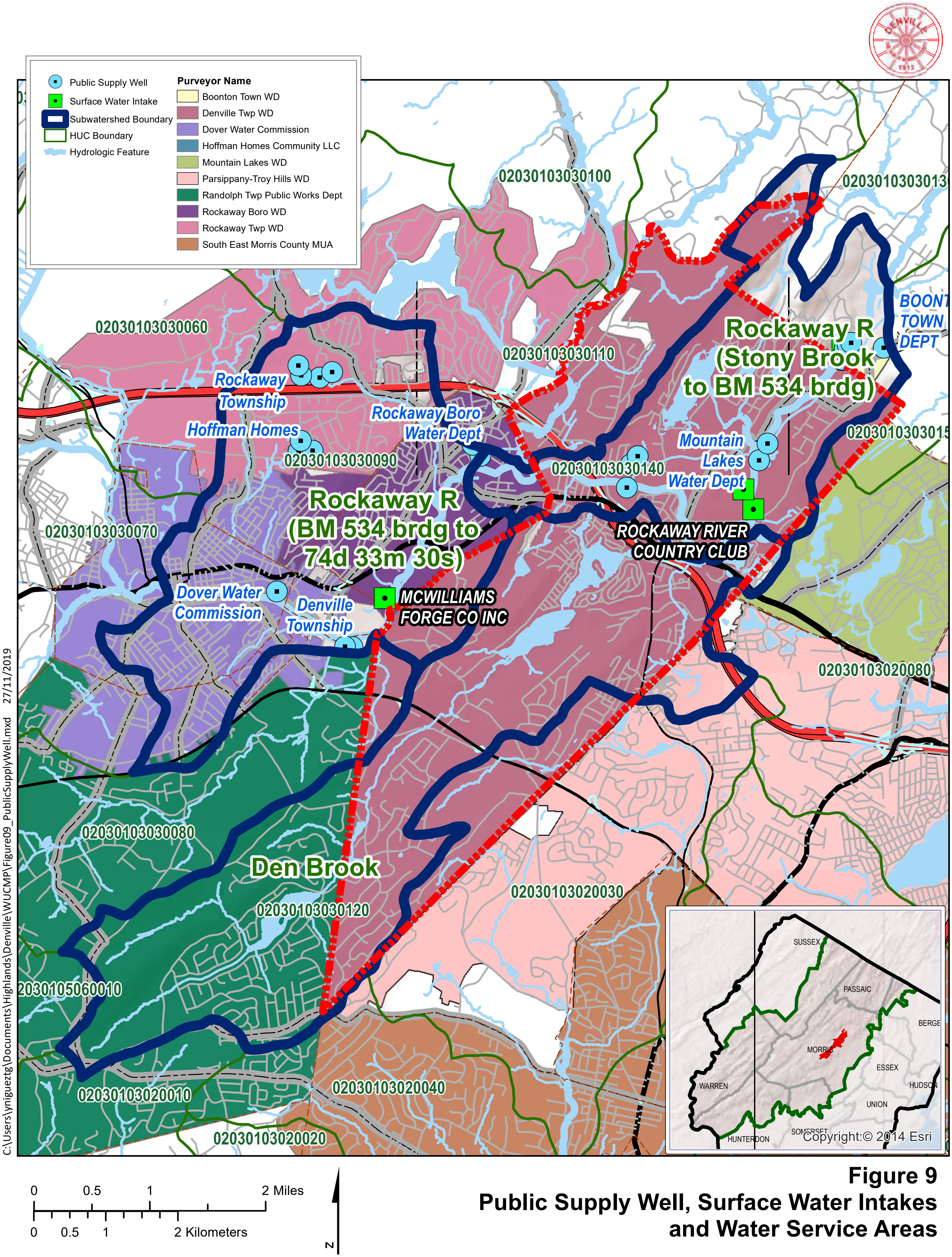


Figure 9
Public Supply Well, Surface Water Intakes and Water Service Areas

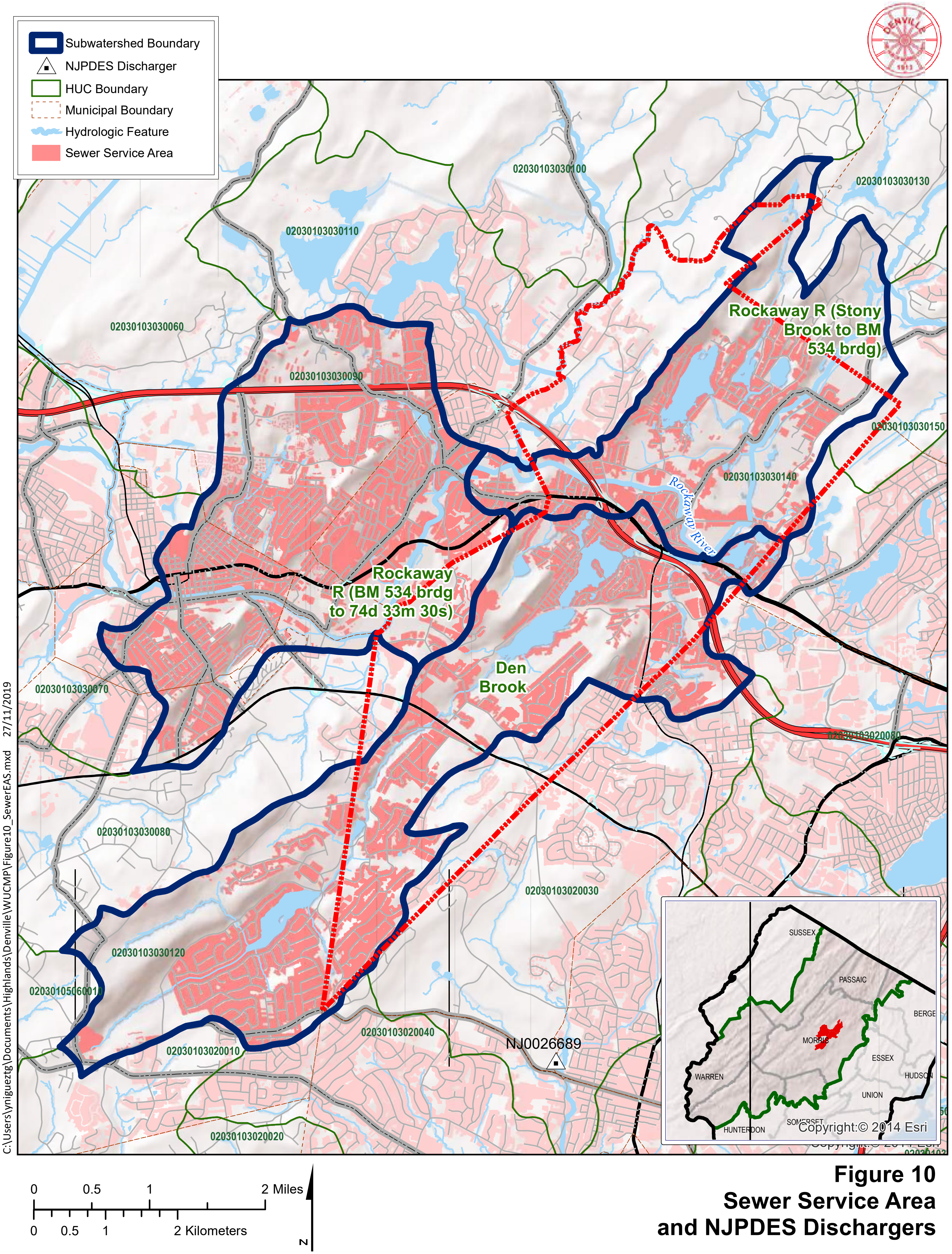


Figure 10
Sewer Service Area and NJPDES Dischargers

Table 2

Re-evaluated Net Water Availability for 02030103030120 (Den Brook)

HUC 1	Ground Water Availability			Wastewater Return			Potable Water Supply	Surface Water Withdrawal	Non-Potable Ground Water Pumping	Septic Return		Consumptive Uses						Net Water Availability		
02030103030120	Ag Ground Water Availability (mgd)	Non-Ag Ground Water Availability (mgd)	Ground Water Availability Zone	WW Return to GW (mgd)	Sept. WW Return to Sfc Water (mgd)	Month of Maximum Pumping	Adjusted Total Potable Supply (mgd)	Total Surface Water Withdrawal (mgd)	Total Non-Potable Ground Water Pumping (mgd)	Septic Return from Public Supply (mgd)	Imported Septic Return (mgd)	Adjusted Consumptive Domestic (mgd)	Consumptive Public Supply (mgd)	Total Non-Ag Consumptive Use from Surface Water (mgd)	Other Non-Ag Consumptive Use from Ground Water (mgd)	Total Non-Ag Consumptive Use (mgd)	Total Ag Consumptive (mgd)	Ag Net Water Availability (mgd)	Non-Ag Net Water Availability (mgd)	Surplus for Potential Use (mgd)
PUBLISHED	**0.0000**	**0.3015**	**ECZ**	**NA**		**NA**	**0.0948**	**0.0000**	**0.0000**	**NA**	**NA**	**0.0275**	**0.0000**	**0.0000**	**0.0000**	**0.0275**	**0.0000**	**0.0000**	**0.0754**	**P**
2000	0.0000	0.3015	ECZ	0.0000	0.0000	August	1.0202	0.0000	0.0000	0.0008	0.0000	0.0301	0.9158	0.0000	0.0000	0.9458	0.000	0.0000	-0.6443	0.000
2001	0.0000	0.3015	ECZ	0.0000	0.0000	July	1.1207	0.0000	0.0000	0.0009	0.0000	0.0301	1.0161	0.0000	0.0000	1.0462	0.000	0.0000	-0.7446	0.000
2002	0.0000	0.3015	ECZ	0.0000	0.0000	July	1.1050	0.0000	0.0000	0.0011	0.0000	0.0301	1.0002	0.0000	0.0000	1.0303	0.000	0.0000	-0.7288	0.000
2003	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0292	0.000	0.0000	0.2723	0.000
2004	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0009	0.0000	0.0301	-0.0009	0.0000	0.0000	0.0292	0.000	0.0000	0.2724	0.000
2005	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0007	0.0000	0.0301	-0.0007	0.0000	0.0000	0.0294	0.000	0.0000	0.2722	0.000
2006	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0292	0.000	0.0000	0.2723	0.000
2007	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0292	0.000	0.0000	0.2723	0.000
2008	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0009	0.0000	0.0301	-0.0009	0.0000	0.0000	0.0292	0.000	0.0000	0.2723	0.000
2009	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0293	0.000	0.0000	0.2723	0.000
2010	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0292	0.000	0.0000	0.2723	0.000
2011	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0293	0.000	0.0000	0.2722	0.000
2012	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0007	0.0000	0.0301	-0.0007	0.0000	0.0000	0.0293	0.000	0.0000	0.2722	0.000
2013	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0007	0.0000	0.0301	-0.0007	0.0000	0.0000	0.0294	0.000	0.0000	0.2721	0.000
2014	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0007	0.0000	0.0301	-0.0007	0.0000	0.0000	0.0293	0.000	0.0000	0.2722	0.000
2015	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0009	0.0000	0.0301	-0.0009	0.0000	0.0000	0.0292	0.000	0.0000	0.2723	0.000
2016	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0007	0.0000	0.0301	-0.0007	0.0000	0.0000	0.0293	0.000	0.0000	0.2722	0.000
2017	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0007	0.0000	0.0301	-0.0007	0.0000	0.0000	0.0293	0.000	0.0000	0.2722	0.000
2018	0.0000	0.3015	ECZ	0.0000	0.0000	NA	0.1037	0.0000	0.0000	0.0008	0.0000	0.0301	-0.0008	0.0000	0.0000	0.0293	0.000	0.0000	0.2723	0.000

Note: WW = Wastewater; GW = Ground Water

Non-Ag Ground Water Availability based on entire HUC14, not only portion of HUC14 within Highlands Region (published)

TOWNSHIP OF DENVILLE
PLANNING BOARD

ADOPTING THE HIGHLANDS COUNCIL WATER USE AND CONSERVATION MANAGEMENT PLAN AS A SUB-ELEMENT OF THE CONSERVATION PLAN OF DENVILLE'S MASTER PLAN

WHEREAS, the Planning Board of the Township of Denville, County of Morris, State of New Jersey has a Master Plan which has been adopted and re-examined from time to time pursuant to the applicable laws of the State of New Jersey; and

WHEREAS, it has been deemed that the proposed Water Use and Conservation Management Plan ("WUCMP"), as initially drafted by the New Jersey Highlands Council ("Council") dated October 2020 and last revised August 2021, is an essential part of said Master Plan; and

WHEREAS, the Planning Board through its Engineer, John Ruschke of Mott MacDonald Group, Inc., presented and discussed the WUCMP at its duly noticed public meeting held on May 11, 2022; and

WHEREAS, copies of the WUCMP were made available for review by the public at least 10 days prior to May 11, 2022 and adequate notice of the meeting advising that the WUCMP was on the agenda for discussion and the public was given the opportunity to attend and comment; and

WHEREAS, based on the Planning Board's review of the WUCMP, as well as the presentation of John Ruschke, the Planning Board has determined that the proposed WUCMP is consistent with the goals and objectives of the Township's Master Plan and the adoption and implementation of the proposed WUCMP would be in the public interest by protecting the public health, safety, and general welfare;

WHEREAS, the Planning Board has determined that it is in the best interest of the Township to implement the WUCMP in order to protect, restore, and enhance water resources in our municipality, as well as the Highlands region, as a whole.

NOW, THEREFORE, BE IT RESOLVED that the Planning Board hereby adopts the Highlands Council's Water Use and Conservation Management Plan dated October 2020 and last revised August 2021 as a Sub-Element of the Conservation Plan of Denville's Master Plan.

MEMBERS ELIGIBLE TO VOTE: Ciardi, Buie, Venis, Maffei, Kuser, Andes, Schmitt

CERTIFICATION

I, Dagmara Stroisz, Administrative Secretary of the Planning Board of the Township of Denville, County of Morris, State of New Jersey, hereby certify that the foregoing is a true and exact copy of a Resolution adopted at a meeting of the Planning Board held on May 11, 2022.

Dagmara Stroisz, Administrative Secretary