Water Use and Conservation Management Plan

for

HUC14 02040105150040 Lubbers Run (above/ incl. Dallis Pond)
HUC14 02040105150050 Lubbers Run (below Dallis Pond)
HUC14 02040105150060 Cranberry Lake / Jefferson Lake & tribs

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

July 2021

Prepared for Byram Township by:

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WATER USE AND CONSERVATION MANAGEMENT PLAN

for

HIGHLANDS REGIONAL MASTER PLAN CONFORMANCE

BYRAM TOWNSHIP
SUSSEX COUNTY, NEW JERSEY

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Executive Summary

Introduction

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

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.
- **Reevaluation 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), review of reuse potential and storage. While each WUCMP includes a comprehensive list of deficit mitigation strategies, it is understood the application of individual strategies will vary amongst municipalities. In addition, municipalities may have additional strategies that are not included. Deficit mitigation strategies have been ranked within these WUCMPs but the rankings are subject to change, based on municipal preference.
- **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.

Summary

This WUCMP area covers the following HUC14 subwatersheds:

- 02040105150040: Lubbers Run (above/ incl. Dallis Pond)
- 02040105150050: Lubbers Run (below Dallis Pond)
- 02040105150060: Cranberry Lake / Jefferson Lake & tribs.

Byram Township is within these subwatersheds. Although ten (10) subwatersheds intersect Byram Township, water withdrawals from Byram Township are minimal relative to neighboring municipalities and a full evaluation of those subwatersheds has been therefore reserved for those municipalities.

Major water services providers included in planning area include:

- Sparta Department of Utilities
- Aqua (formerly Byram Homeowners Association)
- Suez (formerly East Brookwood Estates Property Owners Association)
- Hopatcong Water Department (outside of Byram but in HUC14)
- Colby Homeowners Association Water Company
- North Shore Water Association
- Strawberry Point Property Owners Association
- Briar Heights & Della Heights Property Owners Association
- Frenches Grove Water Association

Two additional water system serve Byram Township but are not in the planning area. Forest Lakes Water Company wells are located in Andover Borough in HUC14 02040105070020 (New Wawayanda Lake/Andover Pond trib). Because Andover Borough is not in the Highlands region, withdrawals from the well does not need to be accounted for in the WUCMP. Brookwood Musconetcong River Property Owners Association has wells within HUC14 02040105150070 (Musconetcong R (Waterloo to/incl WillsBk)) and HUC14 02040105150030 (Musconetcong R (Wills Bk to LkHopatcong)). Because the wells account for less than 10% of both HUCs withdrawals, the HUCs are not part of Byram Township's WUCMP.

Net Water Availability

The analysis of net water availability (NWA) for this planning area indicates the following variation in NWA between 2000 and 2018.

Summary of Variation in Net Water Availability - 2000 - 2018

HUC14	Minimum (mgd)	Maximum (mgd)
02040105150040	-0.2042	-0.0355
02040105150050	-0.0296	-0.0224
02040105150060	-0.0171	-0.0171

Water Conservation and Deficit Reduction and Elimination Strategies

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

- Irrigation System Design – promotion of intelligent irrigation system design
- Low Flow Showerheads and Toilet Fixtures – promotion of water-efficient showerheads and toilet fixtures
- Stormwater Ordinance – promote recharge and/or infiltration within the subwatershed.
- Retrofit Detention Basins – convert existing detention basins to infiltration basins. Water Bill Structure/Comparison – highlight historical use patterns for residential customers
- Rate Structure – develop water utility rate structures that promote water conservation.

Monitoring and Implementation Plans

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

It is important that biennial 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 ground water resources throughout the Highlands region.

One of the highest priority objectives described in the RMP is to restore and protect water resources within the Highlands Region. The development of Water Use and Conservation Management Plans specific to HUC14[2] subwatersheds is intended to address the requirements of this objective in a practical way that is applicable to each subwatershed.

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

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

Net Water Availability is total available groundwater minus consumptive and depletive water uses within a HUC14 subwatershed. Net Water Availability varies greatly from one area within the Highlands Region to another. Some areas have a water surplus (positive Net Water Availability). Other areas are in significant deficit (negative Net Water Availability). To reduce or eliminate the water deficits within the Region, Water Use and Conservation Management Plans are required under RMP Objective 2B8c:

> *Water Use and Conservation Management Plans shall be required through municipal Plan Conformance for all subwatersheds to meet the policies and objectives of Goal 2B, to ensure efficient*

1 Highlands Regional Master Plan, (Highlands Council, 2008), p. 159.
2 Referring to the Hydrologic Unit Code (HUC) system established by the United States Geological Survey.
3 Highlands Regional Master Plan, (Highlands Council, 2008), p. 160, Policy 2B2.

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

Implementation Strategy

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

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

This WUCMP includes the following components:

- **Identification of water sources and uses** – The Highlands Region uses both groundwater and surface water for potable water supply. Additional uses include irrigation (including agricultural), commercial, industrial and institutional.
- **Expanded evaluation of Net Water Availability** (expanded from the original analysis in the RMP) – Original calculations of Net Water Availability were based on maximum monthly 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 ten (10) HUC14 subwatersheds that intersect Byram Township, although the Township has a significant impact to NWA in only three (3) of these ten (10) HUC14s. Therefore, the focus of this WUCMP is within the following HUC14s (**Figure 1**):

- 02040105150040: Lubbers Run (above/incl Dallis Pond);
- 02040105150050: Lubbers Run (below Dallis Pond); and
- 02040105150060: Cranberry Lake / Jefferson Lake & tribs.

Byram has a direct influence on NWA in that one or more major supply wells are located both within the municipal boundary of Byram and within the focused HUC14s. 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 be the responsibility of those neighboring municipalities.

The seven (7) other HUC14s do not have any significant water withdrawals within Byram Township and only a small portion of those HUC14s exist within the Byram Township municipal boundaries. Therefore, Byram Township would have a very minimal impact to the NWA of those HUC14s[4]. That is not to say that water use and conservation does not apply within those HUC14s, rather that the applicable conservation measures would be limited to domestic supply (low-flow fixtures and/or irrigation limitations, for example) within Byram Township. As watersheds do not follow political boundaries, the HUC14s that are discussed within this WUCMP also extend beyond Byram Township and include portions of surrounding municipalities (Hopatcong Borough, Green Township and Sparta Township). Because Byram Township is responsible for managing only its own portion of the water resources within these HUC14s, the analysis and recommendations herein deal only with that portion.

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

WUCMP Area Characteristics

Background

Byram Township is in Sussex County, New Jersey. It covers an area of 22.71 square miles and has a population of approximately 8,350 people (2010 estimate). The area included in this WUCMP consists of three subwatersheds designated by Hydrologic Unit Code (HUC14) as follows:

- 02040105150040: Lubbers Run (above/incl Dallis Pond);
- 02040105150050: Lubbers Run (below Dallis Pond); and
- 02040105150060: Cranberry Lake / Jefferson Lake & tribs.

The land use within the Township and WUCMP area is mostly urban, but includes a large amount of forest land and small areas of agricultural lands and water.

Land Use Capability/Land Cover

Land Use Capability Zones

The Highlands Region is classified into three Land Use Capability Zones, of which Byram 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.
  - Byram Township has approximately 11,963 acres within the Protection Zone (approx. 89% 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 two sub-zones: Existing Community Environmentally-Constrained, and Lake Community.
  - Byram Township has approximately 1,459 acres within the Existing Community Zone (approx. 11% of the township area).
- **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.
  - Byram Township has no area within the Conservation Zone.

Figure 2 shows the Land Use Capability Map for Byram Township.

Preservation and Planning Areas

In addition to Land Use Capability Zones, the Highlands Region is subdivided into Preservation and Planning Areas. Preservation Areas are critical to water resource protection. Planning Areas have more existing development and are less environmentally constrained for further development. A summary of the goals for both the Preservation and Planning Areas is shown in **Table 1**. The majority of the Township is in the Highlands Preservation Area and only a small area of approximately 236 acres is within the Highlands Planning Area. **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 2012 conditions were obtained from the New Jersey Department of Environmental Protection (NJDEP). Based on 2012 conditions, the land use / land cover within the Township is primarily comprised of forest land (65%), urban (18%), wetlands (10%), water (5%), barren land (1%) and agriculture (1%). **Figure 4** depicts the land use types within the Township. The Township includes one mining site and mostly residential areas that contribute to the consumptive uses described in a subsequent section.

NJDEP 2012 impervious surface data are shown on **Figure 5**. For the WUCMP area, there is approximately 89% pervious cover. For individual HUC14s, impervious cover is only 3% for HUC14 02040105150060 and 4% for HUC14 02040105150040 and 0204105150050, respectively.

Major Hydrologic Features

The HUC14 subwatersheds addressed by this WUCMP for areas within Byram include several surface water bodies (**Figure 6**). In total, Byram has 15 named bodies[5] of water within the Township limits with several residential lake communities such as Lake Lackawanna. Another important hydrologic feature in the study area is the Musconetcong River, a major tributary to the Delaware River and runs along the southern border of the Township. Smaller tributaries to the Musconetcong River are also present (for example Lubbers Run) as are other smaller streams and creeks.

Geology and Soil Properties

Byram Township is located within the Highlands. The Highlands Physiographic Province 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**).

Soils within the area are shown on **Figure 8**. Approximately 80% 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 C and D which are generally 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[4]. Soil group B is

[5] Byram Township, https://www.byramtwp.org/index.php/parks_rec/lakes

generally comprised of 10 to 20% clay with a saturated hydraulic conductivity of 1.42 to 5.67 inches per hour[6].

Table 2 - Primary Soil Types within Byram Township.

Soil Symbol	Description	Percent of Township	Hydrologic Group
RokD	Rockaway-Chatfield-Rock outcrop complex, 15 to 35 percent slopes	34%	C/B/D
HncD	Hollis-Rock outcrop-Chatfield complex, New Jersey Highlands, 15 to 35 percent slopes	9%	D/B
RoefDc	Rockaway loam, thin fragipan, 15 to 35 percent slopes, extremely stony	8%	C
ChkE	Chatfield-Hollis-Rock outcrop complex, New Jersey Highlands, 35 to 60 percent slopes	6%	B/D
ChkC	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	5%	C/D
HhmBc	Hibernia loam, 0 to 8 percent slopes, extremely stony	5%	C
CatbA	Catden muck, 0 to 2 percent slopes	4%	B/D
RooC	Rockaway-Urban land complex, thin fragipans, 0 to 15 percent slopes	3%	C
AhcBc	Alden mucky silt loam, gneiss till substratum, 0 to 8 percent slopes, extremely stony	3%	C/D
RkrB	Riverhead sandy loam, 3 to 8 percent slopes	3%	B

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

Identification of Water Sources and Uses

Water System Profile

Description

Multiple water systems serve the WUCMP area. In total, public supply wells from ten service providers exist in the WUCMP area:

- Aqua (formerly Byram Homeowners Association)
- Colby Homeowners Association Water Company
- Hopatcong Water Department
- North Shore Water Association
- Sparta Department of Utilities
- Strawberry Point Property Owners Association
- Suez (formerly East Brookwood Estates Property Owners Association)
- Briar Heights and Della Heights Property Owners Association
- Frenches Grove Water Association
- Brookwood Musconetcong River Property Association (West Brookwood)

Sparta Department of Utilitieshas eleven (11) water supply wells located within the WUCMP area but largely serves areas outside Byram Township's boundaries. The areas served within the WUCMP receive water through the two (2) Sparta Department of Utilities pressure zones identified as Seneca Lake and Intermediate. Hopatcong Water Department's well does not serve Byram Township. Homes and businesses outside of the public water service areas are served by privately owned ground water wells.

Two additional water systems serve Byram Township but are not in the planning area. Forest Lakes Water Company has three wells located in Andover Borough in HUC14 02040105070020 (New Wawayanda Lake/Andover Pond trib). Because Andover Borough is not in the Highlands region, withdrawals from the well does not need to be accounted for in the WUCMP.

Brookwood Musconetcong River Property Owners Association has two wells within HUC14 02040105150070 (Musconetcong R (Waterloo to/incl WillsBk)) and one well in HUC14 02040105150030 (Musconetcong R (Wills Bk to LkHopatcong)). The withdrawals account for less than 10% of all withdrawals in HUC14 02040105150070, and less than 2% of all withdrawals in HUC14 02040105150030. Because Byram is responsible for only a small portion of the net water availability in the HUCs, the HUCs are not included in the WUCMP.

In addition, there are smaller non-community wells associated with individual properties like schools and businesses. The largest non-community system in Byram include Gordon Byram Assoc LLC (ShopRite of Byram), Byram Quick Check 183, Byram Intermediate & Lakes School, and Tomahawk Lake Inc (2 systems).

In addition to the water systems mentioned above, ground water withdrawals for mining (dewatering) are also present in the WUCMP area.

Facilities

Community public water supply wells for most water systems mentioned above are shown on **Figure 9** along with the existing areas served, as obtained from the New Jersey Highlands Council. Community water supply wells are installed in fractured igneous and metamorphic rocks. And data from Byram Township.

Service Areas

Providers operating within the WUCMP area include the following:

- Sparta Department of Utilities serving a small area in the northern part of Byram Township);
- Aqua (formerly Byram Homeowners Association) serving a small area in the north-eastern part of Byram Township;
- Suez (formerly East Brookwood Estates Property Owners Association) serving a small area in the south-eastern part of the Township;
- Hopatcong Water Department serving areas outside the WUCMP area (the provider has a well located within HUC14 020401051510050, but serves areas outside of Byram Township);
- Colby Homeowners Association Water Company serving a very small area in the northern area of HUC14 02040105150060;
- North Shore Water Association serving a small community next to Cranberry Lake in the south-western part of the Township;
- Strawberry Point Property Owners Association serving a community next to Cranberry Lake in the south-western part of the Township;
- Briar Heights and Della Heights Property Owners Association, serving a very small area next to Cranberry Lake in the south-eastern part of the Township;
- Frenches Grove Water Association, serving a community next to Cranberry Lake in the south-western part of the Township.

These service areas can be seen in **Figure 9**. A larger scale map showing individual wells within the three (3) HUC14s can be seen in **Figure 10, 11 and 12**.

Additional service areas located in Byram include Forest Lakes Water Company and Brookwood Musconetcong River Property Owners Association (West Brookwood). Both have wells in HUC14s that are not part of the WUCMP area. Non-community systems located in Byram and WUCMP include Gordon Byram Associates LLC (ShopRite of Byram), Byram Quick Check 183, Byram Intermediate & Lakes School, and Tomahawk Lake Inc (2 systems).

Allocation and Firm Capacity

Available allocation and capacity information for existing public ground water wells 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. Table 3 only shows water systems within the WUCMP area. Note that Briar Heights and Della Heights Property Owners Association and Frenches Grove Water Association are not listed since neither have firm capacity data.

Table 3 – Capacity Information for Public Groundwater Wells[7]

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)
Sparta Department of Utilities							
1918004	3.074	13.782	131.498	2.888	78.218	640.502	0.186
AQUA (formerly Byram Homeowners Association)							
1904009	0.058	2.053	18.250	0.046	1.421	12.234	0.012
SUEZ (formerly East Brookwood Estates Property Owners Association)							
1904002	0.093	1.550	18.600	0.056	1.742	15.698	0.037
Hopatcong Water Department							
1912001	0.680	20.800	193.000	0.534	15.523	154.623	0.146
Colby Homeowners Association **Water Company**							
1904007	0.000	NS	NS	NS	NS	NS	NS
North Shore Water Association							
1904004	0.000	NS	NS	NS	NS	NS	NS
Strawberry Point Property Owners Association							
1904006	0.000	NS	NS	NS	NS	NS	NS

NS = not specified

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 the most current available through NJDEP's Division of Water Supply and Geoscience (accessed May 1, 2020). Data were not available for Colby Homeowners Association Water Company, North Shore Water Association, Strawberry Point

[7] Reference: https://www.state.nj.us/cgi-bin/dep/watersupply/pwsproc.pl

Property Owners Association, Briar Heights and Della Heights Property Owners Association, and Frenches Grove Water Association.

Sparta Department of Utilities

The total peak daily demand for this system was 2.888 mgd which occurred in May 2015.

The Remaining Firm Capacity of this system is 0.186 mgd.

Aqua (formerly Byram Homeowners Association)

The total peak daily demand for this system was 0.046 mgd which occurred in December 2015.

The Remaining Firm Capacity of this system is 0.012 mgd.

Suez (formerly East Brookwood Estates Property Owners Association)

The total peak daily demand for this system was 0.056 mgd, which occurred in May 2017.

The Remaining Firm Capacity of this system is 0.037 mgd.

Hopatcong Water Department

The total peak daily demand for this system was 0.534 mgd, which occurred in May 2017.

The Remaining Firm Capacity of this system is 0.146 mgd.

No data was available for Colby Homeowners Association Water Company, North Shore Water Association and Strawberry Point Property Owners Association. These systems serve a population of 65, 105 and 95 residents, respectively[8]. Data is also not available for Briar Heights and Della Heights Property Owners Association, which serves seven addresses, and Frenches Grove Water Association, which serves 76 addresses[9].

Wastewater Management

Description

Only a very small portion of the Township has public sewer service. The southern part of Byram is served by Musconetcong Sewer Authority and communities at Panther Lake (located in the northern part) are served by Panther Lake Resort. Musconetcong Sewer Authority discharges treated wastewater into the Musconetcong River outside of the study area (Township and HUC14s). Therefore, groundwater withdrawals that serve the sewer customer base within Byram are considered depletive.

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[8] https://www13.state.nj.us/DataMiner

[9] Township of Byram, Water Co. Emergency Contact and Homes Served

The Sewer Service Area is shown in **Figure 13**. 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 WUCMP area. As mentioned above, both utilities discharge treated sanitary effluent outside the study area.

Stakeholders

Potential Stakeholders within the WUCMP area include the following:

- Municipal governments and water utilities in Byram Township, Hopatcong Borough and Sparta Township
- Residents in Byram Township

The listed stakeholders presented above represent the current main water users within the Township, for which reported user/withdrawal information exists. However, Byram 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 Ground Water Availability minus consumptive and depletive water uses. Ground Water Availability is the portion of Ground Water Capacity that can be provided for human use without harm to other ground water users, aquatic ecosystems or downstream users. The Highlands RMP defines Ground Water Capacity based on the Low Flow Margin component of the Low Flow Margin of Safety Method. Low Flow Margin and Ground Water Availability are discussed below.

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 (public supply wells, for example) withdrawals, the onus of any deficits that may result from Net Water Availability analyses will be assigned to the municipality with the more significant withdrawals. For subwatersheds that intersect Byram Township and have significant withdrawals from adjacent municipalities, the only impact to NWA are from domestic withdrawals and public supply within Byram Township.

Net Water Availability has been calculated for HUC14s intersecting Byram 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.[10]

Low Flow Margin is used to calculate Ground Water Capacity, or the natural ability of the watershed to support base flow.[1] Ground Water Capacity is derived from Low Flow Margin, but is adjusted for the consumptive uses incorporated into the stream flow statistics used to derive Low Flow Margin.

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

Ground Water Capacity equals Low Flow Margin multiplied by 1.02, based on a USGS study that showed existing consumptive uses are roughly 2 percent of Low Flow Margin.

Ground Water Availability

Ground Water Availability is that portion of Ground Water Capacity that is available for human uses, absent other constraints.[1] The following threshold values were established by the Highlands Council (**Table 4**):

Table 4 - Ground Water Availability Thresholds as Percentage of Ground Water 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 largely within the Protection Zone, so according to the rules established in the Highlands RMP and Technical Report Vol. II, Ground Water Capacity is multiplied by 5% to arrive at Ground Water Availability. Ground Water Availability for the three (3) subwatersheds within the study area are presented below in **Table 5**.

Table 5 - Ground Water Availability

HUC14 Description	Ground Water Availability (mgd)
02040105150040: Lubbers Run (above/ incl. Dallis Pond)	0.0513
02040105150050: Lubbers Run (below Dallis Pond)	0.0648
02040105150060: Cranberry Lake / Jefferson Lake & tribs.	0.0270

Net Water Availability

Calculation of Net Water Availability

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

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

NWA was originally calculated using maximum monthly 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:

Table 6 - Published Net Water Availability

HUC14 Description	Net Water Availability (mgd)
02040105150040: Lubbers Run (above/ incl. Dallis Pond)	-0.4015
02040105150050: Lubbers Run (below Dallis Pond)	0.0025
02040105150060: Cranberry Lake / Jefferson Lake & tribs.	0.0072

The total published NWA indicated in **Table 6** for non-agricultural use reflects a deficit within one of the three HUC14s and a surplus in the other two.

Each of the three (3) HUC14s listed above is discussed in more detail in the “Revised Net Water Availability Section” below. Two additional water systems are located in Byram Township, but withdrawals are not calculated in the NWA calculations as the wells are not in the three HUC14s listed above. Forest Lakes Water Company wells are in a neighboring HUC14 in Andover Borough. In addition, there are three (3) community water supply wells in HUC14 02040105150070 and 02040105150030 owned by Brookwood Musconetcong River Properties Owners Association. The three wells are within the Township but beyond the HUC14s considered in this WUCMP.

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

- 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, including estimates of returns from on-site wastewater disposal systems (e.g., septic); and
- Selection of specific maximum diversions months to coincide with LFM target months

Ground water uses within these subwatersheds are predominantly for potable use, through domestic ground water and public community supply, with public community supply use generally lower than domestic ground water usage. Groundwater pumping for mining activities are is also prevalent (Weldon Quarry Co LLC). There are no surface water withdrawals reported within the subwatersheds.

Net Water Availability is calculated for each subwatershed based on the maximum total ground water withdrawals for the months of June, July and August for each year. Withdrawals are summarized below and represent average monthly pumpage for the month listed.

Water Supply

Public Community Supply

A summary of Public Community and Non-Community Supply withdrawals within these subwatersheds for the period 2000-2018 is shown in **Table 7.**

Based on the information available using the sources mentioned above, it was not possible to determine groundwater pumping for the water systems Colby Homeowners Association Water Company, North Shore Water Association, Briar Heights and Della Heights Property Owners Association, and Frenches Grove Water Association. A key reason data is missing is because the NJDEP database where well withdrawals data is extracted only list withdrawals for systems that can pump more than 100,000 gallons per day. These systems are small enough to fall under the threshold. As a result, CDM Smith contacted individual suppliers to obtain additional information[11], however, to date no response was received. For the purpose of this updated analysis, we approximated the volumes supplied by the two (2) water systems with population data (Colby Homeowners Association Water Company, North Shores Water Association), and two (2) water systems with list of addresses served (Briar Heights and Della Heights Property Owners Association, Frenches Grove Water Association):

[11] Email correspondence from 2020/04/17 to North Shore Water Association and Colby Homeowners Association Water Company.

- Number of connections as provided by the New Jersey Drinking Water Watch (NJDWW)[12], or number of addresses associated with the system from data provided by Byram Township;
- An average water use of 155 gallons per day per person during summer months based on the EPA WaterSense New Jersey Water Fact Sheet[13];
- One service connection or address is estimated to represent one household of three (3) persons. This equals 465 gallons per day per service connection during the summer months June, July and August.

Using the EPA WaterSense information and the number of service connections allows to approximate the water use per system per day and a plausible estimate of groundwater pumping over the summer months for four of the systems.

Table 7 - Water Supply Withdrawals

HUC/Water Purveyor	Category	Withdrawals[1]	
		Peak Summer Month	Peak Withdrawal (MGD)
HUC 02040105150040: Lubbers Run (above/incl Dallis Pond)			
Sparta Department of Utilities	Public Community	August 2001	0.441
AQUA (formerly Byram Homeowners Association)	Public Community	August 2008	0.077
HUC 02040105150050: Lubbers Run (below Dallis Pond)			
SUEZ (formerly East Brookwood Estates Property Owners Association)	Public Community	July 2007	0.049
HUC 02040105150060: Cranberry Lake / Jefferson Lake & tribs			
Briar Heights & Della Heights Property Owners Association	Public Community	-[3]	0.0033

[12] New Jersey Drinking Water Watch, accessed on April 21st, 2020: https://www9.state.nj.us/DEP_WaterWatch_public/JSP/WSDetail.jsp?tinwsys=532

[13] https://www.epa.gov/sites/production/files/2017-02/documents/ws-ourwater-new-jersey-state-fact-sheet.pdf

Colby Homeowners Association Water Company	Public Community	-[3]	0.0088
Frenches Grove Water Association	Public Community	- [3]	0.035
North Shore Water Association	Public Community	-[3]	0.014
Strawberry Point Property Owners Association	Public Community	July 2018	0.0031

MGD =million gallons per day

1. Withdrawals represent the respective withdrawals for the peak pumping month of the subwatershed. Individual purveyors may have higher pumping periods, but the peak summer month represents the peak of total pumping in the subwatershed.
2. No reported pumpage for purveyor during maximum withdrawal month of subwatershed. Only included here to illustrate the magnitude of the withdrawal.
3. The groundwater withdrawals for the purveyor has been estimated based on an average consumption of 155 gallon/day during summer months (EPA WaterSense New Jersey Water Fact Sheet)[14].

Withdrawals for the well belonging to Hopatcong Water Departments are not listed, as no pumping occurred during the period of consideration.

Missing data between 2000 and 2006 for the SUEZ water system (formerly East Brookwood Estates Property Owners Association) in HUC14 02040105150050 was approximated using the average pumping from 2007-2018 (assuming similar service connections and demand).

CDM Smith will update the information once water suppliers provide the requested information.

Public Non-Community Supply

In addition to public supply systems, there are nearly two dozen public non-community systems located in Byram. Most of these systems are associated with individual businesses and do not have enough pump capacity (100,000 gallons per day) for withdrawals to be listed in the NJDEP databases. Because the volume of withdrawal is significantly small compared to total withdrawals in the HUCs, the withdrawals are not accounted for in the net water availability. The five largest public non-community system are Gordon Byram Assoc LLC (ShopRite of Byram), Byram Quick Check 183, Byram Intermediate & Lakes School, and Tomahawk Lake Inc (2 systems). The system associated with Gordon Byram Assoc LLC has a capacity of 20,000 gallons per day.

Domestic Well Ground Water Usage

Domestic Well Ground Water Usage is an estimate of private well withdrawals within the subwatersheds for areas not served by the public supply. 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

[14] https://www.epa.gov/sites/production/files/2017-02/documents/ws-ourwater-new-jersey-state-fact-sheet.pdf

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 so that domestic usage could be apportioned by municipality, which is not included in the RMP. Domestic ground water usage (2000-2018 average) is shown in **Table 8**.

Table 8 - Domestic Ground Water Usage[1]

HUC	Domestic Ground Water Usage (mgd)
02040105150040: Lubbers Run (above/incl Dallis Pond)	0.3917 / 0.0426
02040105150050: Lubbers Run (below Dallis Pond)	0.2903 /0.1520
02040105150060: Cranberry Lake / Jefferson Lake & tribs	0.0934 / 0.0934
TOTAL	**0.7754 / 0.288**

1. Domestic Ground Water Usage is presented as follows: Total domestic withdrawals within the entire subwatershed / Byram.

Mining

Mining related groundwater withdrawals from Weldon Quarry Co LLC are present in subwatershed HUC14 02040105150040 (**Table 9**):

Table 9 - Water Usage for Mining (Dewatering)

HUC	Owner	Water Source	Peak Summer Month	Peak Withdrawal (mgd)
02040105150040	Weldon Quarry Co LLC	Groundwater	July 2000	0.084

Municipal Consumptive/Depletive Uses

Groundwater models used in support of the Highlands Regional Net Water Availability analysis show that the impact on September stream flows of consumptive/depletive (C/D) ground water use during the summer is not 1:1, but roughly 1:0.9.[15] In other words, 1 gallon of C/D water use is calculated to reduce Ground Water Availability in September by 0.9 gallons. Therefore, ground water use (raw pumpage) during the summer month with the highest demand was multiplied by 0.9 to reflect this impact. The factor is not applied to surface water diversions, which are based on September withdrawals that have an immediate impact on stream flows.

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

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.[16] 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.

Septic return is calculated using GIS and the latest available existing areas served (EAS) coverages for public water and wastewater provided by the Highlands Council. Parcel coverages obtained from the New Jersey Geographic Information Network (NJGIN) were clipped by the public water EAS coverage to obtain the number of parcels served by public water. Using that coverage, parcels that have their centroids within the wastewater EAS were selected and classified as sewered parcels. The remaining are considered to be served by public water, but not public sewer, so septic return is assigned to those parcels. Total pumping and a non-consumptive use from each purveyor is calculated and the non-consumptive use per parcel is calculated based on the number of parcels within a particular water system. This parcel based non-consumptive use is then multiplied by the number of non-sewered parcels within each particular HUC14 to estimate septic return.

Parcel coverages from the NJGIN include common areas such as homeowner's association (HOA) areas within condominium or apartment complexes. These areas are included in the number of parcels used to determine the parcel based non-consumptive use for return. Once the non-sewered parcels are created in GIS, a brief aerial survey is conducted and HOA areas or other open space areas are removed. Actual customer databases are not utilized so this approach represents an approximation.

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

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

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.

Only a small portion of the Township has public sewer service. The southern part of Byram is served by Musconetcong Sewer Authority whereas communities at Panther Lake (located in the northern part) are served by Panther Lake Resort. Musconetcong Sewer Authority discharges treated wastewater into the Musconetcong River outside of the study area. Therefore, groundwater withdrawals that serve customers in sewered areas are considered depletive. Panther Lake Resort returns the treated wastewater back into the groundwater, which is incorporated into the revised NWA calculations as septic returns.

Net Water Availability is shown on **Tables 10, 11** and **12**. A general summary for each of the subwatersheds is described below. Data availability tables can be found in **Appendix C.**

HUC14 Summaries

HUC14 02040105150040. This HUC14 was published in the RMP as having a deficit of 0.4015 mgd, or 401,500 gallons per day.

Only the most western portion of this HUC14 is located within Byram Township. The rest of the HUC14 is located within Hopatcong Borough and Sparta Township.

Water withdrawals within this HUC14 are from potable supply wells for Sparta Department of Utilities and Aqua (formerly Byram Homeowners Association; Aqua as of 2016), as well as mining withdrawals for the Weldon Quarry. Additionally, groundwater withdrawals for domestic use occur in this HUC14 from Byram, Hopatcong Borough and Sparta Township. Pumping for domestic water supply (homeowner wells) represents the largest fraction of total pumping within this HUC14. Of the five largest non-community systems, the two systems owned by Tomahawk Lake Inc is located in the HUC14; however, withdrawals are not accounted for as it is unknown and volume is small enough to not be reported to NJDEP.

Based on the Water Transfer Model (WTM), the average July pumping for domestic use in all three townships from 2000-2013 is 0.3917 mgd, which is higher than the 0.2963 mgd value published in the RMP.

Groundwater pumping from Weldon Quarry Co LLC fluctuates throughout the year but generally remains constant with no visible long-term trend. It appears, that this user alternates pumping between the two wells from year to year as shown in the data availability tables in Appendix C.

There are no wastewater dischargers located in this HUC14. Thus, septic returns through wastewater discharges for those parcels which are not served by public sewer are the only returns applicable to the HUC14. Septic returns calculated for areas covered by the Sparta Department of Utilities were determined based on the different pressure zones (Seneca Lake and Intermediate) intersecting with this HUC14 and Byram Township. For the Seneca Lake pressure zone groundwater is pumped from wells located outside the WUCMP area (HUC14 0220007010010). Thus, septic returns are considered imported and incorporated as such into the NWA calculations.

Calculated Net Water Availability is shown on **Table 10**. The revised NWA ranges from between deficits of 0.2042 mgd to 0.0355 mgd with a decreasing trend in the recent years. This decrease is largely driven by reduced pumping from Sparta Department of Utilities over the last eight (8) years.

Based on this revised analysis, the entire HUC14 averages a deficit of 99,526 gallons per day. The decrease in deficit, compared to the RMP value, is due to the incorporation of septic return from a portion of the Sparta Department of Utilities and Aqua service areas as well as reduced pumping as mentioned in more detail below.

Byram Township is only responsible for a fraction of this deficit as there are major withdrawals from Sparta Township and consumptive use from domestic pumping in Hopatcong Borough.

Byram Township accounts for approximately 19% of the consumptive use and therefore management of any deficits to NWA, as of current withdrawals, would be the primary responsibility of the neighboring municipalities.

HUC14 02040105150050 was published in the RMP as having a slight surplus of 0.0025 mgd (2,500 gallons per day).

Most of the HUC14 is located within Byram Township, with small portions intersecting with Stanhope Borough and Hopatcong Borough.

One groundwater well has data reported starting in 2003 for Hopatcong Water Department, but the reported values from 2003 to 2018 are zero. SUEZ (formerly East Brookwood Estates Property Owners Association) owns three well in this HUC14 but only has reported withdrawals starting in 2007. All groundwater withdrawals within this HUC14 are only for potable supply.

Most of the parcels within the SUEZ (formerly the East Brookwood Estates Property Owners Association) distribution area are not served by public sewer. Further, there are no wastewater dischargers located in this HUC14. Thus, septic returns through wastewater discharges for those parcels which are not served by public sewer are the only returns applicable to the HUC14.

Three of the five largest non-community systems are located in this HUC14: Gordon Byram Assoc LLC (ShopRite of Byram), Byram Quick Check 183, and Byram Intermediate & Lakes School. Withdrawals are not accounted for in the NWA since the volume is not large enough to require reporting to NJDEP.

Using the domestic well withdrawals in the WTM, the average total withdrawals from domestic wells during the month of July between 2000-2013 is 0.2903 mgd, which is higher than the published value of 0.2146 mgd.

Calculated Net Water Availability is shown on **Table 11**. The revised NWA ranges from a deficit between 0.0224 mgd to 0.0296 mgd with no visible trend in the recent years.

Based on this revised analysis, the entire HUC14 averages a deficit of 0.0263 mgd or 26,251 gallons per day. The deficit, compared to the surplus RMP value, is due to increased domestic pumping as well as public supply pumping which in the original NWA calculations in the RMP was zero (0).

Byram Township is responsible for approximately 56% of the consumptive use for this HUC14. Therefore, management of any deficits to NWA, as of current withdrawals, would partly be the responsibility of Byram Township.

HUC14 02040105150060 has a published NWA surplus of 0.0072 mgd (7,200 gallons per day).

This HUC14 has domestic withdrawals for Byram Township and Green Township. Although small domestic withdrawals are reported in the Water Transfer Model for Green Township, an aerial survey does not indicate any development within this HUC14.

Community water supply is served by Colby Homeowners Association Water Company, Strawberry Point Property Owners Association and North Shore Water Association, which together serve approximately 265 residents (as noted above) within the HUC14. Additional purveyors include Frenches Grove Water Association, which serves 76 addresses, and Briar Heights and Della Heights Property Owners Association, which serves seven addresses.

No discharges have been reported within this HUC14 as per WTM/ DataMiner for these users. The pumping for the five (5) suppliers is lower than the domestic pumping in this HUC14. Under the assumptions made above, the five (5) suppliers account for approximately 38.5% of pumping whereas domestic pumpage is approximately 61.5% of the total.

The revised NWA is shown on **Table 12**. As pumping was estimated based on a constant water use of 155 gal/day per person, revised NWA values are constant throughout the years 2000-2018. The values are likely to change once updated information is provided.

Based on this revised analysis, the entire HUC14 averages a small deficit of 17,075 gallons per day, which is largely attributed to increased domestic pumping and the incorporation of public supply related pumping from the water purveyors mentioned above.

Approximately 98.2% of the area of this HUC14 intersects with Byram Township and no significant pumping from neighboring Green Township is present. Thus, Byram Township is responsible for managing the deficit.

Table 10 - Re-evaluated New Water Availability

HUC14 02040105150040: Lubbers Run (above/incl Dallis Pond)

Year	Non-Ag Ground Water Availability (mgd)	Consumptive Public Supply (mgd)	Consumptive Domestic	Consumptive Mining (mgd)	Total Non-Ag Consumptive Use (mgd)[1]	Non-Ag Net Water Availability (mgd)[2]
Published	**0.0513**	**0.3669**	**0.0859**	**0.0000**	**0.4528**	**-0.4015**
2000	0.0513	0.1312	0.1136	0.0000	0.2457	-0.1290
2001	0.0513	0.1844	0.1136	0.0005	0.2980	-0.1973
2002	0.0513	0.1343	0.1136	0.0005	0.2484	-0.1531
2003	0.0513	0.1711	0.1136	0.0002	0.2852	-0.2042
2004	0.0513	0.0682	0.1136	0.0001	0.1819	-0.1306
2005	0.0513	0.0537	0.1136	0.0007	0.1673	-0.0604
2006	0.0513	0.0306	0.1136	0.0002	0.1450	-0.0590
2007	0.0513	0.0214	0.1136	0.0003	0.1353	-0.0358
2008	0.0513	0.0198	0.1136	0.0000	0.1337	-0.0355
2009	0.0513	0.0141	0.1136	0.0002	0.1277	-0.0387
2010	0.0513	0.0485	0.1136	0.0000	0.1622	-0.0674
2011	0.0513	0.0175	0.1136	0.0001	0.1311	-0.0496
2012	0.0513	0.0424	0.1136	0.0001	0.1561	-0.1047
2013	0.0513	0.0385	0.1136	0.0001	0.1522	-0.1008
2014	0.0513	0.0354	0.1136	0.0001	0.1491	-0.0978
2015	0.0513	0.0463	0.1136	0.0003	0.1600	-0.1087
2016	0.0513	0.0480	0.1136	0.0002	0.1619	-0.1106
2017	0.0513	0.0342	0.1136	0.0003	0.1480	-0.0967
2018	0.0513	0.0485	0.1136	0.0009	0.1625	-0.1111

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

Table 11 Re-evaluated New Water Availability
HUC14 02040105150050: Lubbers Run (below Dallis Pond)

Year	Non-Ag Ground Water Availability (mgd)	Consumptive Public Supply (mgd)	Consumptive Domestic (mgd)	Consumptive Mining (mgd)	Total Non-Ag Consumptive Use (mgd)[1]	Non-Ag Net Water Availability (mgd)[2]
Published	**0.0648**	**0.0000**	**0.0622**	**0.0000**	**0.0622**	**0.0025**
2000	0.0648	0.0070	0.0842	0.0000	0.0912	-0.0264
2001	0.0648	0.0075	0.0842	0.0000	0.0917	-0.0269
2002	0.0648	0.0070	0.0842	0.0000	0.0912	-0.0264
2003	0.0648	0.0075	0.0842	0.0000	0.0917	-0.0269
2004	0.0648	0.0070	0.0842	0.0000	0.0912	-0.0264
2005	0.0648	0.0058	0.0842	0.0000	0.0900	-0.0252
2006	0.0648	0.0062	0.0842	0.0000	0.0904	-0.0256
2007	0.0648	0.0096	0.0842	0.0000	0.0938	-0.0290
2008	0.0648	0.0030	0.0842	0.0000	0.0872	-0.0224
2009	0.0648	0.0033	0.0842	0.0000	0.0874	-0.0227
2010	0.0648	0.0099	0.0842	0.0000	0.0941	-0.0293
2011	0.0648	0.0069	0.0842	0.0000	0.0910	-0.0263
2012	0.0648	0.0095	0.0842	0.0000	0.0937	-0.0289
2013	0.0648	0.0082	0.0842	0.0000	0.0923	-0.0276
2014	0.0648	0.0073	0.0842	0.0000	0.0914	-0.0267
2015	0.0648	0.0032	0.0842	0.0000	0.0874	-0.0226
2016	0.0648	0.0057	0.0842	0.0000	0.0899	-0.0251
2017	0.0648	0.0102	0.0842	0.0000	0.0944	-0.0296
2018	0.0648	0.0056	0.0842	0.0000	0.0898	-0.0250

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

Table 12- Re-evaluated New Water Availability

HUC14 02040105150060: Cranberry Lake / Jefferson Lake & tribs

Year	Non-Ag Ground Water Availability (mgd)	Consumptive Public Supply (mgd)	Consumptive Domestic (mgd)	Consumptive Mining (mgd)	Total Non-Ag Consumptive Use (mgd)[1]	Non-Ag Net Water Availability (mgd)[2]
Published	**0.0270**	**0.0000**	**0.0198**	**0.0000**	**0.0198**	**0.0072**
2000	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2001	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2002	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2003	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2004	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2005	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2006	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2007	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2008	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2009	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2010	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2011	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2012	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2013	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2014	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2015	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2016	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2017	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171
2018	0.0270	0.0169	0.0271	0.0000	0.0440	-0.0171

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

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

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)
02040105150040	-0.2042	-0.0355
02040105150050	-0.0296	-0.0224
02040105150060	-0.0171	-0.0171

mgd = million gallons per day

Significant causes of the deficits noted above include:

- **02040105150040**: Consumptive use is largely driven by domestic pumping with minor contributions from mining activities.
- **02040105150050**: Public supply represents only 11% of the overall pumping in this HUC14. Thus, the largest contributions to the NWA deficit originate from domestic pumping (89%).
- **02040105150060**: The deficit for this HUC14 is largely driven by domestic withdrawals which account for approximately 62% of total pumping.

Characterization of Deficit

The deficit in this WUCMP area varies from mild to medium (less than 1 mgd). HUC14 02040105150040 has the largest deficit of the three (3) HUC14 intersecting with Byram Township. However, the NWA for this HUC14 increased (i.e. became less negative) between 2004 and 2011 and has remained fairly constant since then. HUC14 02040105150050 has a low deficit with no clear upward or downward trend. Due to the lack of pumping data, the updated NWA for HUC14 02040105150060 has been estimated. The estimated NWA shows a small deficit.

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[17] 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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[17] 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 14**. 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 14- Annual and Seasonal Increases in Air Temperatures (in °F) Over the Period 1895 to 2019 (NJDEP 2020a, modified).[18]

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

[18] 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 14**).

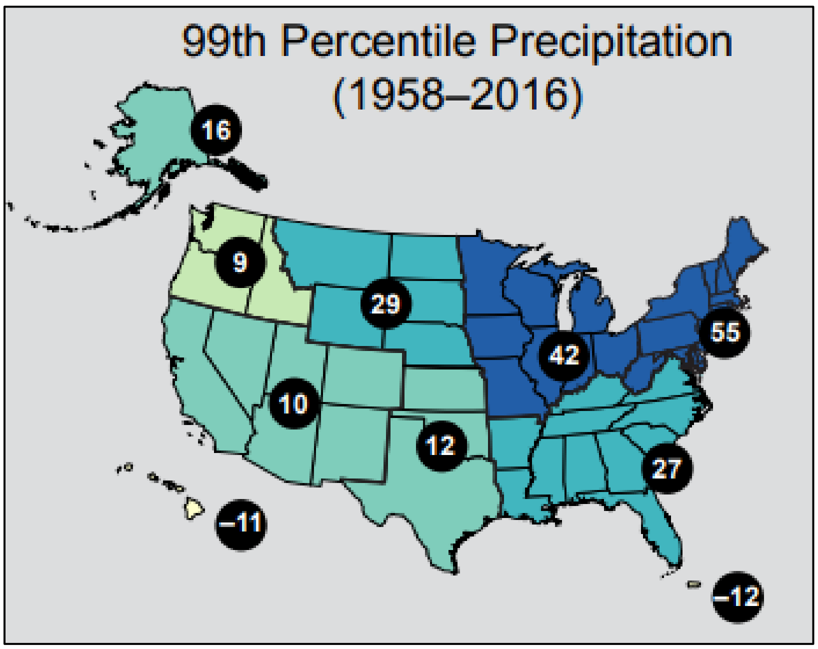

Figure 14: Percent increase of precipitation falling in daily events that exceed the 99th percentile of all non-zero precipitation days

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[19] 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 Byram'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[20] 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

[19] 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.

[20] 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 increasing deficits and help mitigate existing deficits within the three subwatersheds of this WUCMP. The mitigation strategies focus on limiting consumptive and depletive use, largely through residential conservation.

Table 15 – Summary of Conservation and Deficit Mitigation Strategies

Measure	Res	Comm	Water Purveyor	Mining	Mun
Water Use Reduction					
Heating System Upgrades		✓			
Hot Water Heater Upgrade	✓	✓			
Hydrant Locks			✓		
Avoid Overspray	✓	✓		✓	
Building and Pipe Insulation	✓	✓			
Community Garden	✓				
Cooling System Upgrades		✓			
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	✓	✓	✓		

Measure	Res	Comm	Water Purveyor	Mining	Mun
Meter Calibration/Replacement			✓		
Night Watering	✓	✓			
Plumbing Incentive Program		✓			✓
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 users 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, the highest, 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 15** through **19** for residential, commercial / institutional, water purveyors, mining, 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 16 - 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

Table 16 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Residential Users

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

Table 17 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial / Institutional 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

Table 17 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial / Institutional Users

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
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
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 18 - 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 19 - 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

Table 20 - Scoring for Conservation and Deficit Mitigation Strategies Applicable to Mining

Measure	Feasibility	Effectiveness	Resilient/ Reliable	Reduction Potential	Complexity	Cost	Schedule
Avoid Overspray	3	2	2	1	1	2	1
Well Optimization	2	2	2	1	1	3	3
Water Storage Tank Management	3	2	2	2	2	2	2
Assisted Infiltration	3	2	1	2	1	3	3

Ranking of Deficit Mitigation Strategies

A subset of 10 deficit mitigation strategies that are relevant to the WUCMP area have been ranked, and the top ten strategies for each water user category are listed in **Tables 20** through **24**. 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 15** through **19** along with a determination as to 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 21 - 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 22 - Ranked Mitigation Management Strategies for Commercial/Industrial/Institutional Users

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

Table 23 - 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 24 - 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 25 - Ranked Mitigation Management Strategies for Mining

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Assisted Infiltration/Enhanced Recharge	Water Storage Tank Management	1
2	Avoid Overspray	Assisted Infiltration/Enhanced Recharge	2
3	Water Storage Tank Management	Well Optimization	3
4	Well Optimization	Avoid Overspray	4

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 for Byram Township. 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, Byram Township may request additional planning funds to develop mitigation strategies, perform periodic reviews of the effectiveness of strategies and prepare updates to the Net Water Availability tables of this WUCMP. 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, researchers should 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 that are striving to conserve energy. The following website details some of the funding opportunities provided by EPA in support of 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 HUC14 intersecting with Byram Township are in a low to moderate deficit. As most groundwater pumping and usage is for domestic supply, water conservation, deficit reduction and elimination strategies should focus on residential users. Note that domestic water supply involves significantly more water use for irrigation and outdoor summer activities. Therefore, conservation strategies should also consider irrigation and/or offsetting the water used for irrigation.

As mentioned earlier, pumping for public supply is fairly small compared to the domestic use within the Byram's subject HUC14s. However, as the HUC14s in the WUCMP area only have mild NWA deficits, conservation strategies for public supply can help to alleviate deficits. Implementation of public supply-oriented strategies should be coordinated with neighboring municipalities since Byram Township's public supply contribution to the NWA deficit is relatively low.

The following selected strategies are provided as initial recommendations targeting deficit reductions in all three (3) HUC14s. Additional strategies should be added and/or replaced as appropriate.

Irrigation System Design

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

Low Flow Shower Heads and Toilet Fixtures

Toilets are the main source of water use in residential homes, accounting for nearly 30% of an average home's indoor water consumption[21]. Showering is another main source of indoor water consumption accounting for nearly 17% of the residential water use[16]. According to EPA WaterSense, an average family can save:

- 13,000 gallons per year by replacing old, inefficient toilets with EPA WaterSense labeled models
- 2,700 gallons per year by replacing standard showerheads with water-saving showerheads.

Notably, replacing showerheads will also reduce demands on water heaters and consequently save energy.

[21] EPA WaterSense: https://www.epa.gov/watersense/residential-toilets (website accessed on July 31, 2020)

This strategy will involve the promotion of use of low flow shower heads and toilet fixtures through public education for residential and commercial use.

Stormwater Ordinance

This strategy involves developing a stormwater ordinance or improving an existing stormwater ordinance to promote recharge and/or infiltration within the subwatersheds as development occurs, beyond typical minimum standards such as those contained in N.J.A.C. 7:8 et seq, N.J.A.C. 5:21 et seq. (Residential Site Improvement Standards), or the Highlands Area Land Use Ordinance.

NOTE: The Township adopted an updated Stormwater Control Ordinance in February 2021 to include amendments that have been made to the New Jersey Department of Environmental Protection Stormwater Management Rules included in N.J.A.C. 7:8. which were adopted on October 25, 2019 with an effective date of March 2, 2020. This new Stormwater Control Ordinance aims to improvement flood control, groundwater recharge, and pollutant reduction through the use of stormwater management measures, including green infrastructure Best Management Practices and nonstructural stormwater management strategies.

Retrofit Detention Basins

This strategy involves converting detention basins to infiltration basins, and often involves rehabilitation or renewal of antiquated stormwater infrastructure. By promoting the conversion of detention basins to infiltration basins by current basin owners or individuals seeking new approvals from the Township Land Use Board, water supply can be increased within the Township.

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. Byram Township is responsible for managing the following:

- HUC14 02040105150040 - Lubbers Run (above/ incl. Dallis Pond): Byram Township accounts for only 19% of the consumptive use. Thus, neighboring municipalities are primarily responsible for the management of the deficit within this HUC14.
- HUC14 02040105150050 - Lubbers Run (below Dallis Pond): Byram Township accounts for 56% of the consumptive use and is a major stakeholder for the management of the deficit within this HUC14.
- HUC14 02040105150060 - Cranberry Lake / Jefferson Lake & tribs: Byram Township accounts for 100% of the consumptive use and Byram Township is fully responsible for the management of the deficit within this HUC14.

Water Conservation and Deficit Reduction Estimates

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.[22]. 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 subwatershed of interest was estimated using a GIS analysis. Using NJDEP's 2012 Land Use/Land Cover feature dataset, land use types associated with residential land uses was isolated.

The total irrigated portion of the land use types indicated above was assumed to be 10% of the total pervious land area identified in the residential 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.[23]

Based on the total irrigated acreage and a peak irrigation rate of 8 gpm/acre, a total of 1,346 gpm peak irrigation is estimated in the Township. This peak rate is estimated to occur for a total of 8-hours over the course of a 1-week period. Using these boundary conditions, and assuming an irrigation period of five months (20 weeks) (May-September), this equates to approximately 520,000 gallons per week of irrigated water usage.

Irrigation water usage can be reduced by 10% using this strategy (conservative estimate), resulting in water savings of approximately 52,000 gallons per week (7,400 gpd) between May and September

Low Flow Shower Heads and Toilet Fixtures

There are approximately 2,926 households[24] within Byram Township. Assuming, 5% of those households can be targeted with low flow shower head and toilet fixture replacements, the following water savings could be achieved using the EPA WaterSense estimates[25]:

- Toilets – potential savings of approximately 13,000 gallons per year

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[22] Outdoor Water Use in the United States, Environmental Protection Agency, Water Sense – An EPA Partnership, Retrieved from <https://www.epa.gov/watersense >.

[23] 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.

[24] Estimate taken from 2010 Census.

[25] WaterSense Products, Environmental Protection Agency, Water Sense – An EPA Partnership, Retrieved from < https://www.epa.gov/watersense/watersense-products >.

- Shower Heads – potential savings 2,700 gallons per year

Using estimates for a single toilet and single shower head, and 146 possible households, this equates to approximately 2.3 million gallons per year (6,300 gpd) of water savings.

Stormwater Ordinance

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

In keeping with current NJDEP guidance, this strategy is based on the infiltration facilitated by a design storm of 0.31 inches (one-quarter of the NJDEP stormwater quality design storm of 1.25 inches).[26] For the purpose of this estimate, we are assuming 50% of the total rainfall is infiltrated and the infiltration basin is approximately 3 acres in size.

Refer to Retrofit Detention Basins estimate below.

Retrofit Detention Basins

Thousands of gallons per storm event can be infiltrated as opposed to runoff into streams. Based on the assumptions for the Stormwater Ordinance strategy, 12,626 gallons of additional infiltration can be added through the conversion of detention to infiltration basins. Over a 90-day period, this equates to 140 gallons per day for an individual rainstorm. Larger basins or more frequent recharge will increase this estimate.

Summary of Savings Potential

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

Table 26 – Potential Water Use Saving Totals per HUC14 and Strategy

Strategy	Potential Savings in Water Use (gpd)
Irrigation System Design	7,400
Low Flow Shower Head & Toilet Fixtures	6,300
Stormwater Ordinance*	Supports Retrofit Detention Basin Strategy
Retrofit Detention Basin*	140
Total Savings in Water Use (gpd)	13,840

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

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

The above table presents potential savings that are representative of withdrawals during the June-July-August period. The total savings potential is 13,840 gpd. As shown in Table 25, the strategies described above are very effective in eliminating the deficit in HUC14s 02040105150050 and 02040105150060 and turning the NWA into a surplus. As for HUC14 02040105150040, the water conservation measures can significantly alleviate the NWA. However, the estimates are conservative, and it is expected additional deficit reduction can be achieved with additional measures and careful implementation.

As described earlier, Byram Township has different responsibilities depending on the HUC14 of consideration. While Byram is fully responsible for HUC14 02040105150060, water conservation for the other two HUC14s requires coordination with adjacent municipalities (especially with regard to strategies targeting public supply).

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

Monitoring and Biennial Water Use and Return Data

The mitigation strategies selected to reduce the deficit in the subwatershed must be evaluated periodically. A cursory biennial review of each strategy should be conducted to determine its effectiveness and a more detailed review every five yearswill update the Net Water Availability tables of this WUCMP. The detailed 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.

Biennial Water Use and Return Data

A review of water use data for these watersheds for the preceding years should be completed every other year as Highlands grants and other funding is made available to assist the Township is performing such reviews.

The data to be reviewed can be obtained from the water purveyors (Aqua, SUEZ, Sparta Department of Utilities).

The NJDEP well database, which identifies well systems by Public Water System Identification (PWSID) numbers, should also be monitored 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 every five years to 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 review will end with a calculation of the current deficit/surplus. As the WUCMP is implemented and adjusted, the results of each five-year 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.

Program Plan Review

If a deficit remains after a 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 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 periodic 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.

- Public Education for Intelligent Irrigation System Design
- Public Education for Use of Low Flow Shower Heads and Toilet Fixtures
- Adopt an updated Stormwater Control Ordinance to Promote Recharge and/or Infiltration.
- Promote the Retrofitting of Detention Basins to Infiltration Basins by way of Public Education and Land Use Board application reviews.

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

Schedule to Achieve Water Balance

The goal of the deficit mitigation strategies listed in this WUCMP is to promote water conservation and groundwater infiltration for the purpose to alleviate the deficits that exists today in HUC14 02040105150040, HUC14 02040105150050 and HUC14 02040105150060. All strategies being proposed are long term strategies and the objective is to over time change public behavior and eventually achieve water balance in the Township.

The Township is looking to achieve water balance in each of the HUC14 areas over time. After five (5) years of the adoption of this WUCMP, a grant will be requested to determine if the expected water balance was achieved and if not look to modify the plan with revised or additional strategies.

Funding Commitments

Funding of the public education strategies and the adoption of updated Stormwater Control Ordinances will be handled by way of the General fund that is part of the existing funding available through Township's Municipal Budget that is adopted each year. Public education will be completed in coordination with the public education that the Township is currently performing related to its NJDEP Municipal Separate Storm Sewers Systems (MS4s) permit.

Periodic reviews of water use data and the review of the success of the various water use strategies will require grants from other funding sources and will be dependent on the Township securing such grants and/or obtaining assistance from outside agencies.

Appendix A - Definitions

Background

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

Basis for Net Water Availability

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

Year	Ag Ground Water Availability (mgd)	Non-Ag Ground Water Availability (mgd)	Total Non-Ag Consumptive Use (mgd)	Imported Septic Return (mgd)	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.

Ground Water Availability

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

Agricultural (Ag) Ground Water Availability

Agricultural (Ag) Ground Water Availability – Ag Ground Water Availability is not applicable in each watershed. This type of Ground Water Availability is used when the Conservation Zone covers a majority of the watershed. In this case, Ag Ground Water Availability is established and tracked separately to support sustainable agriculture.[27]

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

Non- Agricultural (Non-Ag) Ground Water Availability

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

Consumptive/Depletive Uses

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

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

Total Non-Ag Consumptive Use

Non-Ag Consumptive Use is 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 Ground Water]

Adjusted Consumptive Domestic Use

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

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

Consumptive Public Supply Use

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

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

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

Total Non-Ag Consumptive Use from Surface Water

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

This quantity often includes golf course irrigation.

Other Non-Ag Consumptive Use from Ground Water

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

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

Imported Septic Return

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

Net Water Availability

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

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

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

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

Surplus for Potential Use

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

Appendix B

WUCMP Monitoring Form Template

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

Municipal Water Use and Conservation Management Plan
Byram Township

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form

Year:		**Prepared By:**	
HUC14:			
Name:		**Title:**	
Ground Water 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

Owner	Type	Year Installed				

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form

Year:		**Prepared By:**	
HUC14:			
Name:		**Title:**	
Ground Water Availability (mgd):			
Baseline Net Water Availability (mgd):		**Date:**	

			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.

Appendix C

Data Availability

Wells and Intakes for 02040105150040: Lubbers Run (above/incl Dallis Pond)

HUC14: 02040105150040	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sparta Department of Utilities																			
Potable Supply																			
WSWL137179	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WSWL137368	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WSWL137512	X	X	X	X	X	X	O	O	O	O	O	O	O	O	O	O	O	O	O
WSWL137513	X	X	X	X	X	O	O	O	O	O	O	O	O	O	O	O	O	O	O
WSWL64013	X	X	X	X	X	O	O	X											
WSWL64188	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WSWL64189	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WSWL64211		X		X															
WSWL64212		X		X															
WSWL81659				X	X	O	O	O	X	O	O	O	O	O	O	O	O	O	O
Unknown (BWA:5358:2218717)	X	X	X																
Weldon Quarry Co LLC																			
Mining																			
WSWL64092	X	X	X	X	X	O	X	O	O	O	O	O	O	O	X	X	O	O	O
WSWL64142	O	O	O	X	X	O	X	X	X	O	X	X	O	X	O	O	X	X	X
Aqua (formerly Byram Homeowners Association)																			
Potable Supply																			
WSWL70035				O	X	O	O	X	O	O	O	X	X	X	X	O	O	O	O
WSIN75570	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

"X" indicates that withdrawals were reported for the appropriate month (June-August for wells, September for intakes).
"O" indicates that withdrawals were reported for the appropriate month (June-August for wells, September for intakes), but the value was "0".
If value is blank, withdrawals were not reported in the WTM or Data Miner.

Wells and Intakes for 02040105150050: Lubbers Run (below Dallis Pond)

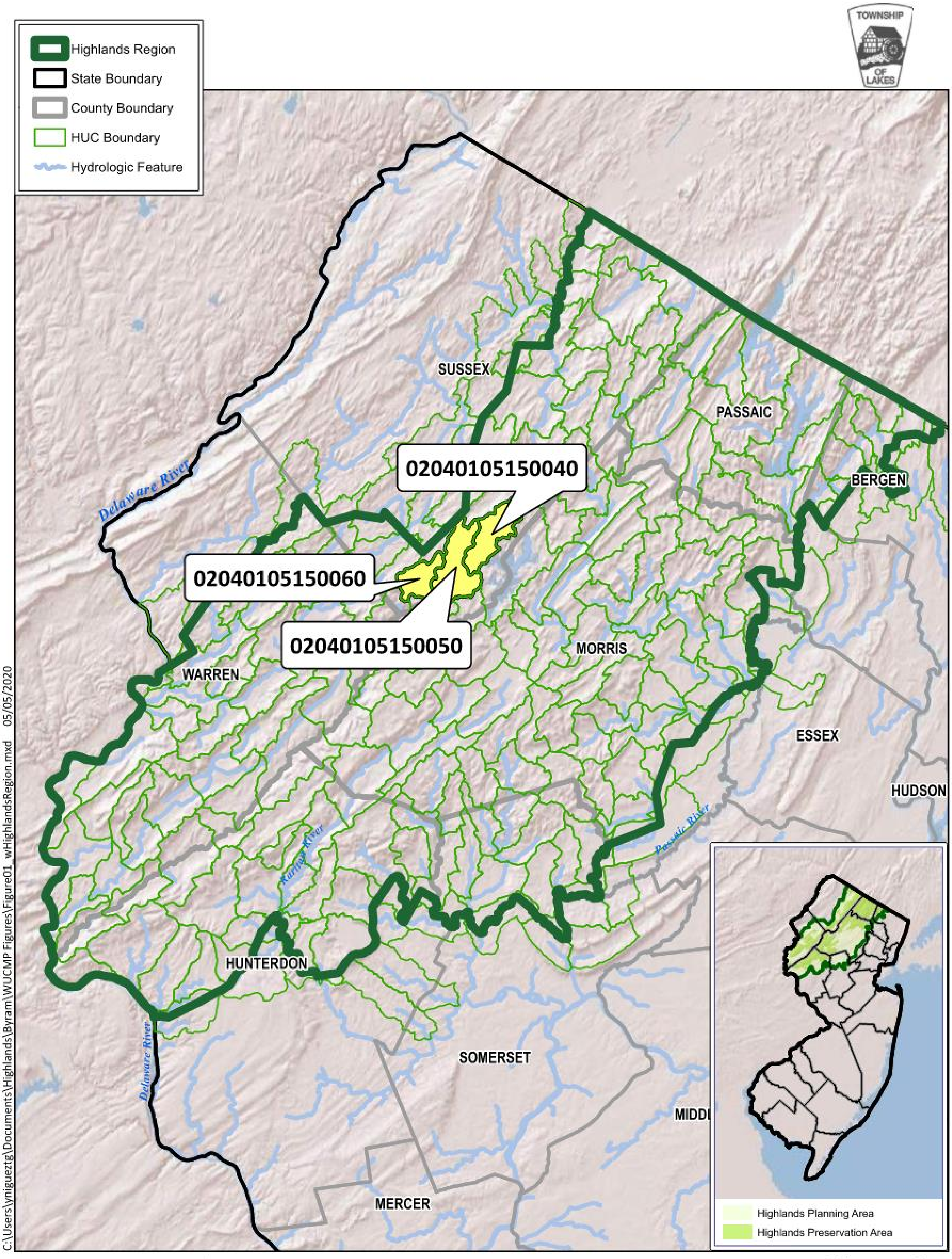
HUC14: 02040105150040	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SUEZ (formerly East Brookwood Estates Property Owners Association)																			
Potable Supply																			
WSWL191640								X	X	X	X	X	X	X	X	X	X	X	X
WSWL191663								X	X	X	X	X	X	X	X	X	X	X	X
WSWL696220								X	X	X	X	X	X	X	X	X	X	X	X
Hopatcong Water Department																			
Potable Supply																			
WSWL69763				O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

"X" indicates that withdrawals were reported for the appropriate month (June-August for wells, September for intakes).
"O" indicates that withdrawals were reported for the appropriate month (June-August for wells, September for intakes), but the value was "0".
If value is blank, withdrawals were not reported in the WTM or Data Miner

Wells and Intakes for 02040105150060: Cranberry Lake / Jefferson Lake & tribs

HUC14: 02040105150050	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Colby Homeowners Association **Water Company**																			
Potable Supply																			
WSWL191649 (Well 1)																			
North Shore Water Association																			
Potable Supply																			
Well 1 (Allamuchy Trail)																			
Strawberry Point Property Owners																			
Potable Supply																			
Well 1																			X
Well 2																			X

"X" indicates that withdrawals were reported for the appropriate month (June-August for wells, September for intakes).
"O" indicates that withdrawals were reported for the appropriate month (June-August for wells, September for intakes), but the value was "0".
If value is blank, withdrawals were not reported in the WTM or Data Miner
Note: French Groves Water Association and Briar Heights and Della Heights Property Owners Association wells are in the HUC14 but are not listed.



HUC14	Subwatershed Name
02040105150040	Lubbers Run (above/incl Dallis Pond)
02040105150050	Lubbers Run (below Dallis Pond)
02040105150060	Cranberry Lake / Jefferson Lake & tribs

Figure 1
Highlands Region and WUCMP Location

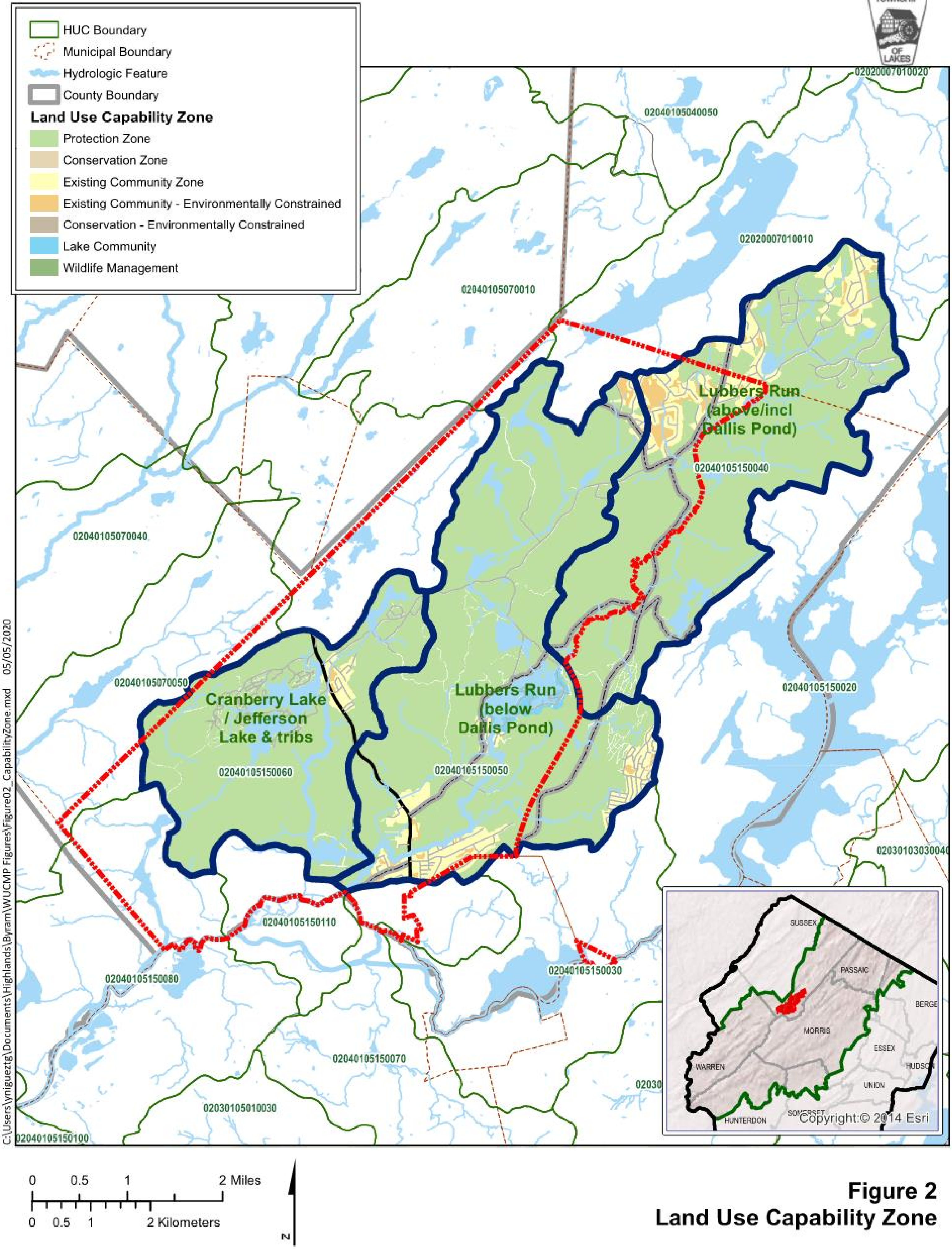


Figure 2
Land Use Capability Zone

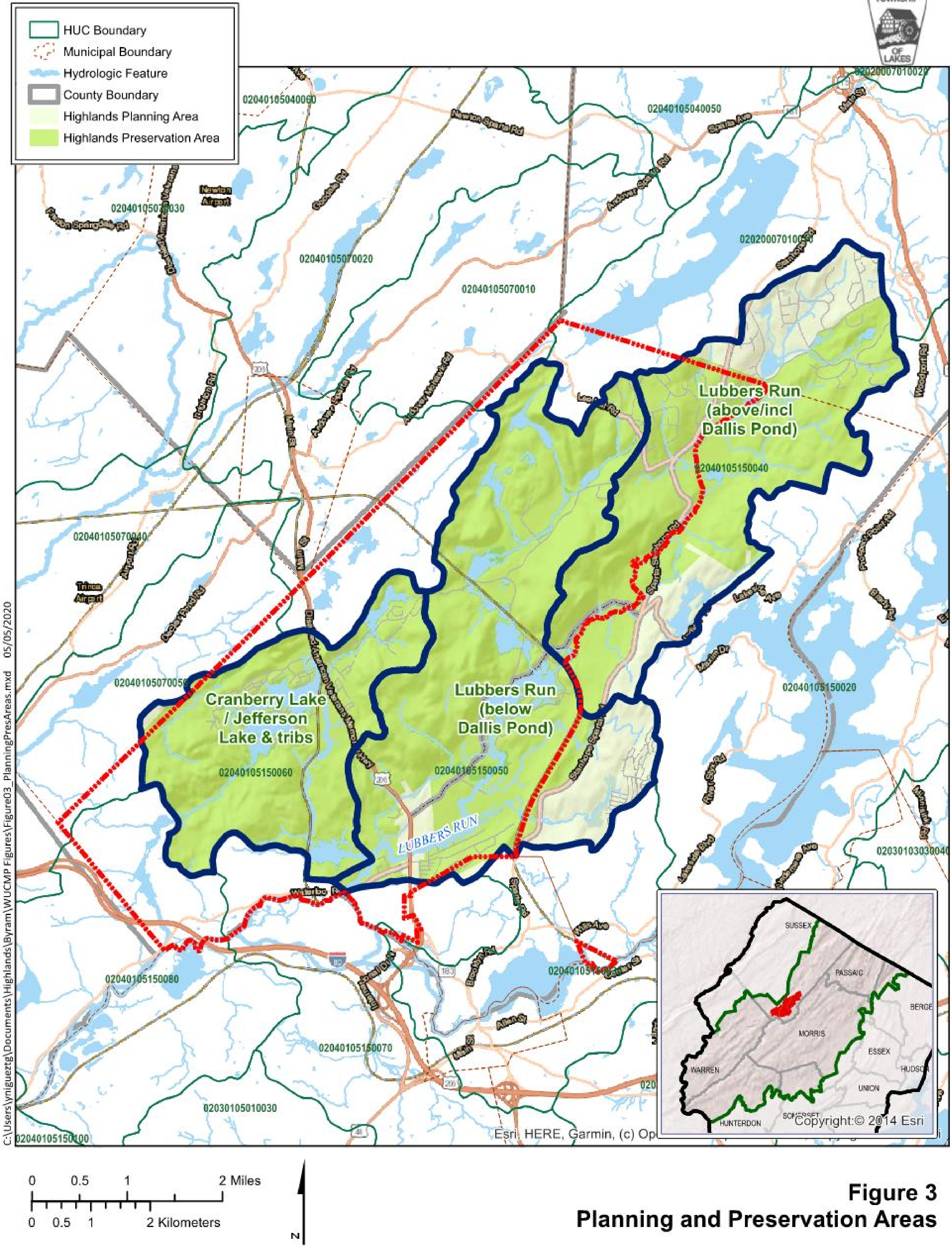
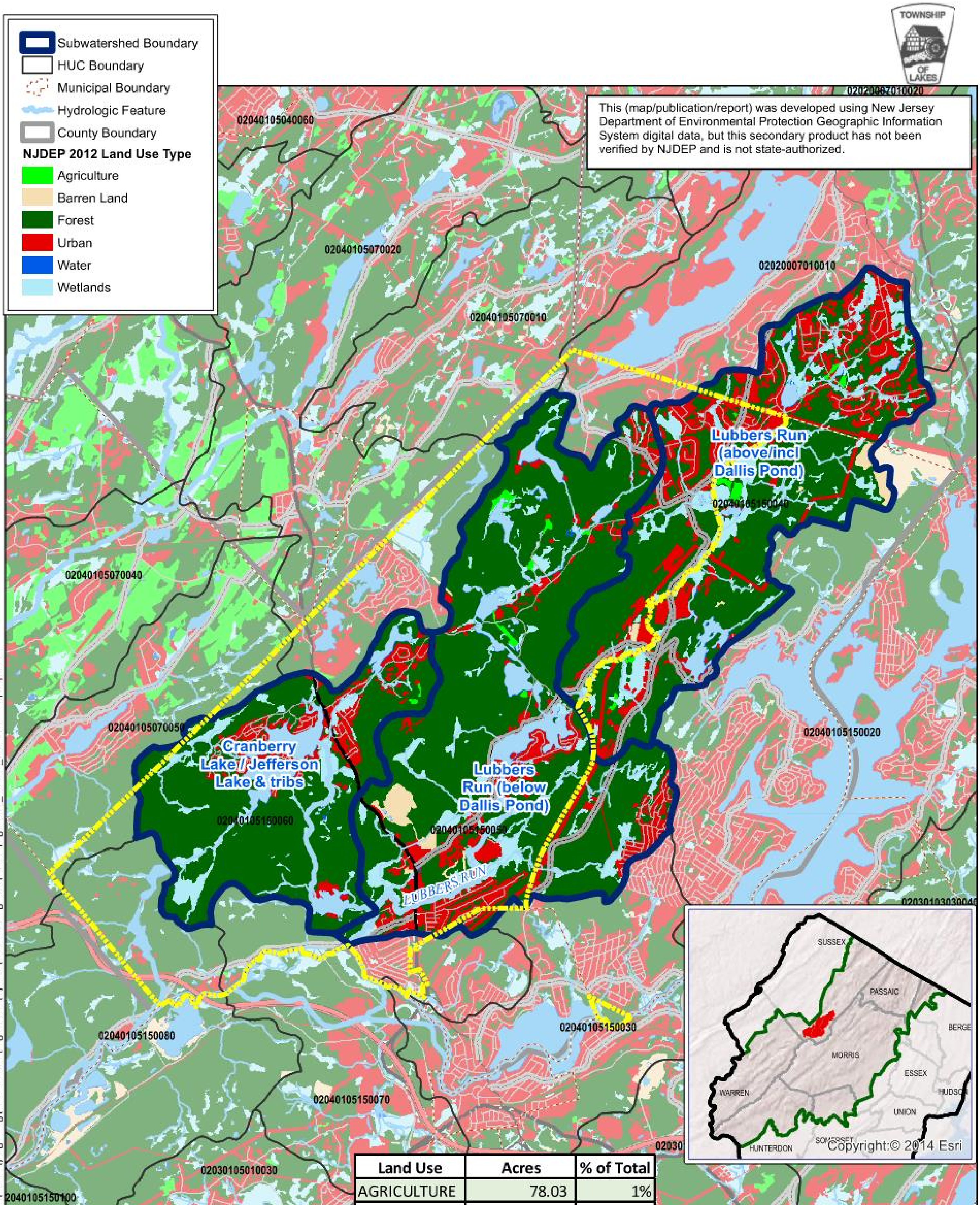
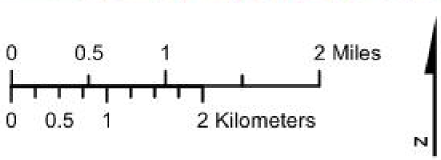


Figure 3
Planning and Preservation Areas





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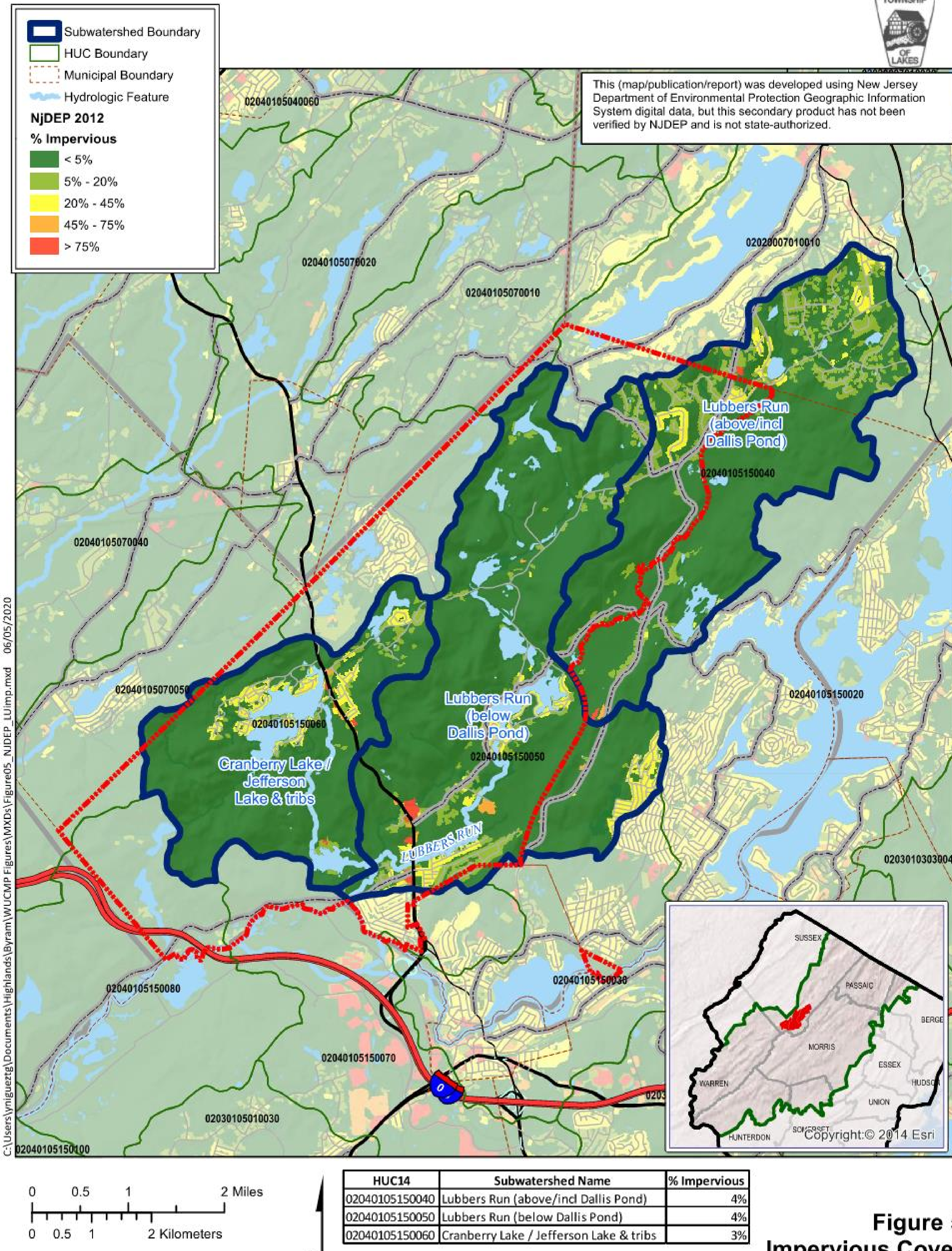
Land Use	Acres	% of Total
AGRICULTURE	78.03	1%
BARREN LAND	152.40	1%
FOREST	9,656.17	65%
URBAN	2,717.55	18%
WATER	801.44	5%
WETLANDS	1,520.54	10%

Figure 4
Land Use



HUC14	Subwatershed Name	% Impervious
02040105150040	Lubbers Run (above/incl Dallis Pond)	4%
02040105150050	Lubbers Run (below Dallis Pond)	4%
02040105150060	Cranberry Lake / Jefferson Lake & tribs	3%

Figure 5
Impervious Cover

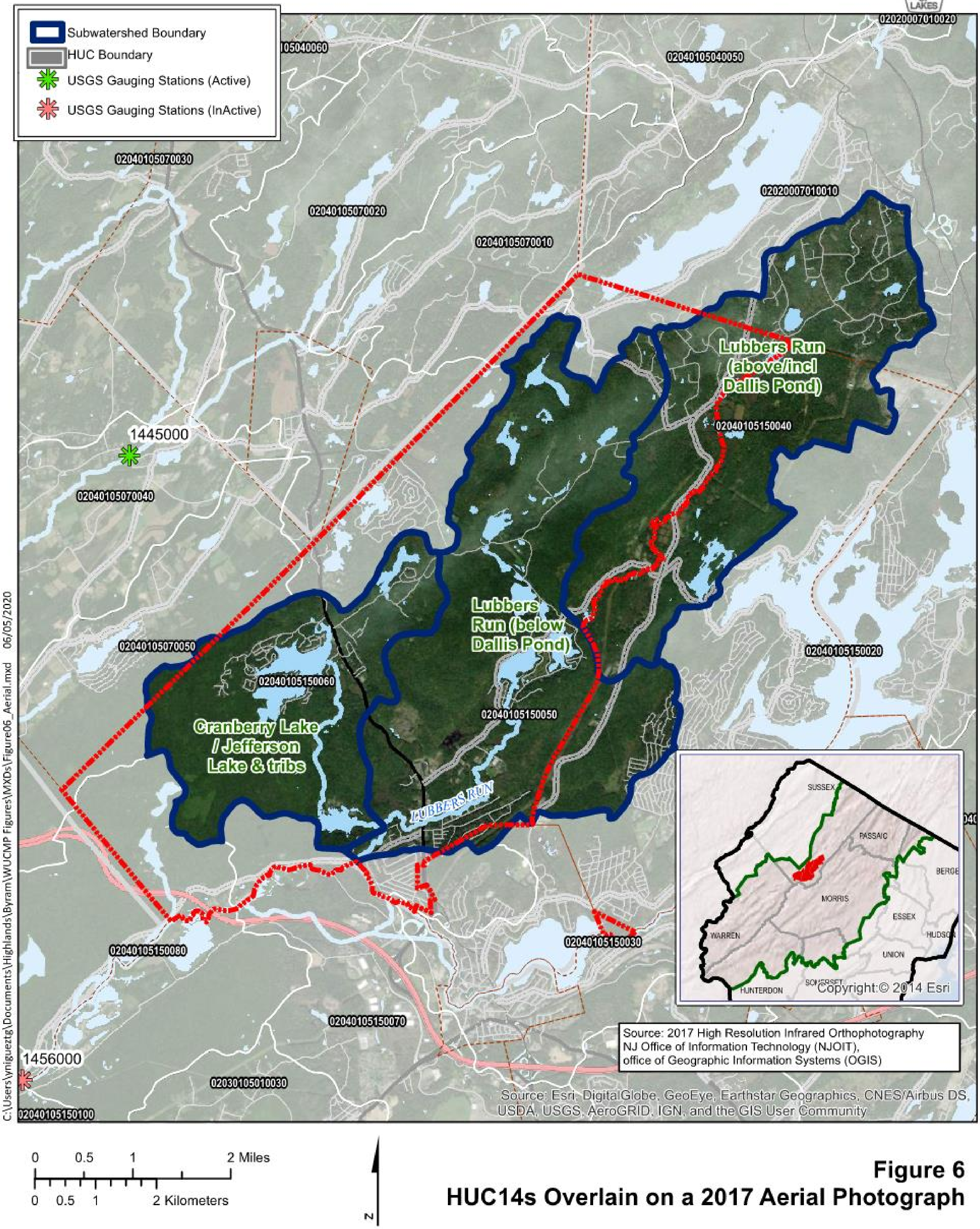


Figure 6
HUC14s Overlain on a 2017 Aerial Photograph

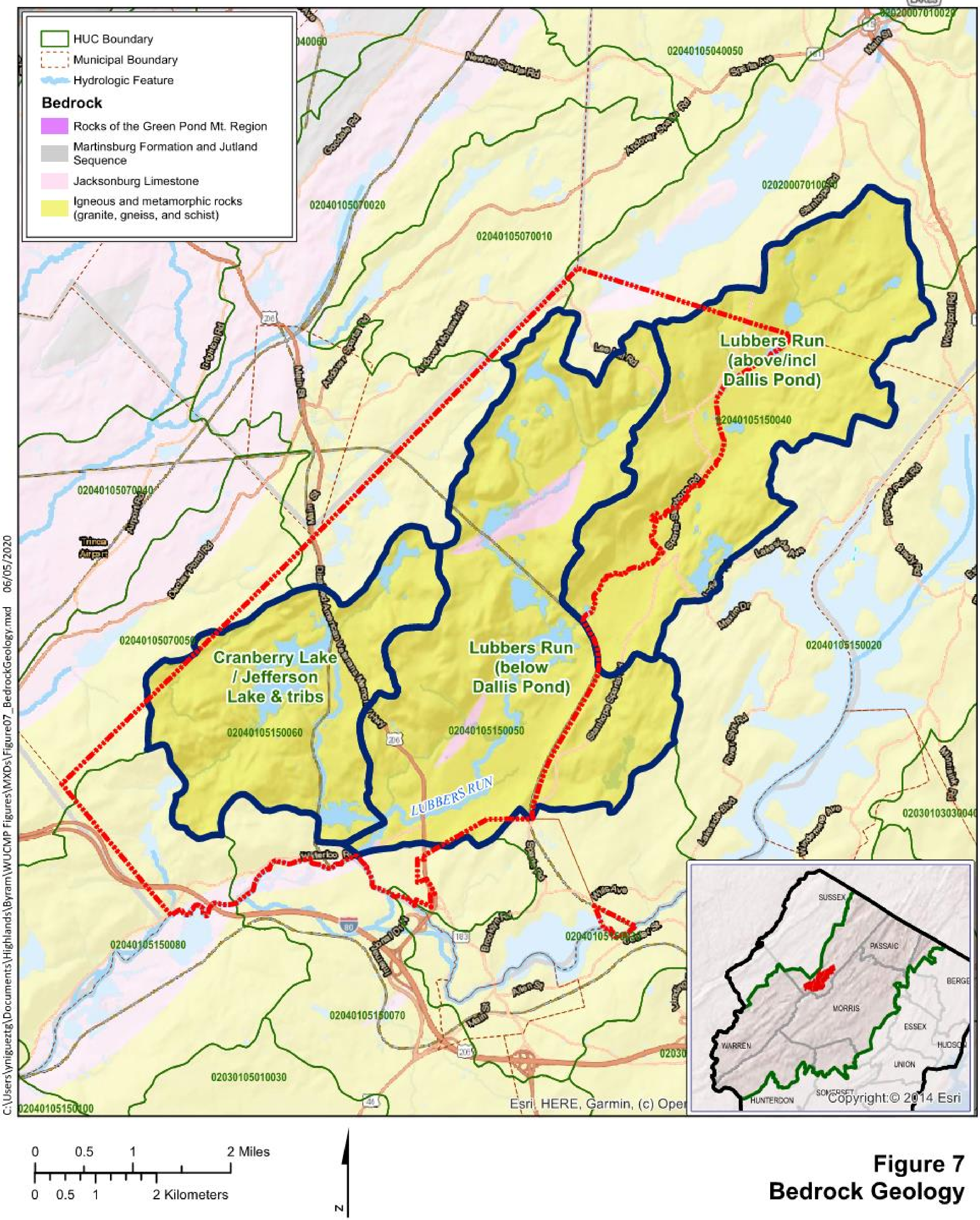


Figure 7
Bedrock Geology

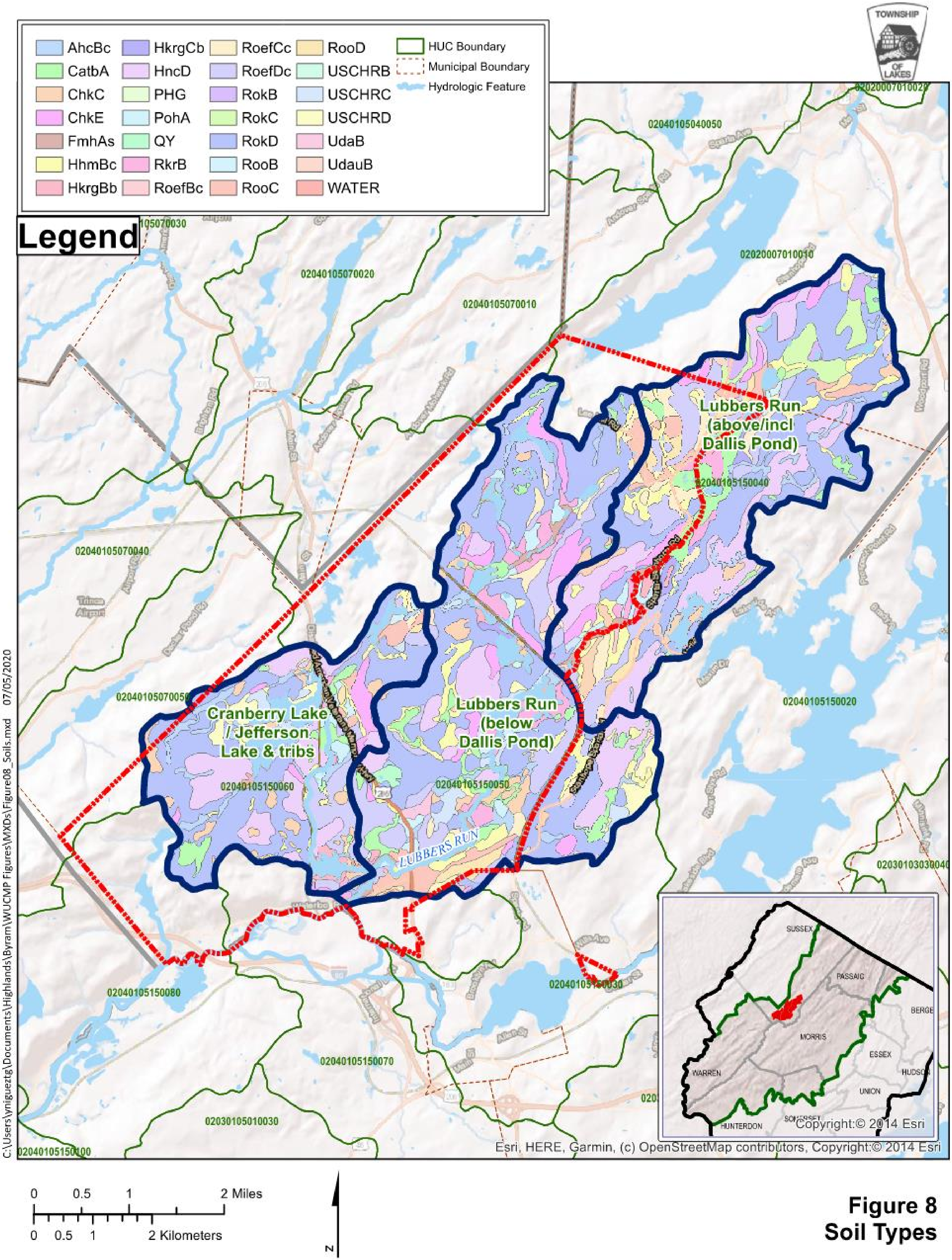


Figure 8
Soil Types

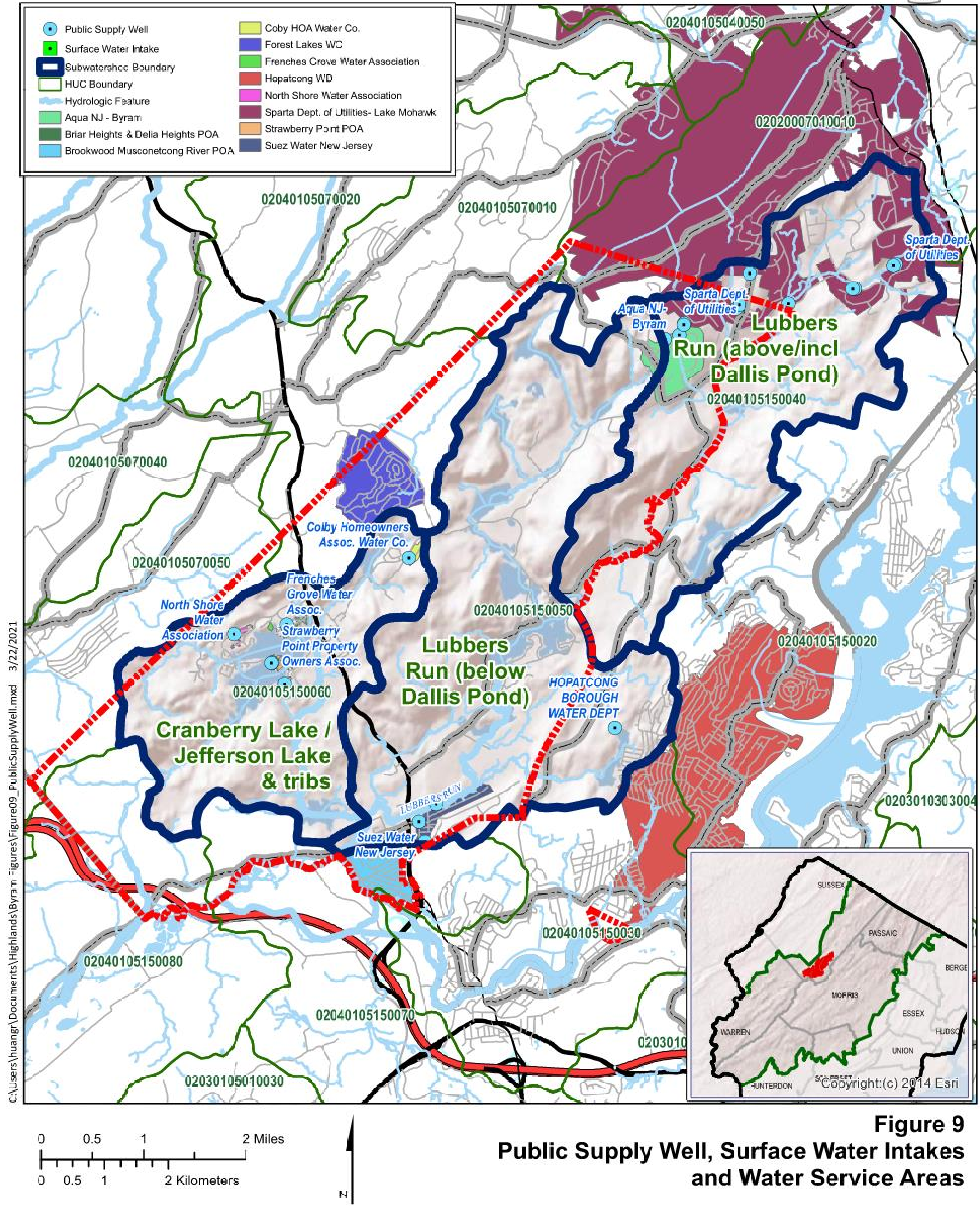


Figure 9
Public Supply Well, Surface Water Intakes and Water Service Areas

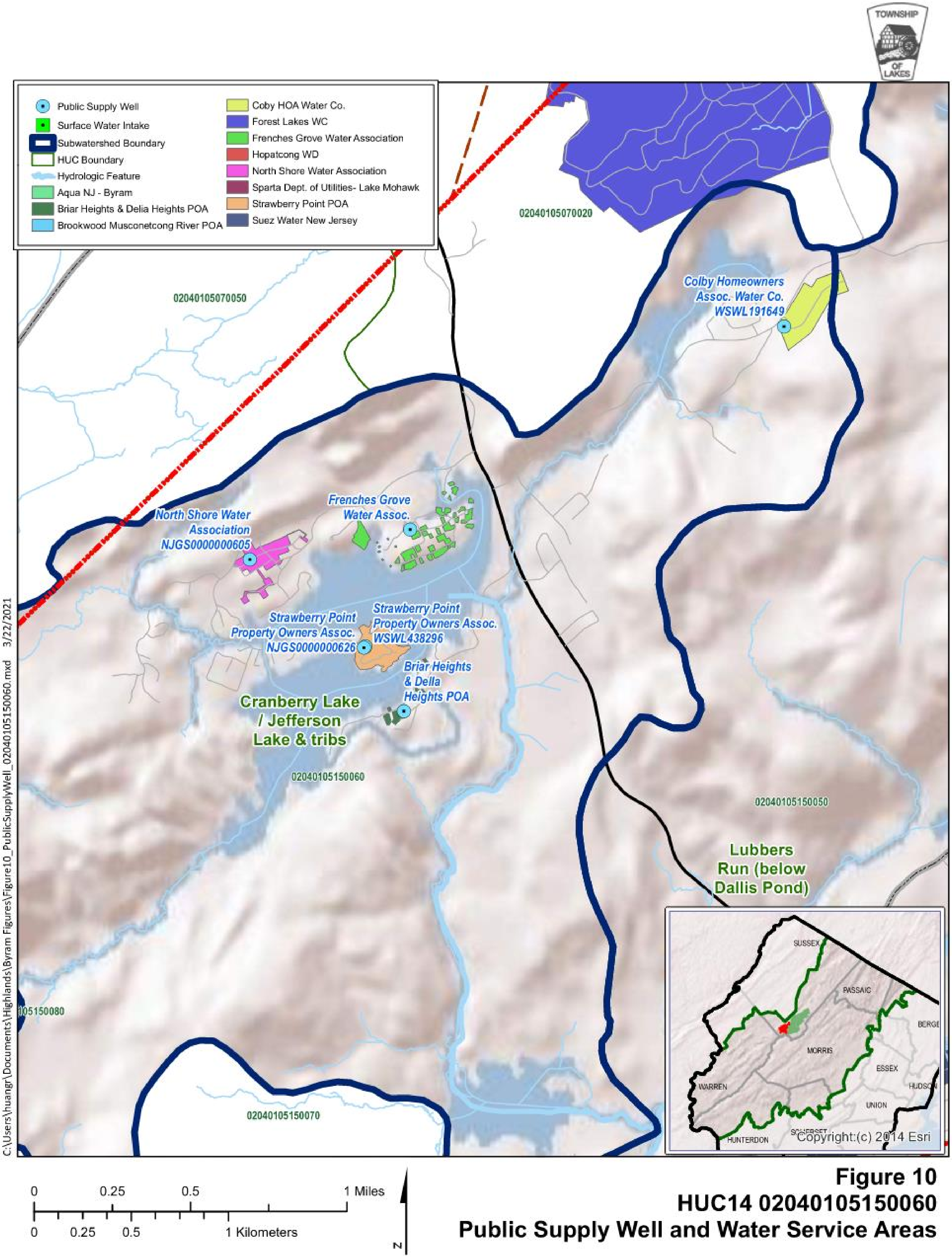


Figure 10
HUC14 02040105150060
Public Supply Well and Water Service Areas

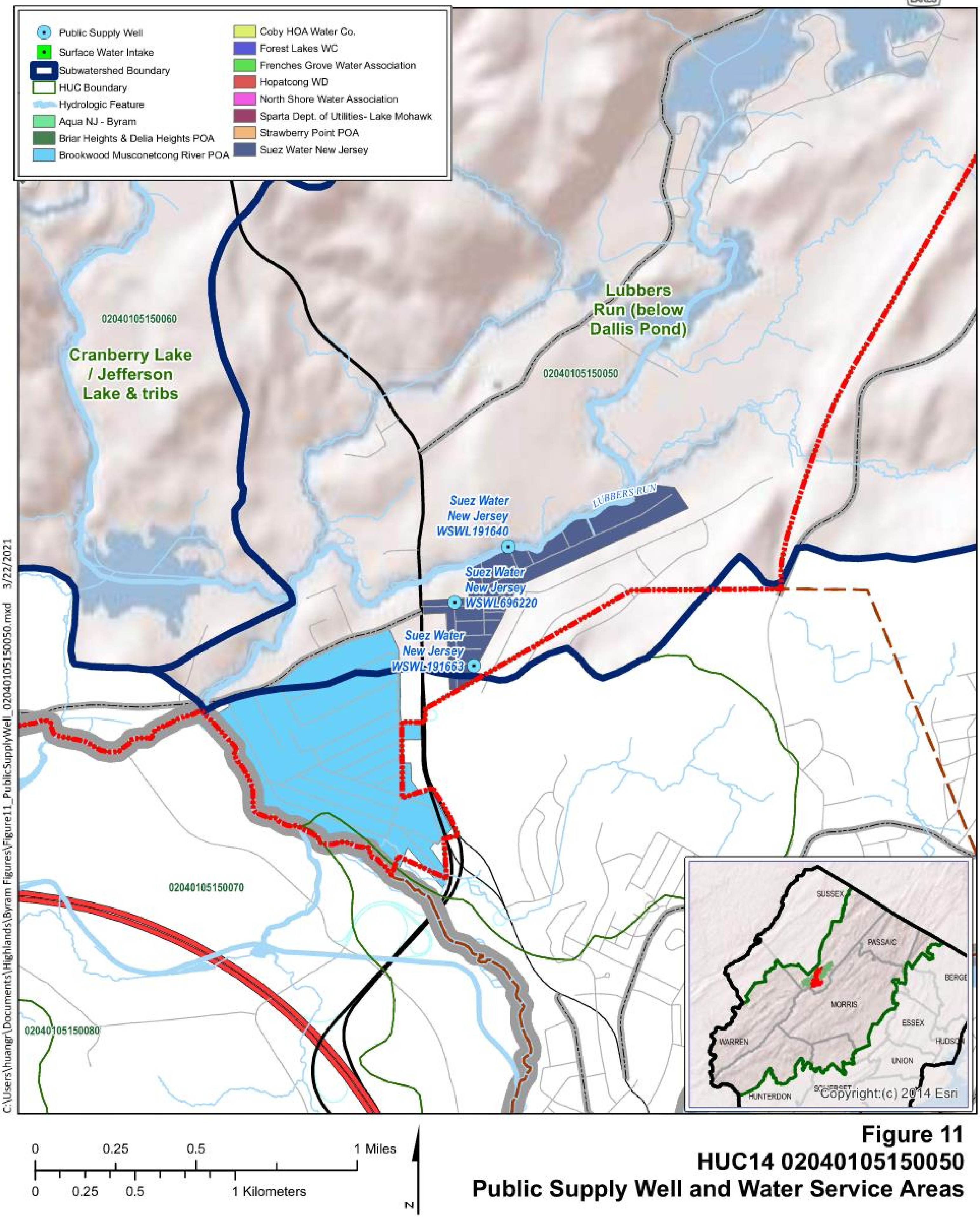


Figure 11
HUC14 02040105150050
Public Supply Well and Water Service Areas

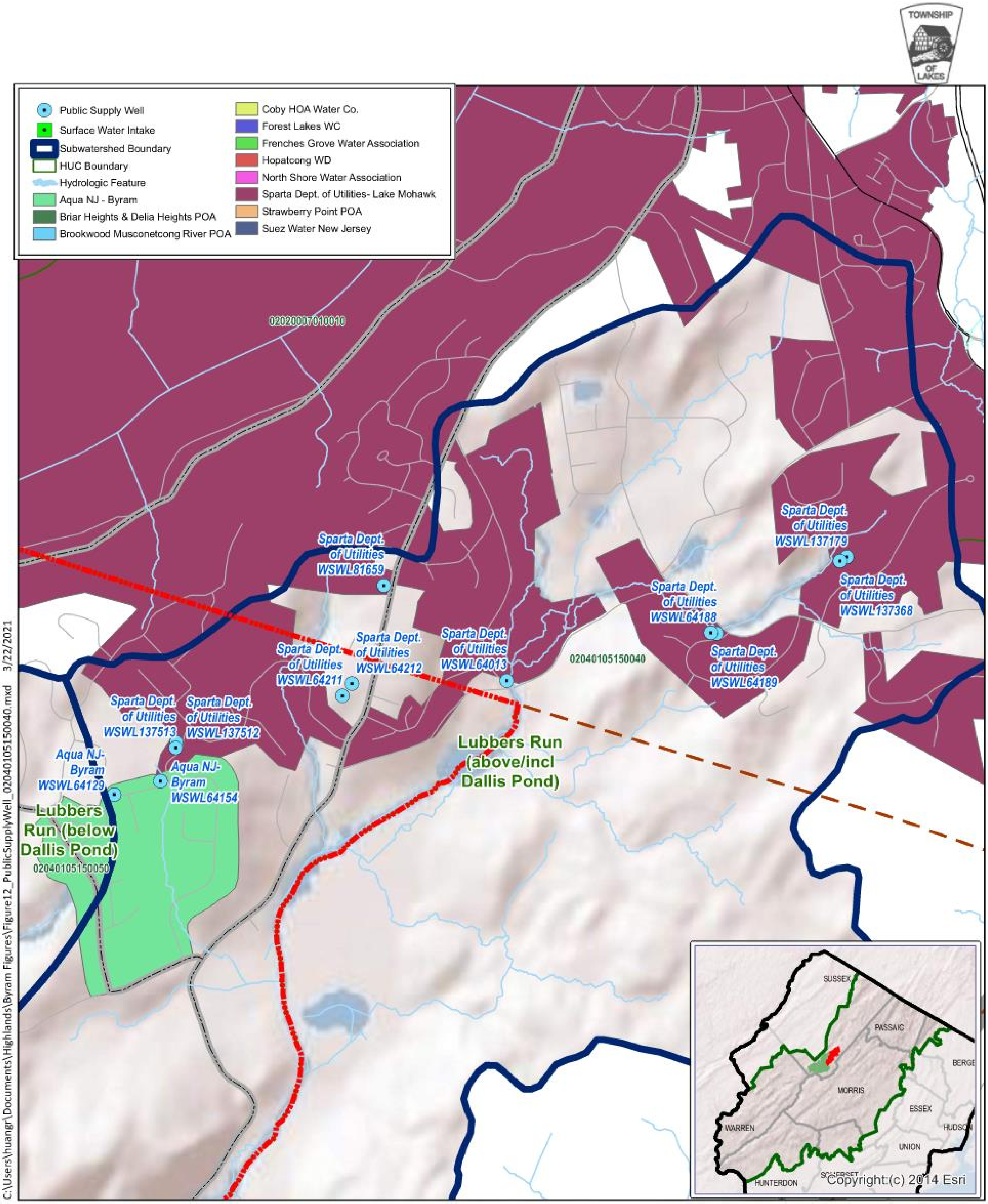


Figure 12
HUC14 02040105150040
Public Supply Well and Water Service Areas

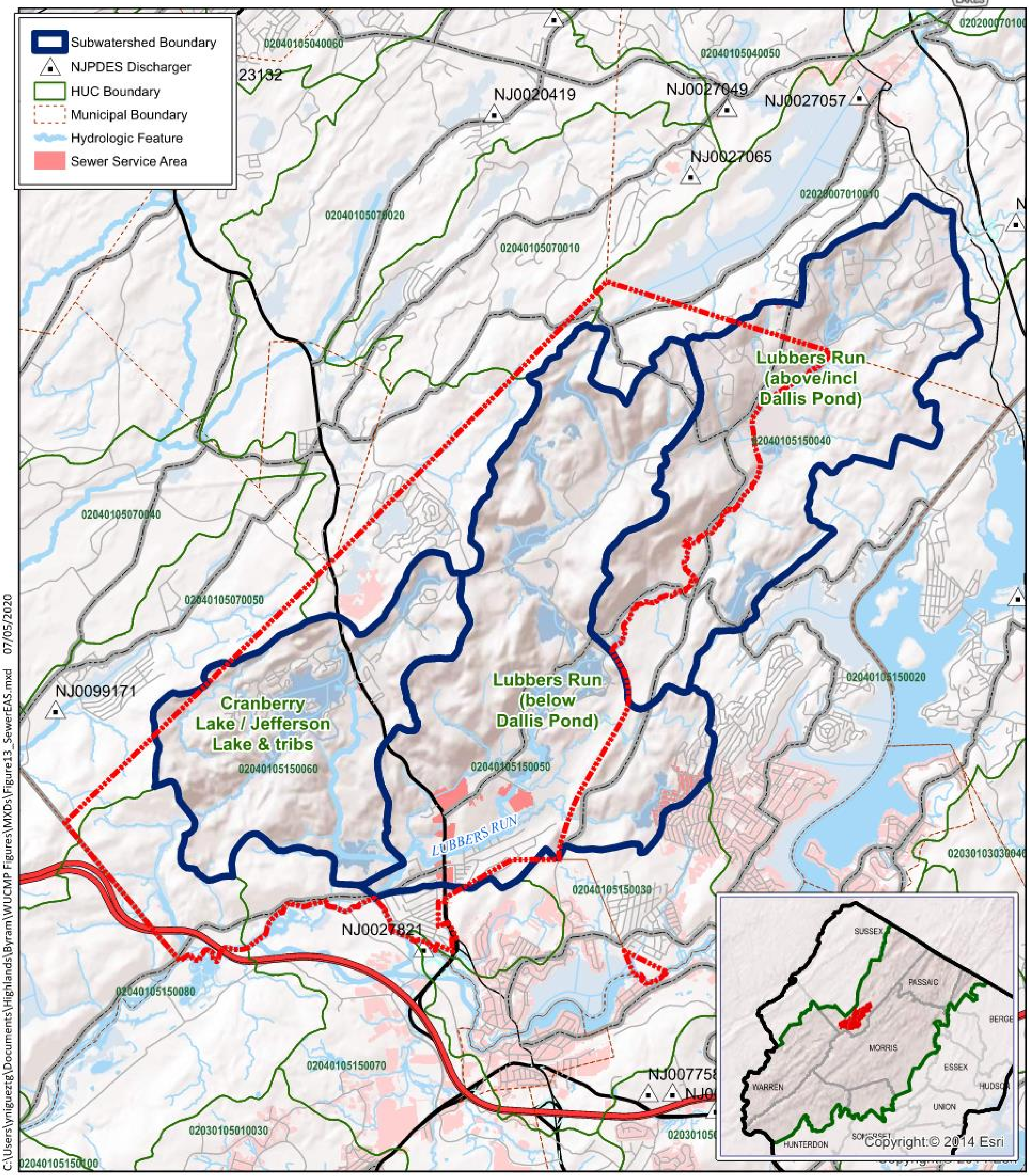


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Figure 13
Sewer Service Area
and NJPDES Dischargers