Highlands Council
New Jersey

Water Use and Conservation Management Plan

For the Borough of Oakland:

HUC14 02030103100050	**Ramapo River Crystal Lake Bridge to Bear Swamp Brook**
HUC14 02030103100060	**Crystal Lake/Pond Brook**
HUC14 02030103100070	**Ramapo River (below Crystal Lake Bridge)**

This WUCMP was developed through the provisions of a State of New Jersey Highlands Water Protection and Planning Council Grant and may assist in the development of municipal WUCMPs in support of Highlands Regional Master Plan Conformance.

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EXECUTIVE SUMMARY

The Highlands region encompasses a total area of approximately 859,000 acres, 48.3% of which are designated as *Preservation Area* lands and the remaining 51.7% are within the *Planning Area* (NJ-HWPPC, n.d.). The Highlands is comprised of 183 fourteen-digit hydrological units (HUC14s), which are either partially or completely located within the region. The Highlands Regional Master Plan (RMP) (NJHC, 2008a) aimed to evaluate, among others: smart growth (planning), preservation area requirements, and resources assessment and protection, with a focus on water resources availability to protect ecosystems and water supply for different uses. These tasks are accomplished through the development of Water Use and Conservation Management Plans (WUCMPs).

This WUCMP uses some information from the WUCMP developed for Pilot Area 9 (HUC14 02030103100070) (NJHC, 2016). The information presented in this WUCMP includes: (a) HUC14 area characteristics, (b) identification of water sources and types, (c) stakeholders, (d) reevaluation of net water availability, (e) deficit mitigation strategies (including those aiming at mitigating the inter-basin transfer), (f) funding opportunities, (g) monitoring plan, and (h) deficit mitigation implementation plan for the three hydrological units that intersect the Borough of Oakland, namely HUC14 02030103100050 (Ramapo River Crystal Lake Bridge to Bear Swamp Brook), 02030103100060 (Crystal Lake/Pond Brook), and 02030103100070 (Ramapo River below Crystal Lake Bridge). All three subwatersheds are found within New Jersey Department of Environmental Protection (NJDEP) Water Management Area 03 (WMA 03: Pompton, Pequannock, Wanaque, Ramapo). They are located within the *Protection* (HUC14s 02030103100050 and 02030103100070) or *Existing Community* (HUC14 02030103100050) Land Use Capability Zones (LUCZs). The Borough lies within the northwest portion of Bergen County (in the northeast section of New Jersey) with an approximate land area of 8.782 square miles (mi^2), of which 96.86% is land and 3.14% is water. Based on the 2010 Census, the population estimate for 2018 is 13,021 with approximately 4,319 households.

With respect to the net water availability (NWA, understood as groundwater availability minus consumptive and depletive water uses) of the subwatersheds assessed herein, in the context of the Borough of Oakland, HUC14s 02030103100050, 02030103100060, and 02030103100070 have, respectively, groundwater availability values of 0.046 million gallons per day (MGD), 0.103 MGD, and 0.041 MGD and NWA values ranging from –0.456 MGD to –0.246 MGD (deficit), –1.163 MGD to –0.186 MGD (deficit), and 0.0789 MGD (surplus). The deficits observed are primarily due to community public supply pumpage from Oakland's Water Department for HUC14 02030103100050 and from Suez and Oakland Water Department for HUC14 02030103100060.

Based on the nature of the deficit, several water conservation and deficit reduction and elimination strategies have been proposed to tackle the abovementioned deficits, namely: Water Bill Structure/Comparison, Irrigation Ordinance, Irrigation System Design, Leak Detection and Repair, Rate Structure, Stormwater Ordinance, Stormwater Basin Program and Public Education Program.

Assessment of the effectiveness of all proposed mitigation strategies shall be performed on a yearly basis. A 5-year follow-up on the NWA values of this WUCMP is also recommended as part of the assessment.

1 INTRODUCTION

1.1 Purpose and Scope

According to Highlands Regional Master Plan, "*the primary purpose of a Water Use and Conservation Management Plan is to reduce and where feasible eliminate deficits; the plan can identify appropriate management strategies that can help ameliorate such water deficits or potential impacts on water supply source areas*" (NJHC, 2008a). Furthermore, Water Use and Conservation Plans are one of the tools/mechanisms to achieve one of the fundamental purposes of the Highlands Act (NJHC, 2008a, p. 158): "*to protect water supplies for human use and ecological sustainability both within and outside of the Highlands Region*." In addition, the Highlands restoration water deficit program consists of the following five tasks (NJHC, 2008a, p. 244):

- 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 permits, including transfers of water between subwatersheds where required, supports the reduction and elimination of water deficits.

This WUCMP encompasses the three subwatersheds within the Borough of Oakland boundaries, namely HUC14s 02030103100050, 02030103100060, and 02030103100070. The Borough of Oakland has a total area of 8.77 mi^2, of which 2.98 mi^2 (33.98%) are in HUC14 02030103100050, 1.82 mi^2 (20.75%) in HUC14 02030103100060, and 3.97 mi^2 (45.27%) in HCU14 02030103100070. This document includes:

- Identification of water sources and uses, and the associated/corresponding water availability deficit or surplus of each of the three identified subwatersheds. The primary water source for the Borough of Oakland is groundwater, which is mainly used for potable (domestic groundwater and public community supply). However, industrial and agricultural uses are also found.

- A revised version of the Net Water Availability, which updates the previous version with new data from 2000 through 2018.

- Deficit reduction and elimination strategies and implementation plan.

- Reduction targets, responsible parties, a schedule for action and implementation, and funding mechanisms. The proposed strategies are: Water Bill Structure/Comparison, Irrigation System Design, Leak Detection and Repair, Rate Structure, and Stormwater Ordinance.

- Funding opportunities for the implementation of proposed mitigation strategies.

- A monitoring plan to both assess the effectiveness of the proposed mitigation strategies over time and make any necessary adjustments, if needed.

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

With respect to the water resources within the Highlands region, the Highlands Regional Master Plan has established thirteen goals (A through M) (NJHC, 2008a, pp. 157-177):

- **Goal 2A.** Protection of the value of the Highlands region as an "*essential source of drinking water, providing clean and plentiful drinking water for one-half of the State's population*" (Highlands Act, Section 2), along with the ecological values of clean water, through the protection, enhancement and restoration of water resources quantity, flow characteristics and quality as fundamental to ensuring that there are adequate water supplies to support these needs.
- **Goal 2B.** Protection, restoration and enhancement of water quality and quantity of surface and groundwaters (Sections 10.b(1) and 10.c(1)), and to determine "*the amount and type of human development and activity which the ecosystem of the highlands region can sustain while still maintaining the overall ecological values thereof, with special reference to surface and ground water quality and supply…*" (Section 11.a.(1)(a)).
- **Goal 2C.** Refinement of water availability methods and estimates.
- **Goal 2D.** Maintenance of hydrologic integrity through the protection of groundwater recharge.
- **Goal 2E.** Improvement of groundwater recharge through regional management efforts.
- **Goal 2F.** Assessment and restoration of surface and groundwater quality of the Highlands region.
- **Goal 2G.** Protection, restoration and enhancement of the water quality of the Highlands region.
- **Goal 2H.** Limitation of the type and amount of human development in the wellhead protection areas of public water supply wells.
- **Goal 2I.** Limitation of the expansion of water and wastewater infrastructure in the preservation area.
- **Goal 2J.** All existing and future development in the Highlands region that use public water supply systems are served by adequate and appropriate infrastructure
- **Goal 2K.** All existing and future development in the Highlands region that use public wastewater treatment systems are served by adequate and appropriate infrastructure.
- **Goal 2L.** Ensure that on-site wastewater system discharges do not exceed the natural capacity of ground water to attenuate loadings, exacerbate existing nitrate impairment, or contribute to potential nitrate impairment for subwatersheds of the Highlands region.
- **Goal 2M.** Refinement and improvement of the groundwater resource management element.

Although the development of a Water Use and Conservation Plan includes –to a lesser or greater extent– the abovementioned goals, it focuses more specifically on the eight polices established in Goal 2B: "*Protection, restoration and enhancement of water quality and quantity of surface and groundwaters*."

2 WUCMP Area Characteristics

2.1 Background

The Borough of Oakland lies in the northwestern portion of Bergen County (northeastern New Jersey) with an approximate land area of 8.77 mi^2, of which 96.86% is land and 3.14% is water. The borough is within Watershed Management Area 3 (WMA 3), which includes watersheds that drain the Highlands portion of New Jersey. WMA 3 lies mostly in Passaic County but also includes parts of Bergen, Morris, and Sussex Counties and is comprised of 21 municipalities that lie entirely or partially within the watershed boundary. There are four sub-watersheds in WMA 3: Pompton, Ramapo, Pequannock and Wanaque River watersheds. The Pequannock, Wanaque and Ramapo Rivers all flow into the Pompton River. The Pompton River is, in turn, a major tributary to the Upper Passaic River. WMA 3 contains some of the State's major water supply reservoir systems including the Wanaque Reservoir, the largest surface water reservoir in New Jersey. Table 1 compiles information on the HUCs that intersects the Borough of Oakland WUCMP. Figure 1 (Appendix C) shows the HUCs' geographical location.

Table 1. Summary of WUCMP Area

Item	HUC14		
	02030103100050	**02030103100060**	**02030103100070**
Name	Ramapo River, Crystal Lake Bridge to Bear Swamp Brook	Crystal Lake/Pond Brook	Ramapo River below Crystal Lake Bridge
Perimeter (mi)	11.4	16.4	20.4
Total Area (mi^2)	6.31	7.86	12.04
Area within the Borough of Oakland (mi^2)	2.98	1.82	3.97
Area in each County	• 6.15 mi^2 within Bergen County. • 0.16 mi^2 within Passaic County.	• 0.27 mi^2 within Passaic County. • 7.59 mi^2 within Bergen County.	• 0.0461 mi^2 within Morris County. • 4.068 mi^2 within Bergen County. • 7.924 mi^2 within Passaic County.
Municipalities	• **Oakland (2.975 mi^2)** • Franklin Lakes (0.152 mi^2) • Mahwah (3.001 mi^2) • Wanaque (0.049 mi^2) • Ringwood (0.129 mi^2)	• **Oakland (1.824 mi^2)** • Franklin Lakes (5.776 mi^2) • North Haledon (0.002 mi^2) • Wayne (0.254 mi^2)	• **Oakland (3.969 mi^2)** • Franklin Lakes (0.0989 mi^2) • Wayne (5.352 mi^2) • Pompton Lakes (1.481 mi^2) • Wanaque (1.09 mi^2) • Pequannock (0.0461 mi^2)
Water Region Name	Northeast	Northeast	Northeast
Watershed Management Area	03	03	03
Subwatershed ID	03CA05	03CA06	03CA07

Item	HUC14		
	02030103100050	02030103100060	02030103100070
Approximate location of the subwatershed's centroid	41°3'17.57"N 74°13'38.91"W	41°0'25.06"N 74°13'11.55"W	41°0'29.11"N 74°15'46.27"W

Source: adapted from NJGIN (2020). 1 mi^2 = 640 acre.

2.2 Land Use Capability/Land Cover

The Borough of Oakland consists of two primary Land Use Capability Zones (Figure 2, Appendix C): (1) the Protection Zone and (2) the Existing Community Zone. The latter has two subzones: (a) Environmentally Constrained Subzone and (b) Lake Community Subzone. These zones and subzones are defined below.

2.2.1 Protection Zone.

Areas with the highest quality natural resource value lands that are essential to maintaining water quality, water quantity and sensitive ecological resources and processes. Development activities are subject to stringent limitations on consumptive and depletive water use, degradation of water quality, and impacts to environmentally sensitive lands and natural resources.

2.2.2 Existing Community Zone

Areas with developed areas of existing communities and certain limited environmental constraints so as to not negatively impact the ecological value of the Highlands Region ecosystems.

2.2.2.1 Environmentally-Constrained Subzone

Areas with critical habitat, steep slopes, and forested lands within the Existing Community Zone that should be protected from further fragmentation. Development is limited to avoid consumptive and depletive water use, degradation of water quality, and impacts to environmentally sensitive lands.

2.2.2.2 Lake Community Subzone

Areas with community development within 1,000 feet of lakes aiming to protect and enhance water quality, resource features, shoreline recreation, scenic quality, and community character of an Existing Community Zone.

Table 2 summarizes the corresponding area of each the identified zones within this WUCMP.

Table 2. Summary of Land Use Capability Zones within Oakland's WUCMP

Land Use Capability Zones	HUC14 (mi²)			Total (mi²)
	02030103100050	02030103100060	02030103100070	
Protection Zone	1.83	0.19	1.82	**3.84**
Exisiting Community Zone	0.77	1.17	1.16	**3.10**
Environmentally-Constrained Subzone	0.21	0.14	0.29	**0.64**
Lake Community Subzone	0.002	0.08	0.23	**0.312**
Total (mi²)	**2.812**	**1.58**	**3.50**	**7.892**

Table 3 shows the planning areas distribution within each HUC14s (Figure 3, Appendix C).

Table 3. WUCMP Planning Area Distribution

Planning Areas	HUC14 (mi²)			Total (mi²)
	02030103100050	02030103100060	02030103100070	
Environmentally Sensitive	0.07	0.03	0.16	**0.26**
Highlands Preservation	1.73	0.11	2.23	**4.07**
Metropolitan	0.92	1.68	1.58	**4.18**
Park 1st Plan	0.25			**0.25**
Total (mi²)	**2.98**	**1.82**	**3.97**	**8.77**

Source: Planning Areas of the NJ State Development and Redevelopment Plan (NJSDRP) at NJGIN Open Data (https://njogis-newjersey.opendata.arcgis.com/datasets/dosopa::planning-area-boundaries-of-the-nj-state-development-and-redevelopment-plan-new-jersey-1?geometry=-74.530%2C40.982%2C-73.957%2C41.072).
Note: discrepancies in total areas are due to rounding

2.3 Land Use/Zoning

The WCUMP area is composed of six (6) land uses, namely Agriculture, Barren Land, Forest, Urban, Water, and Wetlands, whose area distribution is shown in Table 4 and Figure 4 (Appendix C). In terms of the land zoning, the following categories can be found (Figure 5, Appendix C):

- **Residential:** Affordable Housing, Cluster Single Family Residence, Multifamily Residence, Residential Cluster, Single Family Residence, and Single-Family Residence/Life Care Facility
- **Commercial:** Corporate Office, Neighborhood Business, Local Business, and Professional Office
- **Industrial:** Industrial, Industrial Office and Industrial Park
- **Recreational:** Recreational Public Purpose
- **Conservation**

Table 4. Summary of Land Use within Oakland's WUCMP

Land Use	HUC14 (mi²)			Total (mi²)
	02030103100050	02030103100060	02030103100070	
Agriculture	0.004	0.02	0.02	**0.044**
Barren Land	0.01	0.01	0.03	**0.05**
Forest	1.68	0.34	1.91	**3.93**
Urban	1.06	1.35	1.74	**4.15**
Water	0.06	0.08	0.13	**0.27**
Wetlands	0.16	0.04	0.14	**0.34**
Total (mi²)	**2.974**	**1.83**	**3.97**	**8.784**

Quantities based on 2015 Land Use Map

Table 5 summarizes the zoning area distribution in each HUC14.

Table 5. WUCMP Zoning Area Distribution

Zoning Type	Code	HUC14 (mi^2)			Total (mi^2)
		02030103100050	02030103100060	02030103100070	
Conservation	C	1.49		0.93	**2.42**
Recreational Public Purpose	R/PP			0.05	**0.05**
Single Family Residence	RA-1	0.31	0.11	0.47	**0.89**
Single Family Residence	RA-2	0.47	0.18	0.23	**0.88**
Single Family Residence	RA-3	0.26	1.01	1.01	**2.28**
Cluster Single Family Residence	RA-C	0.45			**0.45**
Single Family Residence-Life Care Facility	RA-1A			0.14	**0.14**
Multi Family Residence	RA-MD			0.02	**0.02**
Residential Cluster	RC			0.09	**0.09**
Townhouse	TH			0.01	**0.01**
Affordable Housing	AH-2		0.02	0.11	**0.13**
Affordable Housing	AH			0.06	**0.06**
Local Business	B-2		0.02	0.25	**0.27**
Neighborhood Business	B-3			0.01	**0.01**
Corporate Office	CO		0.18	0.04	**0.22**
Corporate Office	CO & IP			0.18	**0.18**
Professional Office	PO			0.05	**0.05**
Industrial	I-1			0.14	**0.14**
Industrial Office	I-3		0.07	0.07	**0.14**
Industrial Park	IP		0.22	0.13	**0.35**
	Total (mi^2)	**2.98**	**1.81**	**3.98**	**8.77**

Note: discrepancies in total areas are due to rounding

Table 6 presents the impervious areas within the Borough of Oakland in each of the HUC14s (Figure 6, Appendix C).

Table 6. Impervious areas

HUC14	Impervious Area Type								
	Building			Other			Road		
	Area (acres)	As a percentage of		Area (acres)	As a percentage of		Area (acres)	As a percentage of	
		Oakland Borough	Full HUC14		Oakland Borough	Full HUC14		Oakland Borough	Full HUC14
02030103100050	64.62	3%	2%	74.60	4%	2%	89.65	5%	2%
02030103100060	107.38	9%	2%	140.21	12%	3%	111.18	10%	2%
02030103100070	113.34	4%	1%	231.11	9%	3%	163.08	6%	2%

Note: 'Other' refers to areas that are either paved and/or highly compacted such as parking lots, sidewalks, driveways, etc.

2.4 Major Hydrologic Features

Table 7 compiles the surface streams and waterbodies in the three (3) HUC14s that intersect the Borough of Oakland. Also, the United States Geological Survey (USGS) maintains several stream gauges and monitoring stations within this WUCMP (Figure 7, Appendix C).

Table 7. Water bodies and streams within the Borough of Oakland's HUC14s

HUC14	Category	Water Body	Length (ft)	Remarks
02030103100050	FW2-NT	Ramapo River UNT	5,901.7	Freshwaters are classified as FW1 waters (not subject to any man-made wastewater discharges) and FW2 waters (all other freshwaters except Pinelands waters). FW1 waters are non-degradation waters set aside for posterity because of their unique ecological significance. FW2 waters are further classified based on their ability to support trout, which thrive in cooler stream temperatures. Trout classifications include trout production (FW2-TP), trout maintenance (FW2-TM), and non-trout (FW2-NT). Category One (C1) waters are protected from any measurable changes to the existing water quality Category Two (C2) waters are all fresh surface waters not designated FW1, PL or Category One.
	FW2-NT	Tamarack Lake	615.0	
	FW2-NTC1	Ramapo River	8,241.2	
	FW2-NTC1	Ramapo River UNT	18,389.5	
	FW2-TPC1	Ramapo River UNT	19,475.6	
02030103100060	FW2-NT	Pond Brook	9,385.3	
	FW2-NT	Pond Brook UNT	12,562.7	
	FW2-NT	Uncoded Tributary	2,733.8	
02030103100070	FW2-NT	Pompton Lake	49.7	
	FW2-NT	Pond Brook	263.2	
	FW2-NT	Ramapo Lake Brook	1,225.7	
	FW2-NT	Ramapo Lake Brook UNT	4,952.1	
	FW2-NT	Ramapo River	5,374.0	
	FW2-NT	Ramapo River UNT	2,560.9	
	FW2-NT	Uncoded Tributary	8,770.0	
	FW2-NTC1	Potash Lake	1,768.6	
	FW2-NTC1	Ramapo Lake	950.7	
	FW2-NTC1	Ramapo Lake Brook	3,561.9	
	FW2-NTC1	Ramapo Lake Brook UNT	6,029.0	
	FW2-NTC1	Ramapo River	13,802.6	
	FW2-NTC1	Ramapo River UNT	485.9	
	FW2-TPC1	Little Pond Brook	5,137.9	
	FW2-TPC1	Little Pond Brook UNT	7,520.8	

2.5 Geology and Soil Properties

The Borough of Oakland is situated within two physiographic provinces, namely Highlands and Piedmont (Table 8 and Figure 8 in Appendix C). The former is characterized by ridges and deep, steep-sided valleys carved by streams composed of metamorphic and igneous rocks of Late Precambrian and Early Paleozoic age, while the latter has gently rolling hills with sedimentary and igneous rocks from the late Triassic and Early Jurassic age. The western and eastern part of the borough are respectively composed of fourteen types of bedrock, soft shales, sandstone and hard basalt. A total of sixteen geological formations are found in the Borough of Oakland (Figure 9, Appendix C): *Feltville Formation* (**Jf**, 19.16% of the borough's total area), *Feltville Formation Conglomerate and Sandstone facies* (**Jfc**, 0.99% of the borough's total area), *Orange Mountain Basalt* (**Jo**, 12.32% of the borough's total area), *Preakness Basalt* (**Jp**, 25.34% of the borough's total area), *Towaco Formation* (**Jt**, 1.38% of the borough's total area), *Bushkill Member* (**Omb**, 0.20% of the borough's total area), *Amphibolite* (**Ya**, 2.39% of the borough's total area), *Biotite-Quartz-Feldspar Gneiss* (**Yb**, 4.44% of the borough's total area), *Hornblende Granite* (**Ybh**, 13.77% of the borough's total area), *Biotite-Quartz-Oligoclase Gneiss* (**Ylb**, 3.77% of the borough's total area), *Quartz-Oligoclase Gneiss* (**Ylo**, 13.38% of the borough's total area), *Microcline Gneiss* (**Ym**, 0.22% of the borough's total area), *Hornblende-Quartz-Feldspar Gneiss* (**Ymh**, 2.53% of the borough's total area), and *Pyroxene Gneiss* (**Yp**, 0.09% of the borough's total area). Depth to bedrock ranges from zero to 125 inches on the western portion of the borough (Kratzer, 2014).

With respect to soil types, 16 soil series (Adrian, Boonton, Carlisle, Dunellen, Fluvaquent, Haledon, Hasbrouck, Hibernia, Otisville, Pascack, Pits, Preakness, Riverhead, Rockaway, Udorthents, and Urban land) and 44 different map units can be found in the Borough of Oakland. Regarding the soils infiltration rates, the majority of the soils have slow or very slow rates. However, some areas exhibit high to moderate rates (Kratzer, 2014). In general, the Borough has soils with Hydrologic Soil Group (HSG) A through D, being *HSG Type C* the most predominant: Adrian (A/D), Boonton (C), Carlisle (A/D), Dunellen (A/D), Fluvaquents (B/D), Haledon (C), Hasbrouck (D), Hibernia (C), Otisville (A), Pascack (C), Preakness (D), Riverhead (B), Rockaway (C), and Udorthent (D).

Table 8. Summary of Physiographic Provinces within Oakland's WUCMP Area

Physiographic Provinces	HUC14		
	02030103100050	02030103100060	02030103100070
Highlands (mi^2)	1.80	0.01	1.76
Piedmont (mi^2)	1.17	1.82	2.21
Total (mi^2)	**2.97**	**1.83**	**3.97**

3 IDENTIFICATION OF WATER SOURCES AND USES

3.1 Water System Profile

3.1.1 Description

The Borough of Oakland produces 100% of its water from seven wells (one of them, Well 8A, is a backup well) (BONJ, 2020a). The system is composed of six water storage tanks (Andrew Ave, Thornton Rd, Overlook Ridge, Darlington, Spear Street, and Camp Todd), four booster pumping stations (Well # 5, Iroquois Ave, Walnut Ave, and Overlook Ridge), and 72 miles of water main. Table 9 compiles information on the Water Utility Existing Area(s) Served within the Borough of Oakland.

Table 9. Water Utility Existing Areas

Area Type	Area (acres)	
	Oakland's Water Department	OTHER WAP040001
Planning Area	1,750	1
Preservation Area	226	37
Total	**1,976**	**38**

Source: http://state.nj.us/njhighlands/bergen_county/oakland/council_approved/oakland_eri.pdf (p. 37)

3.1.2 Facilities

The Borough's Water Department operates and maintains seven wells (Wells # 5, 6, 7, 8, 8A, 9, and 10) (Figure 10, Appendix C). Well 8A is a backup well.

3.1.3 Service Areas

The service area purveyor of Oakland's WUCMP is the Borough of Oakland Water Department (Figure 10, Appendix C).

3.1.4 Allocation and Firm Capacity

According to Water Allocation Permit (WAP) No. 5199, the Oakland Water Department has allocation limits of: (a) 759 million gallons per year (MGY), (b) 124 million gallons per month (MGM), and (c) 4,200 gallons per minute (gpm).

Based on the New Jersey Safe Drinking Water Rules, New Jersey Administrative Code 7:10-11.4, Part (a)(3) (NJAC, 2020), *Firm Capacity* is defined as adequate pumping equipment and/or treatment capacity (excluding coagulation, flocculation, and sedimentation) to meet peak daily demand when the largest pumping station or treatment unit is out of service. Table 10 summarizes information on the allocation and Firm Capacity of the Oakland's Water Department (NJDEP, 2020).

Table 10. Public Groundwater Wells within Oakland WUCMP

Water Purveyor	System	HUC14	Well Name	Well Capacity (gpm)	Allocation (MGM)	Firm Capacity (MGD)
Oakland Water Department (PWSID#0242001)	Public	02030103100050	Well 6	200	124	2.785
			Well 7	400		
			Well 8	1,300		
			Well 8A(*)	1,150		
		02030103100060	Well 9	350		
		02030103100070	Well 5	700		
			Well 10	1,050		

(*) Well 8A is a backup well

3.1.5 Remaining Firm Capacity

The Oakland's Water Department highest peak daily demand value recorded until now was 2.508 MGD, which was reported on September 2015 (NJDEP, 2020). With this value, the Remaining Firm Capacity is 0.277 MGD (which is the result of subtracting 2.508 MGD from 2.785 MGD).

3.2 Wastewater Management

3.2.1 Description

At present, only 5% of the population of the Borough of Oakland is connected to sanitary sewer. The remaining 95% of the area is served by nearly 3,000 commercial and residential properties with septic systems. The Borough owns three wastewater treatment plants (WWTPs), namely Skyview-Hibrook, Chapel Hill, and Oakwood Knolls, which have a 2012-2018 rolling/moving average flow of 0.01446 MGD (or 10.04 gpm), 0.006283 MGD (or 4.63 gpm), and 0.02079 MGD (or 14.44 gpm), respectively. Additionally, there is one (1) WWTP owned by The Oakland Board of Education. The area of the current sanitary sewer service area is approximately 358.4 acres. Table 11 compiles the information on the sewer service area within each HUC14. Figure 11 (Appendix C) shows the service area and the main wastewater facilities.

Table 11. Sewer Service Area

Sewer Area	HUC14			Total (mi²)
	02030103100050	**02030103100060**	**02030103100070**	
Sanitary Sewer	0.24	0.20	0.12	**0.56**
Septic tanks	1.17	1.28	1.48	**3.93**
Total (mi²)	**1.41**	**1.48**	**1.60**	**4.49**

3.2.2 Facilities

Table 12 shows the major domestic wastewater treatment plants in the Borough of Oakland.

Table 12. Major domestic WWTPs

Owner	Wastewater Facility	Geographical Coordinates		Area Served
		North	**West**	
Borough of Oakland	Skyview-Hibrook	41.023542	74.240001	68 homes in the vicinity of Lakeside Blvd
	Oakwood Knolls	41.036746	74.226775	166 connections from Oakcrest Townhouse Development and the Coppertree Mall
	Chapel Hill	41.031410	74.215851	24 homes in Chapel Hill Estates
Oakland Board of Education	Indian Hills High School	41.022430	74.231325	Indian Hills High School

The Skyview-Hibrook, Chapel Hill, and Oakwood Knolls WWTPs are operated by the Borough's Department of Public Works (DPW). These WWTPs are approaching their useful life. Thus, they will be decommissioned and replaced by pumping stations that will convey the wastewater flow to the North Bergen County Utilities Authority (NBCUA) WWTP, which collects wastewater from fourteen (14) municipalities and has a total capacity of 16.8 MGD and an annual average flow of about 10.3 MGD. The Borough of Oakland is not currently within the Sewer Service Area of NBCUA. Oakland is requesting for the majority of the Borough, beyond these three facilities, to be included in the Sewer Service Area of NBCUA. However, the Borough and NBCUA are discussing this matter in search of a long-term solution. In this context, this WUCMP proposes various strategies that help with mitigating this scenario involving inter-basin transfer, considering the generation of a wastewater flow of up to nearly 0.5 MGD as a result of the redevelopment opportunities the Borough estimates for the next 30 years.

4 STAKEHOLDERS PARTICIPATION

Potential Stakeholders within this WUCMP area include the following:

- Municipal government of the Borough of Oakland
- Borough of Oakland Water Department
- Borough of Oakland DPW
- Residents of the applicable areas within the Borough of Oakland

5 ANALYSIS OF NET WATER AVAILABILITY

5.1 Introduction

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

On a municipal basis, Net Water Availability is calculated for subwatersheds that are either entirely within the municipality where the municipality has significant (non-domestic) withdrawals in a portion of the subwatershed. For subwatersheds that are within a municipality that only has domestic water withdrawals, but another municipality has more significant (public supply wells, for example) withdrawals, the onus of Net Water Availability will be assigned to the municipality with the more significant withdrawals. Although a total of four HUC14s intersect Oakland Borough, only three have significant influence on the Borough's NWA. The Borough has less than an acre in the other HUC14 and no significant withdrawals from public supply or private water use occur within that limited area.

Net Water Availability has been calculated for the three HUC14s within the Borough of Oakland from 2000 through 2018 and results are documented within this chapter.

5.2 Low Flow Margin (LFM)

Low Flow Margin (LFM) 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 (NJHC, 2008c, p. 46).

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

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

5.3 Groundwater Availability

Groundwater Availability is that portion of Groundwater Capacity that is available for human uses, absent other constraints. The following threshold values were established by the Highlands Council (Table 13):

Table 13. Groundwater Availability Thresholds as Percentage of Groundwater Capacity

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

The subwatersheds addressed by this WUCMP are within the Protection Zone and the Existing Community Zone, so according to the rules established in the Highlands RMP and Technical Report Vol. II, Groundwater Capacity is multiplied by 5% and 20%, respectively, to arrive at Groundwater Availability. Groundwater Availability for the three (3) subwatersheds covering Oakland Borough are presented below in Table 14.

Table 14. Groundwater Availability

HUC14 Description	Land Use Compatibility Zone	Groundwater Availability (MGD)
02030103100050 (Ramapo River, Crystal Lake Bridge to Bear Swamp Bk)	Protection	0.046
02030103100060 (Crystal Lake/ Pond Brook)	Existing Community	0.103
02030103100070 (Ramapo River, below Crystal Lake Bridge)	Protection	0.041

Source: NJHC (2008c, Appendix D)

5.4 Net Water Availability

5.4.1 Calculation of Net Water Availability

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

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

NWA was originally calculated using maximum water withdrawals from 2003, which represented the most recently available compiled and checked data for use in the Highland Regional Master Plan (RMP). The NWA values for the subwatersheds in the *Highlands Council Technical Report Water Resources*

Volume II Water Use and Availability (NJHC, 2008c, Appendix D) for this WUCMP area are presented below in Table 15. Note that HUC14 02030103100050 is in extreme (> 1 MGD) deficit based on the published value and regional approach.

Table 15. Published Net Water Availability

HUC14 Description	Net Water Availability (MGD)
02030103100050 (Ramapo River, Crystal Lake Bridge to Bear Swamp Bk)	–2.9811
02030103100060 (Crystal Lake/ Pond Brook)	–0.3357
02030103100070 (Ramapo River, below Crystal Lake Bridge)	–0.1337

Source: NJHC (2008c, Appendix D)

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

- Partitioning potable demands into groundwater-based demands vs. augmented surface-based demands
- Incorporation of additional years of water diversion data (obtained from NJDEP)
- Incorporation of additional years of wastewater discharge data
- Calculating NWA for the entire subwatershed and allocating responsibility of deficit mitigation by consumptive use
- Assessment of additional wastewater returns beyond Highlands Domestic Sewerage Facilities (HDSFs)
- Selection of specific maximum diversions months to coincide with LFM target months
- Incorporation of aquifer recharge through on-site wastewater disposal systems (Onsite Wastewater Disposal Systems; e.g., septic systems)

Groundwater uses within these subwatersheds are predominantly for potable use, through domestic groundwater and public community supply, with public community supply use far exceeding that of domestic groundwater. However, groundwater use for industrial and agricultural use is also reported.

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

5.4.2 Water Supply

5.4.2.1 Public Community Supply

Public community and non-community supply withdrawals within these subwatersheds for the period 2000-2018 is shown in Table 16.

Table 16. Groundwater Supply Withdrawals

HUC/Water Purveyor	Category	Withdrawals (*)	
		Peak Summer Month	Peak Withdrawal (MGD)
HUC14 02030103100050: Ramapo River (Crystal Lake Bridge to Bear Swamp Brook)			
Oakland Water Department	Potable Supply	August 2012	1.745
HUC14 02030103100060: Crystal Lake/ Pond Brook			
Oakland Water Department	Potable Supply	August 2014	0.523
Suez Water Franklin Lakes	Potable Supply	July 2013	2.17
Becton Dickenson & Company	Potable Supply	August 2008	0.094
High Mountain Regional E.S.	Potable Supply	August 2012	0.015
HUC14 02030103100070: Ramapo River (below Crystal Lake Bridge)			
Oakland Water Department	Potable Supply	June 2000	1.458
Pompton Lakes Works/Dupont	Industrial	August 2014	0.332
Riverside Nursery	Agricultural	August 2012	0.022

(*) These represent maximum withdrawals by purveyor for the months of June, July, and August from 2000-2018. The months shown do not necessarily match the month where the maximum pumping occurs within the HUC14 as this table includes public supply, industrial, and agricultural uses (commercial, etc., not represented here). Withdrawals represent raw pumping data as reported by NJDEP.

5.4.2.2 Domestic Well Groundwater Usage

Domestic well groundwater usage is an estimate of private well withdrawals within the subwatersheds for areas not served by the public supply. Domestic withdrawals were updated for each watershed by utilizing the domestic withdrawals in the New Jersey Department of Environmental Protection (NJDEP)/New Jersey Geological Survey (NJGS) Water Transfer Model (WTM). The values for domestic withdrawals represent the average July values from 2000 to 2015. Values used in the RMP were calculated based on population estimates for the subwatersheds from the 2000 Census, multiplied by a factor of 100 gallons per person per day. Values in the WTM were utilized instead in order to apportion the domestic usage by municipality, which is not included in the RMP. Domestic groundwater usage is summarized below in Table 17. As shown in the table, the Borough of Oakland accounts for approximately 11% of the total domestic withdrawal within all three HUC14s.

Table 17. Domestic Groundwater Usage

HUC14	Domestic Groundwater (MGD)
02030103100050: Ramapo River (Crystal Lake Bridge to Bear Swamp Brook)	0.054 / 0.018
02030103100060: Crystal Lake/ Pond Brook	0.332 / 0.011
02030103100070: Ramapo River (below Crystal Lake Bridge)	0.095 / 0.024
Total	**0.481 / 0.053**

Note: Withdrawals represent total domestic withdrawals within the entire subwatershed / Borough of Oakland

5.4.2.3 Commercial and Industrial Usage

Commercial and industrial water use is limited and only include groundwater withdrawals. As shown on Table 18, industrial withdrawal is more than an order of magnitude greater than commercial.

Table 18. Water Usage for Commercial and Industrial Sources

HUC14	Owner	Water Source	Peak Summer Month	Peak Withdrawal (MGD)
02030103100060	Urban Farms Shopping Center (commercial)	Groundwater	August 2010	0.028
02030103100070	Pompton Lakes Works/Dupont (industrial)	Industrial	August 2014	0.332

5.4.2.4 Agricultural

The only agricultural source within the three HUC14s is Riverside Nursery, a nursery within the Borough of Oakland. Water usage is for irrigation and maximum usage is listed in Table 19. Reported water usage during June, July, and August ranges between 0.014 to 0.022 MGD (14,000 to 22,000 gallons per day).

Table 19. Water Usage for Irrigation/Agricultural

HUC14	Owner	Water Source	Peak Summer Month	Peak Withdrawal (MGD)
02030103100070	Riverside	Groundwater	August 2012	0.022

5.4.2.5 Municipal Consumptive/Depletive Uses

Groundwater models used in support of the Highlands Regional Net Water Availability analysis showed that the impact on September stream flows of consumptive/depletive (C/D) groundwater use during the summer was not 1:1, but roughly 1:0.9 (NJHC, 2008c, p. 116). In other words, one (1) gallon of C/D water use is calculated to reduce groundwater availability in September by 0.9 gallons. Therefore, groundwater use (raw pumpage) during the summer month with the highest demand was multiplied by 0.9 to reflect this impact. The factor is not applied to surface water diversions, which are based on September withdrawals that have an immediate impact on stream flows.

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 (NJHC, 2008c, p. 119). 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.

5.5 Revised Net Water Availability

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

Net Water Availability was calculated for each of the years 2000-2018, incorporating additional water supply pumpage data from users in the subwatersheds. Pumping during summer months is typically greatest and has the largest impact on September base flow, which is used in calculating Net Water Availability. Therefore, maximum aggregate monthly water usage from June, July or August was used to calculate updated C/D use for these subwatersheds.

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

Most of Oakland Borough is unsewered and as a result, groundwater quality has been impacted due to excessive nitrogen load. While there are plans in place to expand a sewer distribution system, NWA is calculated here to represent existing conditions. Although there are relatively small package plants which serve scattered developments throughout the Borough, most of the Borough remains served by Onsite Wastewater Disposal Systems (OWDS). Although groundwater quality has been impacted, incorporating groundwater recharge from OWDS alleviates much of the deficit which was previously calculated (published in RMP (NJHC, 2008a)) that assumed all water was depletive.

Net Water Availability is shown on Tables 20, 21, 22, and 23. A general summary for each of the subwatersheds is described below.

HUC14 02030103100050: Ramapo River (Crystal Lake Bridge to Bear Swamp Brook) was published in the RMP as having a deficit of 2.981 MGD (2,981,000 gallons per day). This HUC14 is divided between the Borough of Oakland, the Township of Mahwah, and the Borough of Ringwood. A small area is also intersected with the Boroughs of Wanaque and Franklin Lakes. However, a fraction of the area of Franklin Lakes and Mahwah is located outside of the Highlands Region. Per the RMP, 97.56% of the HUC14 is within the Highlands Region.

As a result of this new evaluation, the HUC14 averages a deficit of 0.3618 MGD (361,800 gallons per day). While this deficit is not insignificant, it is nearly an order of magnitude lower than the published deficit in the RMP. As the significant water users are within the Borough of Oakland, Oakland accounts for approximately 98% of this deficit.

HUC14 02030103100060: Crystal Lake/Pond Brook was published in the RMP as having a deficit of 0.3357 MGD (335,700 gallons per day), based on the portion of the HUC14 within the Highlands Region (29.69%). The limited area of this HUC14 within the Highlands Region is handled by multiplying the low flow margin of the HUC14 by this percentage as well as the consumptive use. As stated in the introduction, simply multiplying the consumptive use by an area weight is a simplifying assumption that is not carried into the municipal analyses.

Based on this revised analysis, the entire HUC14 averages a deficit of 0.4586 MGD (458,600 gallons per day). Further, the NWA for this HUC14 shows variability from year to year with NWA values ranging from –1.1634 MGD to –0.1855 MGD, although that large deficit is an anomalous year (Table 21). As this HUC14 is divided between several boroughs and townships, the NWA for this HUC14 was previously calculated based on an area percentage, which is within the Highlands (29.69%). Oakland accounts for an average of approximately 5.8% of the consumptive use within this HUC14, or 5.8% of the deficit (26,530 gallons per day). This is because most of the withdrawals within this HUC14 are due to the Suez System in Franklin Lakes.

HUC14 02030103100070: Ramapo River (below Crystal Lake Bridge) was published in the RMP as having a deficit of 0.1337 MGD (133,700 gallons per day), based on the portion of the HUC14 within the Highlands Region. Based on this revised analysis, the entire HUC14 averages a surplus of 0.431 MGD (431,000 gallons per day), due to the incorporation of the discharge from the Pompton Lakes MUA.

5.6 Summary of Significant Causes of Deficit

Following is a summary of the range of re-evaluated NWA calculations (Table 20):

Table 20. Summary of NWA Results

HUC14	NWA Minimum (MGD)	NWA Maximum (MGD)
02030103100050: Ramapo River (Crystal Lake Bridge to Bear Swamp Brook)	–0.456	–0.246
02030103100060: Crystal Lake/ Pond Brook	–1.163	–0.186
02030103100070: Ramapo River (below Crystal Lake Bridge)	0.0789	0.0789

Significant causes of the deficits noted above include:

- **HUC14 02030103100050:** The driver behind the deficit in this HUC14 is community public supply pumpage from Oakland Water Department
- **HUC14 02030103100060:** The driver behind the deficit in this HUC14 is community public supply pumpage from Suez and Oakland Water Department
- **HUC14 02030103100070:** This HUC14 is in surplus. The driver behind the consumptive use in this HUC14 is community public supply pumpage from Oakland Water Department

5.7 Characterization of Deficit

The deficit in this study area varies from a surplus to extreme deficit (> 1 MGD). There is no evident trend in NWA any of the HUC14s within the study area. An extreme deficit is noted in HUC14

02030103100060 in 2013 due to excessive public supply pumping in July (and August) from Suez. This year appears to be an anomaly however, and not representative of typical conditions in the HUC14. Although a surplus exists within HUC14 02030103100070, the Groundwater Availability is not enough to make a significant impact on the two other HUC14s (should withdrawals be shifted, for example). Water conservation and management measures should be prioritized for this study area. Water Conservation approaches are discussed below.

Table 21. Re-evaluated Net Water Availability for HUC14 02030103100050: Ramapo River (Crystal Lake Bridge to Bear Swamp Bk)

Year	Non-Ag GW Availability (MGD)	WW Return (MGD)	Consumptive Domestic Use (MGD)	Consumptive Public Supply (MGD)	Total Non-Ag Consumptive Use from SW (MGD)	Total Non-Ag Consumptive Use[2] (MGD)	Non-Ag Water Availability[3] (MGD)	Surplus Potential Use Downstream (MGD)
Published[1]	0.0457	0	0.0101	3.0923	0.2488	3.1	-2.9811	N/A
2000	0.0468	0	0.0132	0.3903	0	0.4036	-0.3579	0
2001	0.0468	0	0.0133	0.3903	0	0.4036	-0.3579	0
2002	0.0468	0	0.0133	0.4085	0	0.4218	-0.3761	0
2003	0.0468	0	0.0134	0.4252	0	0.4386	-0.3929	0
2004	0.0468	0	0.0134	0.3828	0	0.3962	-0.3505	0
2005	0.0468	0	0.0134	0.4269	0	0.4403	-0.3946	0
2006	0.0468	0	0.0134	0.3945	0	0.4079	-0.3622	0
2007	0.0468	0	0.0135	0.3587	0	0.3721	-0.3264	0
2008	0.0468	0	0.0135	0.4322	0	0.4457	-0.4	0
2009	0.0468	0	0.0135	0.2783	0	0.2918	-0.2461	0
2010	0.0468	0	0.0135	0.4585	0	0.472	-0.4263	0
2011	0.0468	0	0.0135	0.4126	0	0.4261	-0.3804	0
2012	0.0468	0	0.0135	0.447	0	0.4605	-0.4148	0
2013	0.0468	0	0.0135	0.3633	0	0.3768	-0.3311	0
2014	0.0468	0	0.0135	0.4143	0	0.4278	-0.3821	0
2015	0.0468	0	0.0135	0.3519	0	0.3654	-0.3197	0
2016	0.0468	0	0.0134	0.4883	0	0.5017	-0.456	0
2017	0.0468	0	0.0134	0.3023	0	0.3157	-0.27	0
2018	0.0468	0	0.0134	0.3612	0	0.3746	-0.3289	0

GW = Groundwater; SW = Surface water = WW = Wastewater

[1] Based on 97.56% of area being within the Highlands Region

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

[3] [Non-Ag Groundwater Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return].

Table 22. Re-evaluated Net Water Availability for HUC14 02030103100060: Crystal Lake/Pond Brook

Year	Non-Ag GW Availability (MGD)	WW Return to GW (MGD)	WW Return to SW (MGD)	Consumptive Domestic Use (MGD)	Consumptive Public Supply (MGD)	Other Non-Ag Consumptive Use from GW (MGD)	Total Non-Ag Consumptive Use[1] (MGD)	Non-Ag Water Availability[2] (MGD)
Published[3]	0.103	0	0	0.0925	1.3406	0.0463	0.4392	-0.3357
2000	0.3484	0.0157	0.055	0.0856	0.928	0.042	0.9849	-0.6365
2001	0.3484	0.0107	0.0484	0.0856	0.7114	0.0363	0.7742	-0.4258
2002	0.3484	0.0142	0.054	0.0861	0.7708	0.0235	0.8122	-0.4638
2003	0.3484	0.0098	0.063	0.0864	0.8077	0.0383	0.8597	-0.5112
2004	0.3484	0.0278	0.057	0.0864	0.7745	0.0382	0.8143	-0.4658
2005	0.3484	0.0198	0.06	0.0866	0.7432	0.0259	0.7759	-0.4274
2006	0.3484	0.0167	0.053	0.0868	0.8637	0.012	0.8928	-0.5444
2007	0.3484	0.0186	0.052	0.0869	0.5713	0.0256	0.6132	-0.2647
2008	0.3484	0.02	0.0557	0.0869	0.7622	0.0664	0.8397	-0.4913
2009	0.3484	0.0169	0.0518	0.0869	0.4871	0.0287	0.5339	-0.1855
2010	0.3484	0.0197	0.056	0.0869	0.5288	0.0215	0.5616	-0.2132
2011	0.3484	0.0244	0.059	0.087	0.6627	0.0082	0.6745	-0.3261
2012	0.3484	0.0187	0.048	0.0872	0.5397	0.013	0.5731	-0.2247
2013	0.3484	0.0177	0.049	0.0872	1.4813	0.01	1.5119	-1.1634
2014	0.3484	0.0083	0.044	0.0872	0.9134	0.0129	0.9612	-0.6128
2015	0.3484	0.0109	0.057	0.0872	0.8178	0.0109	0.8481	-0.4996
2016	0.3484	0.0226	0.055	0.0867	0.793	0.01	0.8121	-0.4637
2017	0.3484	0.0139	0.0661	0.0867	0.6485	0.0462	0.7013	-0.3529
2018	0.3484	0.012	0.051	0.0867	0.7446	0.0207	0.789	-0.4406

GW = Groundwater; SW = Surface water = WW = Wastewater

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

[2] [Non-Ag Groundwater Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return].

[3] Reduced by the percentage of area within the Highlands Region.

Table 23. Re-evaluated Net Water Availability for HUC14 020301030070: Ramapo River (below Crystal Lake Bridge)

Year	Non-Ag GW Availability (MGD)	WW Return to GW (MGD)	WW Return to SW (MGD)	Consumptive Domestic Use (MGD)	Consumptive Public Supply (MGD)	Other Non-Ag Consumptive from GW (MGD)	Total Non-Ag Consumptive Use[1] (MGD)	Non-Ag Net Water Availability[2] (MGD)	Surplus for Potential Use (MGD)
Published[3]	0.041	0.912	0.912	0.0148	1.0263	0.024	0.1531	-0.1337	N/A
2000	0.0789	0	0.825	0.0246	0.7013	0.022	-0.33	0.0789	0.077
2001	0.0789	0	0.844	0.0246	0.5421	0.0157	-0.4877	0.0789	0.262
2002	0.0789	0	0.7758	0.0246	0.624	0.0208	-0.3822	0.0789	0.106
2003	0.0789	0	1.052	0.0246	0.4559	0.0179	-0.7961	0.0789	0.554
2004	0.0789	0.0007	1.191	0.0247	0.3434	0.0176	-1.0558	0.0789	0.806
2005	0.0789	0.0007	0.8877	0.0247	0.3451	0.0146	-0.7121	0.0789	0.504
2006	0.0789	0	0.9268	0.0247	0.3968	0.0177	-0.7282	0.0789	0.488
2007	0.0789	0	0.8133	0.0247	0.36	0.0145	-0.6185	0.0789	0.414
2008	0.0789	0.003	0.8122	0.0247	0.3055	0.0138	-0.6797	0.0789	0.471
2009	0.0789	0.0011	0.7744	0.0247	0.3956	0.0221	-0.64	0.0789	0.333
2010	0.0789	0.0012	0.7286	0.0247	0.3956	0.0141	-0.5101	0.0789	0.295
2011	0.0789	0.0007	1.58	0.0247	0.3426	0.0105	-1.4061	0.0789	1.203
2012	0.0789	0.0023	0.7643	0.0247	0.4062	0.015	-0.5674	0.0789	0.321
2013	0.0789	0.0034	0.699	0.0247	0.4194	0.0151	-0.4857	0.0789	0.243
2014	0.0789	0.0013	0.824	0.0247	0.4794	0.0299	-0.6861	0.0789	0.291
2015	0.0789	0.0022	0.793	0.0247	0.34	0.0145	-0.6556	0.0789	0.416
2016	0.0789	0.001	0.738	0.0247	0.2925	0.0198	-0.6163	0.0789	0.402
2017	0.0789	0.0013	0.774	0.0247	0.2809	0.0193	-0.6543	0.0789	0.45
2018	0.0789	0.0017	0.87	0.0247	0.2736	0.0186	-0.7358	0.0789	0.555

GW = Groundwater; SW = Surface water = WW = Wastewater

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

[2] [Non-Ag Groundwater Availability] – [Total Non-Ag Consumptive Use] + [Imported Septic Return].

[3] Reduced by the percentage of area within the Highlands Region.

Table 24 summarizes the revised NWA for each HUC14, along with the municipal responsibility.

Table 24. Summary of Revised Net Water Availability

HUC	Published RMP (MGD)	Min (MGD)	Max (MGD)	Avg. 2000-2018 (MGD)	Net effect	NWA Driver(s)	Municipal Responsibility*
02030103100050 Ramapo River (Crystal Lake bridge to Bear Swamp Brook)	–2.981	–0.4560	–0.2461	–0.3618	Positive/ decreased deficit	Community public supply pumpage by Oakland Water Dept.	98% (354,564 gpd)
02030103100060 Crystal Lake/Pond Brook	–0.3357	–1.1634	–0.1855	–0.4586	Negative/ increased deficit	Community public supply pumpage by Suez and Oakland Water Dept.	5.8% (26,600 gpd)
02030103100070 Ramapo River (below Crystal Lake bridge)	–0.1337	0.0789	0.0789	0.0789	Positive/ decreased deficit	Incorporation of the discharge from Pompton Lakes MUA.	N/A

MGD = Million gallons per day
gpd = gallons per day
*Total mitigation quantity: 0.3816 MGD/381,164 gpd

6 WATER CONSERVATION/DEFICIT MITIGATION STRATEGIES

Table 25 compiles all of the possible deficit mitigation strategies recommended by the Highlands Region Water Use and Conservation Management Program Guidance Pilot Area 9 (NJHC, 2016) that could be utilized to reduce and/or eliminate the water deficits in the three subwatersheds of this WUCMP area.

Table 25. Summary of Deficit Mitigation Strategies Recommended by the WUCMP Guidance

Measure	Residential	Commercial/ Industrial/ Institutional	Water Purveyor	Agriculture	Municipal
Water Use Reduction					
Avoid Overspray	✓	✓		✓	
Building and Pipe Insulation	✓	✓			
Cleaning	✓	✓		✓	
Community Garden	✓				✓
Cooling System Upgrades		✓			
Dishwasher Upgrade	✓	✓			
Drip Irrigation	✓	✓			
Drought Contingency Plans			✓		✓
Equipment Condensation		✓	✓		
Heating System Upgrades		✓			
Hot Water Heater Upgrade	✓	✓			
Hydrant Locks			✓		
Irrigation Conservation	✓	✓		✓	✓
Irrigation Education			✓		✓

Measure	Residential	Commercial/ Industrial/ Institutional	Water Purveyor	Agriculture	Municipal
Irrigation System Design	✓	✓		✓	✓
Landscape Design	✓	✓			
Landscape Incentive Program					✓
Leak Detection and Repair	✓	✓	✓	✓	
Low Flow Faucets/Faucet Aerators	✓	✓			
Low Flow Shower Fixtures	✓	✓			
Low Flow Toilet Fixtures	✓	✓			
Low Volume Irrigation	✓	✓			
Maintenance	✓	✓	✓	✓	
Meter Calibration/Replacement			✓		
Night Watering	✓	✓		✓	
Plumbing Incentive Program		✓			✓
Pre-Rinse/Commercial Kitchen Upgrades		✓			
Process Water Optimization		✓			
Public Education Handouts		✓	✓		✓
Public Workshops					✓
Rate Structure			✓		
Revised Irrigation Ordinance					✓
School Conservation Programs			✓		
Submetering	✓	✓	✓		
Swimming Pool Covers	✓				
Crop and Soil Selection				✓	
Washing Machine Upgrade	✓	✓			
Water Bill Structure/Comparison	✓	✓	✓		
Water Conservation Programs		✓	✓	✓	✓
Water Treatment Improvements			✓		
Waterless Restrooms		✓			
Well Optimization			✓		
Reuse and Reclamation					
Graywater Recharge	✓	✓			
Graywater Reuse for Irrigation	✓	✓			
Internal Infrastructure Graywater Reuse		✓			
Internal Infrastructure Stormwater Reuse		✓			
Storage					
Composting	✓	✓		✓	
Install Geotextiles Under Plantings	✓	✓			
Rainwater Harvesting/Rainwater Cistern	✓	✓			

Measure	Residential	Commercial/ Industrial/ Institutional	Water Purveyor	Agriculture	Municipal
Water Storage Tank Management			✓		
Recharge					
Assisted Infiltration/Enhanced Recharge	✓	✓			✓
Building Interceptor Dikes, Swales, and Berms	✓	✓			✓
Injection Wells		✓			
Modifications to Zoning					✓
Stormwater Ordinance					✓
Porous Paving	✓	✓			✓
Rainwater Harvesting/Rain Gardens	✓	✓			
Retrofit Existing Detention Basins		✓			✓

7 EVALUATION AND RANKING OF WATER CONSERVATION STRATEGIES

7.1 Evaluation

The established evaluation system considers the seven attributes recommended by the Highlands Region Water Use and Conservation Management Program Guidance Pilot Area 9 (NJHC, 2016):

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

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

Scores for each strategy are listed in Tables 26 through 30 for residential, commercial/industrial/institutional and water purveyors, and municipalities respectively.

The evaluation was conducted under two scenarios and it is anticipated that it will be repeated based on stakeholder input regarding weights to be assigned 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 26. Scoring for Conservation and Deficit Mitigation Strategies Applicable to Residential Users

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

Table 27. Scoring for Conservation and Deficit Mitigation Strategies Applicable to Commercial/Industrial/Institutional Users

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

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

Table 28. Scoring for Conservation and Deficit Mitigation Strategies Applicable to Water Purveyors

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

Table 29. Scoring for Conservation and Deficit Mitigation Strategies Applicable to Municipalities

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

Table 30. Scoring for Conservation and Deficit Mitigation Strategies Applicable to Agriculture

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

7.2 Ranking of Deficit Mitigation Strategies

Deficit mitigation strategies that are relevant to the subwatersheds included in this WUCMP have been ranked and the top ten strategies for each water user category are listed in Tables 31 through 35. An evaluation program called EVAMIX was used to rank each strategy. EVAMIX is a well-tested multi-criterion evaluation program 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 26 through 30 and determines 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, a stakeholder who thought feasibility was the most important attribute might assign a weight of 40% to that attribute and 10% to each of the others.

Table 31. Ranked Mitigation Management Strategies for Residential Users

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

Table 32. Ranked Mitigation Management Strategies for Commercial/Industrial/Institutional Users

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

Table 33. Ranked Mitigation Management Strategies for Water Purveyors

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

Table 34. Ranked Mitigation Management Strategies for Agriculture

Rank	Equal Weight	Weighted to C/D Reduction	Rank
1	Night Watering	Night Watering	1
2	Avoid Overspray	Avoid Overspray	2
2	Irrigation Conservation	Irrigation Conservation	2
2	Water Conservation Programs	Water Conservation Programs	2
5	Maintenance	Cleaning	5
6	Cleaning	Crop and Soil Selection	6
7	Leak Detection and Repair	Maintenance	7
8	Crop and Soil Selection	Leak Detection and Repair	8
9	Irrigation System Design	Irrigation System Design	9
10	Compost	Compost	10

Table 35. Ranked Mitigation Management Strategies for Municipalities

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

8 FUNDING OPPORTUNITIES

8.1 Public Funding Sources

8.1.1 New Jersey Highlands Council Planning Grants

The New Jersey Highlands Council plan conformance grants provide funding for municipalities with lands in the Preservation Area where conformance with the RMP is mandatory, as well as in the Planning Area where conformance is voluntary. The grants are intended to assist municipalities in developing each of the components required for a petition to the Highlands Council for Basic Plan Conformance. The Borough of Oakland submitted a petition for plan conformance for both the Preservation and Planning Areas. In 2017, the Borough adopted a resolution and passed an ordinance rescinding its petition for plan conformance for the Planning Area of the Borough.

Highlands Council grant programs website: https://www.nj.gov/njhighlands/grantprograms/

8.1.2 State Program Grants

The following State agencies should be considered for grants:

- State of New Jersey grants website: https://www.nj.gov/nj/gov/njgov/grants.html
- New Jersey Department of Agriculture (NJDA) grants website: https://www.nj.gov/agriculture/grants/
- New Jersey Department of Environmental Protection (NJDEP) grants website: https://www.nj.gov/dep/grantandloanprograms/
- New Jersey Department of Community Affairs (DCA) grants website: https://www.nj.gov/dca/divisions/dhcr/grants/
- Funding at low interest rates is also available through the New Jersey Infrastructure Bank for water purveyors, municipalities, counties, and regional authorities in New Jersey who might be interested in projects on water quality infrastructure projects: https://www.njib.gov/njeit

8.1.3 Federal Program Grants

A series of Federal Program Grants is available at www.grants.gov, especially those under the following categories: Agriculture, Community Development, Disaster Prevention and Relief, Energy, Environment, Natural Resources, Opportunity Zone Benefits, Regional Development, and Science and Technology and Other Research and Development. Several agencies offer grants under said categories:

- United States Environmental Protection Agency (USEPA). Also, specific USEPA grants can be found at: https://www.epa.gov/grants/specific-epa-grant-programs
- United States Department of Agriculture (USDA)
- United States Department of Commerce (USDOC) through the National Oceanic and Atmospheric Administration (NOAA)
- 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).
- United States Geological Survey (USGS). There are several fund and grants opportunities through this agency: Urban Waters Federal Partnership Cooperative Marching Funds, State Water Resources Research Act Program, and USGS Cooperative Matching Funds.

8.2 Private Funding Sources

8.2.1 Development

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

8.2.3 Commercial Entities

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

8.2.4 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: http://www.amrivers.org/
- Center for Watershed Protection: http://www.cwp.org/
- Trout Unlimited: http://www.tu.org/
- Fresh Water Future: https://freshwaterfuture.org
- Surdna Foundation: https://surdna.org

8.2.5 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/

8.3 Municipalities and Utilities

8.3.1 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.

8.3.2 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.

9 WATER CONSERVATION AND DEFICIT REDUCTION AND ELIMINATION STRATEGIES

9.1 Proposed Strategies

Residential, commercial, and industrial zones occupy the majority of the area of this WUCMP area, followed by conservation and recreation (Section 2.3). Also, there is small portion of agricultural area within the Borough.

The majority of the deficit is caused by community public supply pumpage from Oakland Water Department. Therefore, the selected strategies will aim to mainly minimize the water demand from these users (residential, commercial, and industrial). The following are the suggested strategies:

9.1.1 Water Bill Structure/Comparison

This strategy highlights for the residents their usage in comparison to historical patterns and other users. Behavioral studies have found that people respond to peer pressure and normative behavior.

This strategy aims to take advantage of that response. The premise is that when water users are aware of the positive behavior of others in their peer group, they are more likely to change their own behavior in a positive way. Further, a reduction in water consumption will have an effect on wastewater flow generation as well, especially in a scenario of redevelopment opportunities mentioned in Section 3.2.2.

9.1.2 Irrigation Ordinance

This strategy pursues the implementation of a series of measures to regulate irrigation in order to promote water conservation through the use of more efficient irrigation systems, irrigation scheduling, enforcement, and possible penalties.

9.1.3 Irrigation System Design

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

9.1.4 Leak Detection and Repair

The strategy involves the use of sonic or other methods to detect water escaping the distribution system. Leaks at stream crossings are among the most difficult to detect and repair. Proactive programs for leak detection can reduce downtime for emergency repairs. Such programs should look to survey the entire system at least once every 5 years in a phased manner. Also, an inflow and infiltration (I/I) detection program, along with strategies aimed at reducing the water consumption, will contribute to reducing the generated wastewater flow within the Borough.

9.1.5 Rate Structure

This strategy entails the development of water utility rate structures that promote water conservation. Generally, these rate structures encourage customers to use less water while still providing affordable water, and informing the public about the real cost of this limited critical resource. Revenue from surcharge rates charged to high-use customers can be used to promote conservation through incentive and education programs. As with the water structure/comparison strategy, any reduction in water demand will reduce the wastewater flow generation.

9.1.6 Stormwater Ordinance

This strategy involves developing a stormwater ordinance or improving an existing stormwater ordinance (Ordinance # 06-Code-525, dated March 22, 2006 (BONJ, 2020b)) 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. This strategy includes:

- A review of existing ordinance (NJDEP, 2020; USEPA, 1990; 2013; 2020), which shall be performed by the County review agency per established in the Borough of Oakland Municipal Code, Chapter 20 (BONJ, n.d.).
- Recommendations for improving the ordinance language to include water conservation strategies (NJDEP, 2020; USEPA, 1990; 2013; 2020).
- Improving upon required mitigation where a stormwater standard cannot be met on site.
- Requiring green infrastructure and/or recharge where it might not be currently required (i.e., redevelopment or minor development). This strategy will gain importance when trying to mitigate the additional stormwater generated by the redevelopment opportunities the Borough foresees within the next 30 years.
- Establishing a mitigation fund and including a description of specific mitigation projects. For instance, the developer or applicant could pay into the fund or construct the identified project if their own project is requesting a variance from the stormwater standard.

9.1.7 Stormwater Basin Program

Stormwater basins are hydraulic structures for stormwater management that detain, retain, and/or infiltrate (if required) surface runoff. The basins help with attenuating high peak runoff/peak flows as well as promoting aquifer recharge if the basin is also used for infiltration purposes. This strategy will be structured and implemented in conjunction with the stormwater ordinance, retrofitting detention basins, and assessing infiltration/enhanced recharge capability in order to increase water conservation. This strategy includes:

- Conducting an inventory of the Borough's stormwater basins
- Performing a conditions assessment of each basin
- Providing recommendations for rehabilitation or retrofitting to an infiltration basin
- Providing recommendations for installation of infiltration basins throughout the Borough
- Implementation of regular inspection and maintenance programs

9.1.8 Public Education Program

This strategy aims to revise the existing local public education program (BONJ, 2018) so that it (a) includes information on the new water conservation strategies to be adopted and implemented and (b) proposes new ways of disseminating the stormwater management strategies information so it both reaches more members of the community and increases people's awareness as to the importance of adopting the proposed strategies in terms of water quantity and quality, and the short- and long-term implications of not implementing them.

9.2 Water Conservation and Deficit Reduction Target

The target for this WUCMP is to (a) work towards the elimination of the deficits identified in the Net Water Availability of each subwatershed and (b) achieve a positive Net Water Availability of at least 10,000 gallons per day (0.01 million gallons per day) per subwatershed within 10 years to ensure sufficient supply during severe droughts and to provide a buffer for potential future needs.

9.3 Water Conservation and Deficit Reduction Estimates

9.3.1 Water Bill Structure/Comparison

The Oakland Water Department serves approximately 12,754 customers throughout the three HUC14s of this WUCMP. Approximately, half the users likely have above average water usage and could potentially be targeted by the strategy. It is reasonable to assume a 1% reduction in water usage using this deficit mitigation strategy, but higher rates are possible (Hoffman, 2010).

The Borough of Oakland Water Department has reported an average water withdrawal of approximately 1.3 MGD in 2018 and 2019 within the existing areas served by public water supply of this WUCMP. Using the 1% reduction rate, a total of 13,000 gallons per day can be conserved.

9.3.2 Irrigation System Design

According to USEPA (2013), up to 50 percent of commercial and residential irrigation water use goes to waste due to evaporation, wind, improper system design, or overwatering. This strategy is focused on the design of intelligent irrigation systems that utilize currently available advanced technologies such as irrigation controllers, soil moisture sensors, rain shut off switches, or efficient sprinkler heads.

As the basis for this strategy, the total amount of irrigated land in the subwatersheds was estimated using a GIS analysis. Using NJDEP's 2015 Land Use/Land Cover feature dataset, land use types associated with residential, commercial, and athletic field land uses were isolated.

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

The peak irrigation rate for residential, commercial, and athletic fields was estimated to be 8 gpm/acre. This is consistent with 1-inch of water per irrigation, occurring for 8 hours over a 7-day period (USDA-NRCS, 2005).

Table 36 summarizes the total areas where this strategy can be applied.

Table 36. Estimated Total Pervious and Irrigated Areas within each HUC14

HUC14	Pervious Acres by land Use Type			Total
	Residential	Commercial	Athletic Field	
02030103100050	606.33	0.00	1.28	607.61
02030103100060	634.12	54.71	29.41	718.24
02030103100070	728.79	142.51	36.34	907.64
Estimated Total Irrigated Acres (*)	**196.92**	**19.72**	**6.70**	**223.35**

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

Based on the total irrigated acreage and a peak irrigation rate of 8 gpm/acre, a total of 1,787 gpm peak irrigation is estimated. However, this rate is estimated to occur for a total of 8-hours over the course of a 7-day period. Using these boundary conditions, this equates to an average irrigation water usage of approximately 122,537 gallons per day (gpd).

Assuming that the estimated irrigation water usage can be reduced by 10% using this strategy, then approximately 12,254 gpd per day can be conserved.

9.3.3 Leak Detection and Repair

Estimates of leak detection and repair will be based on "non-revenue water" which describes water that has been produced and supplied to the distribution system by the water purveyor, but is not delivered to customers. Leaks (real loss) are one component of non-revenue water. Other components include unauthorized consumption, customer metering inaccuracies, overflows at storage tanks, leakage at service connections. Real water loss within distribution systems is typically 10% (Lambert, 2003). This is consistent with current estimates of distribution system in New Jersey (Caroom, 2012).

A conservative estimate of 10% can be applied to the reduction of real water loss volume as the potential savings in water use (GEPD-WPB, 2007).

The Borough of Oakland Water Department has reported an average water withdrawal of approximately 1.3 MGD in 2018 and 2019 within the existing areas served by public water supply in the WUCMP area.

Based on the assumptions indicated above, the real water loss is estimated at 10% or 130,000 gpd. Using the 10% reduction rate indicated above, approximately 13,000 gpd can be conserved.

9.3.4 Rate Structure

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

However, for the purposes of estimating potential water conservation, it is reasonable to assume reductions in water usage of 1% assuming a rate increase of 10% (AWWA, 2000).

The Borough of Oakland Water Department has reported an average water withdrawal of approximately 1.3 MGD in 2018 and 2019 within the existing areas served by public water supply of this WUCMP.

Given a 10% increase in rates, and the resulting 1% reduction in water use, approximately 13,000 gpd day can be conserved.

9.3.5 Assisted Infiltration/Enhanced Recharge

The premise of this deficit mitigation strategy is that baseflow could be enhanced by the construction of recharge and/or infiltration basins, which should also consider the retrofitting of existing basins to convert them into recharge/infiltration basin after performing the inventory and assessment of the Borough's existing basins as part of the stormwater basin program (See Section 9.1). This strategy shall be also part of the stormwater ordinance amendment strategy (See Section 9.1).

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) (Carleton, 2010). For the purpose of this estimate, we are assuming 50% of the total rainfall is infiltrated and the basin is approximately 3 acres in size.

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

9.4 Summary of Savings Potential

Table 37 compiles the total water use savings to be reached by means of the proposed strategies.

Table 37. Potential Water Use Savings

Proposed Strategy	Potential Savings (gpd)
Water Bill/Structure Comparison	13,000
Irrigation System Design	12,254
Leak Detection and Repair	13,000
Rate Structure	13,000
Assisted Infiltration/Enhanced Recharge(*)	210
Total	**51,464**

(*) Based on a rainfall event basis.

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

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

10 MONITORING

Monitoring will be performed to regularly assess the selected mitigation strategies proposed in this WUCMP to reduce the deficit in the two HUC14s that showed deficits and monitor the surplus on the remaining HUC14 (Table 20). The main objectives of the monitoring activities are to: (a) continuously evaluate whether the proposed strategies have contributed to improving water use efficiency goals, (b) perform the necessary adjustments to reach the proposed goals, and (c) propose additional and/or other strategies, if needed. The frequency of the monitoring activities will be both annual and every 5 years. The former will consist of a rapid assessment of each proposed strategy, while the latter will be a detailed report that includes updating the Net Water Availability section of this WUCMP. The 5-year review will also include an analysis of the likelihood of achieving the target reduction in the Net Water Availability deficit via the selected mitigation strategy. The same analytical techniques used in the initial Net Water Availability determination will be used to compute the future deficit or surplus within each of the three HUC14s of this WUCMP.

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

10.1 Annual Water Use and Return Data

Each year, a review will be conducted of water use data for these watersheds for the preceding year. This data can be obtained from the water purveyor (currently, Oakland Water Department).

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

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

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

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

10.2 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.

11 IMPLEMENTATION PLAN

11.1 Annual Program Implementation Plan Strategies

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

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

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

11.3 Strategies

11.3.1 Water Bill Structure/Comparison

The implementation plan consists of coordinating with the Borough of Oakland Water Department to develop customizable charts or tables to compare and contrast individual water usage based on water usage across the entire service area.

11.3.2 Irrigation Ordinance and Irrigation System Design

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

11.3.3 Leak Detection and Repair

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

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

11.3.4 Rate Structure

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

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

11.3.5 Stormwater Ordinance and Stormwater Basin Program

The implementation plan for these strategies involve research by municipal stakeholders to determine the required elements of a new stormwater ordinance, or how an existing stormwater ordinance can be modified to enable additional recharge/infiltration as part of a stormwater basin program.

11.4 Schedule to Achieve Water Balance

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

Implementation of the Irrigation System Design will require the collection or development of recommended standards. Implementation of the standards can be coordinated with the local building departments so that they are integrated into the local planning and approval process. Compilation or development of the standards may take six months, while integration into the local planning process may require an additional six months.

The leak study can be completed in one year, and associated modest repairs can be performed under an existing maintenance budget. Larger or more widespread repairs may require several years to implement and may be included in a capital improvement plan.

Development of the new or revised ordinances can be accomplished within one year, and savings may be evident in the first year.

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

This schedule could be impacted based on the outcome of changes within the Borough of Oakland with regard to current negotiations surrounding the Borough's sewerage treatment and disposal options.

11.5 Responsible Parties

Responsible parties will consist of the Borough of Oakland, the Oakland Water Department, homeowners and major water users within the Borough of Oakland.

11.6 Funding Commitments

To be determined (TBD).

11.7 Next Steps

To be determined by Stakeholders.

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Appendix A. Basis for Net Water Availability

Background

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

Basis for Net Water Availability

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

Year	Ag Groundwater Availability (MGD)	Non-Ag Groundwater Availability (MGD)	Total Non-Ag Consumptive Use (MGD)	Imported Septic Return (MDG)	Non-Ag Net Water Availability (MGD)	Surplus for Potential Use (MGD)

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

Year

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

Groundwater Availability

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

Agricultural (Ag) Groundwater Availability

Agricultural (Ag) Groundwater Availability – Ag Groundwater Availability is not applicable in each watershed. This type of Groundwater Availability is used when the Conservation Zone covers most of the watershed. In this case, Ag Groundwater Availability is established and tracked separately to support sustainable agriculture.[4]

Non- Agricultural (Non-Ag) Groundwater Availability

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

Consumptive/Depletive Uses

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

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

Total Non-Ag Consumptive Use

Non-Ag Consumptive Use is the calculated as follows:

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

Adjusted Consumptive Domestic Use

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

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

Consumptive Public Supply Use

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

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

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

Total Non-Ag Consumptive Use from Surface Water

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

This quantity often includes golf course irrigation.

Other Non-Ag Consumptive Use from Groundwater

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

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

Imported Septic Return

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

Net Water Availability

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

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

Net Water Availability cannot exceed Groundwater Availability, whether it is Ag or Non-Ag. When the watershed has been designated as a Conservation Zone, Ag Net Water Availability will be calculated.

Surplus for Potential Use

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

Appendix B. Monitoring Forms

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form
Borough of Oakland

Year: ____________________ **Prepared by:** ____________________

HUC14: ____________________ **Title:**

Name: ____________________

Groundwater Availability (MGD): ____________________ ____________________

Baseline Net Water Availability (MGD): ____________________ **Date:** ____________________

Diversion / Recharge Inventory							
Owner	**Type**		**No. of Wells/ Intakes/ Discharges**	**MGD**	**Adjusted MGD**	**Total C/D Water Use (MGD)**	**Net Water Availability, NWA (MGD)**
	Recharge or Withdrawal	**Groundwater (GW) or Surface Water (SW)**					
Wells / Intakes							
Wastewater Discharge							

Water Use and Conservation Management Plan (WUCMP)
Monitoring Form
Borough of Oakland

Year: ____________________ **Prepared by:** ____________________

HUC14: ____________________ **Title:** ____________________

Name: ____________________

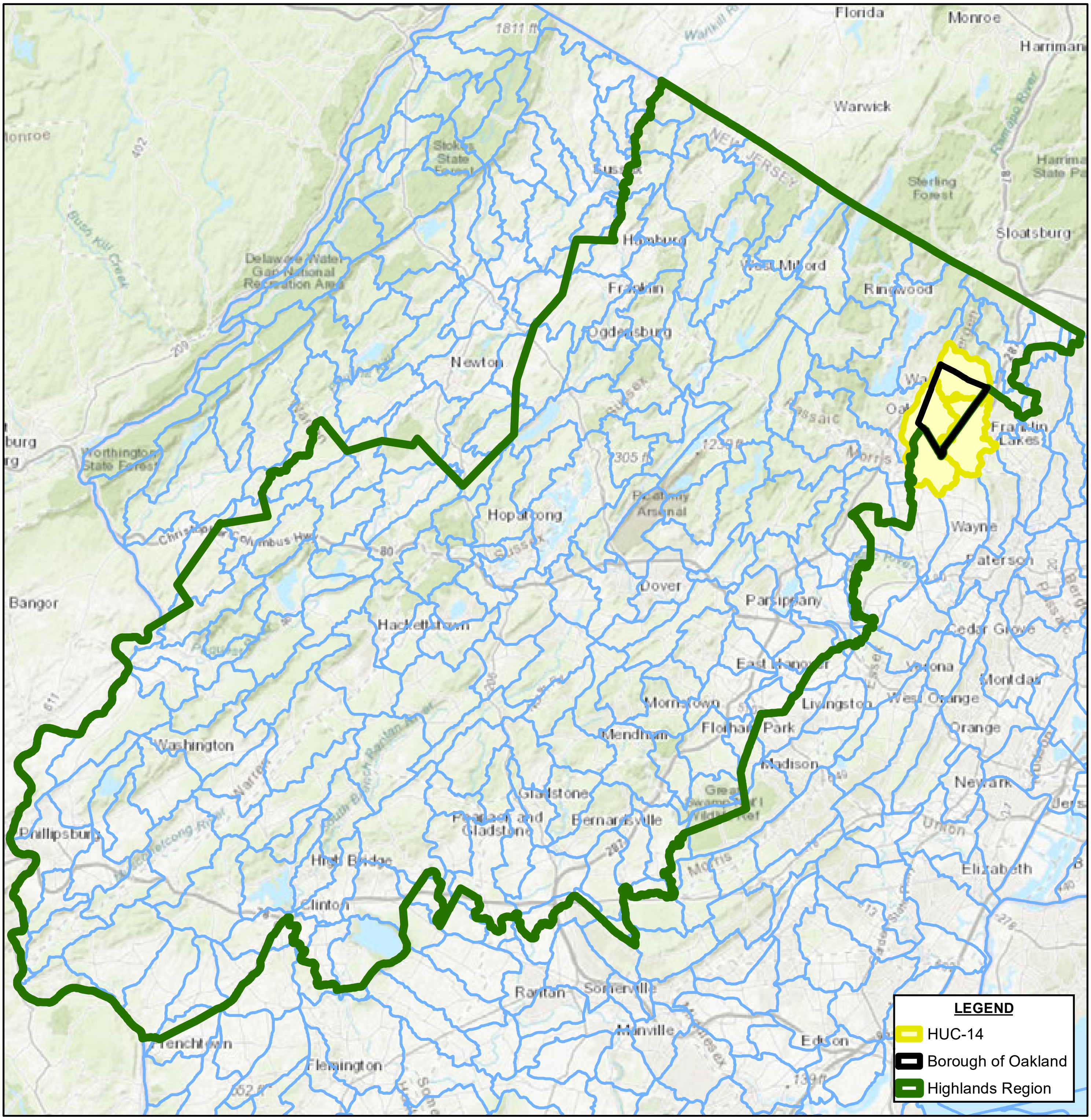
Groundwater Availability (MGD): ____________________

Baseline Net Water Availability (MGD): ____________________ **Date:** ____________________

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

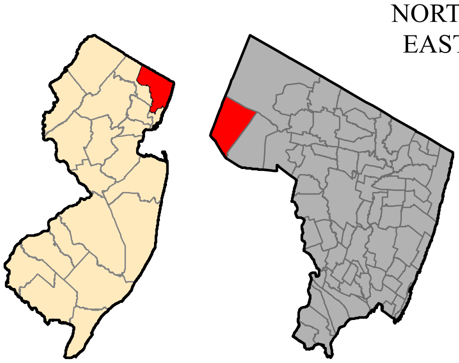
Monitoring Sites					
Stream Name	Gauge Location	Year Installed	Collection Frequency	Minimum September Flow of Record (cfs)	Minimum September Flow (cfs)

Appendix C. Figures



SOURCE: NJ HIGHLANDS REGION BOUNDARY DATALAYER

NORTHING: 756,898
EASTING: 449,084



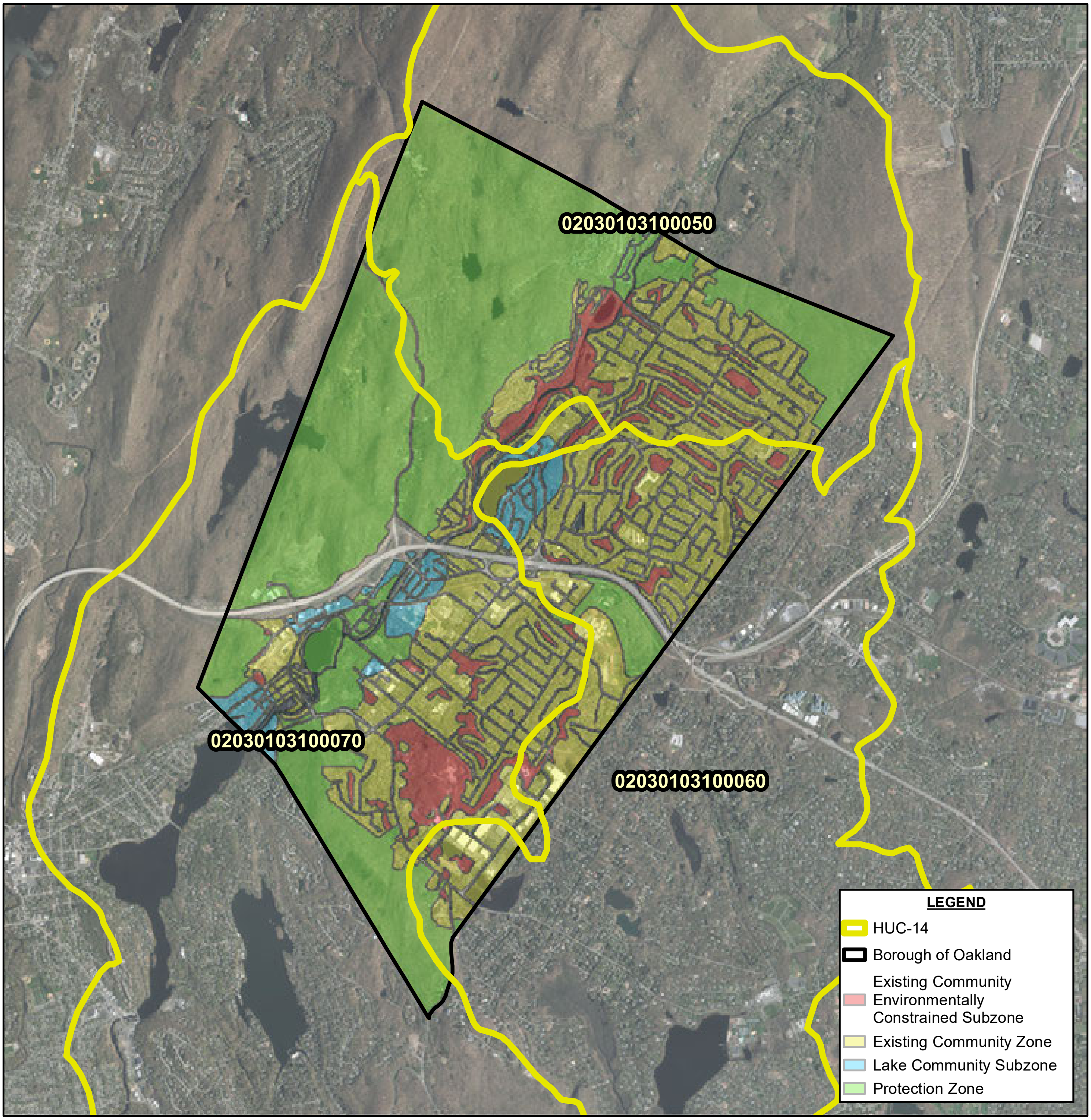
BOSWELL ENGINEERING
330 PHILLIPS AVE., SOUTH HACKENSACK, N.J. 07606

FIGURE 1: HIGHLANDS REGION MAP

WATER USE AND CONSERVATION MANAGEMENT PLAN

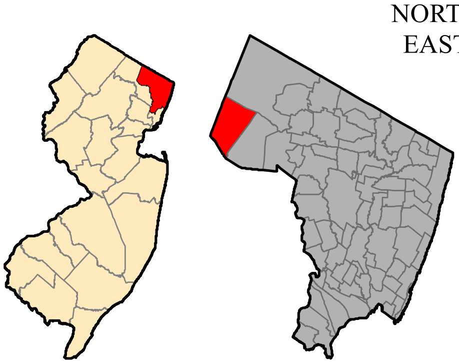
ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

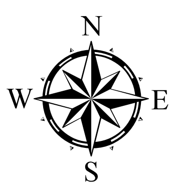
BERGEN COUNTY		NEW JERSEY
DR. BY: JMW CKD. BY: GD	SCALE: 1 IN = 40,000 FT DATE: AUGUST 2020	JOB NO. OK-1684 FIGURE 1



SOURCE: NJ HIGHLANDS COUNCIL LANDUSE CAPABILITY ZONES DATALAYER

NORTHING: 799,445
EASTING: 564,852





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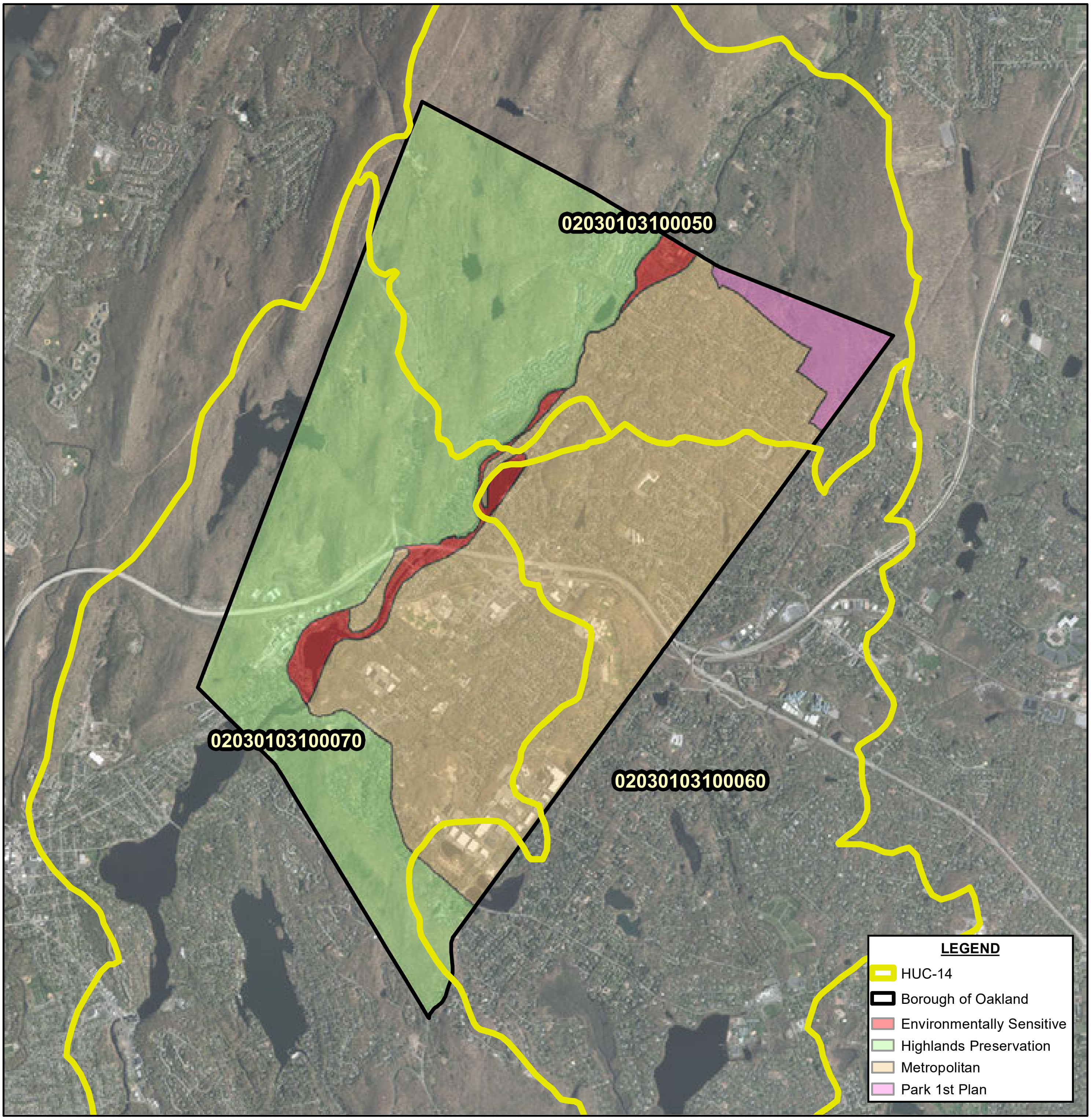
330 PHILLIPS AVE., SOUTH HACKENSACK, N.J. 07606

FIGURE 2: LANDUSE CAPABILITY ZONE MAP
WATER USE AND CONSERVATION MANAGEMENT PLAN
ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY — NEW JERSEY

DR. BY: JMW CKD. BY: GD	SCALE: 1 IN = 4,000 FT DATE: JULY 2021	JOB NO. OK-1684 FIGURE 2



SOURCE: NJDEP PLANNING AREA DATA LAYER

NORTHING: 799,445
EASTING: 564,852

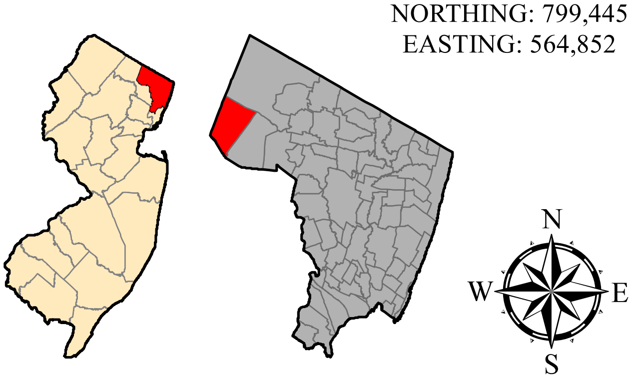


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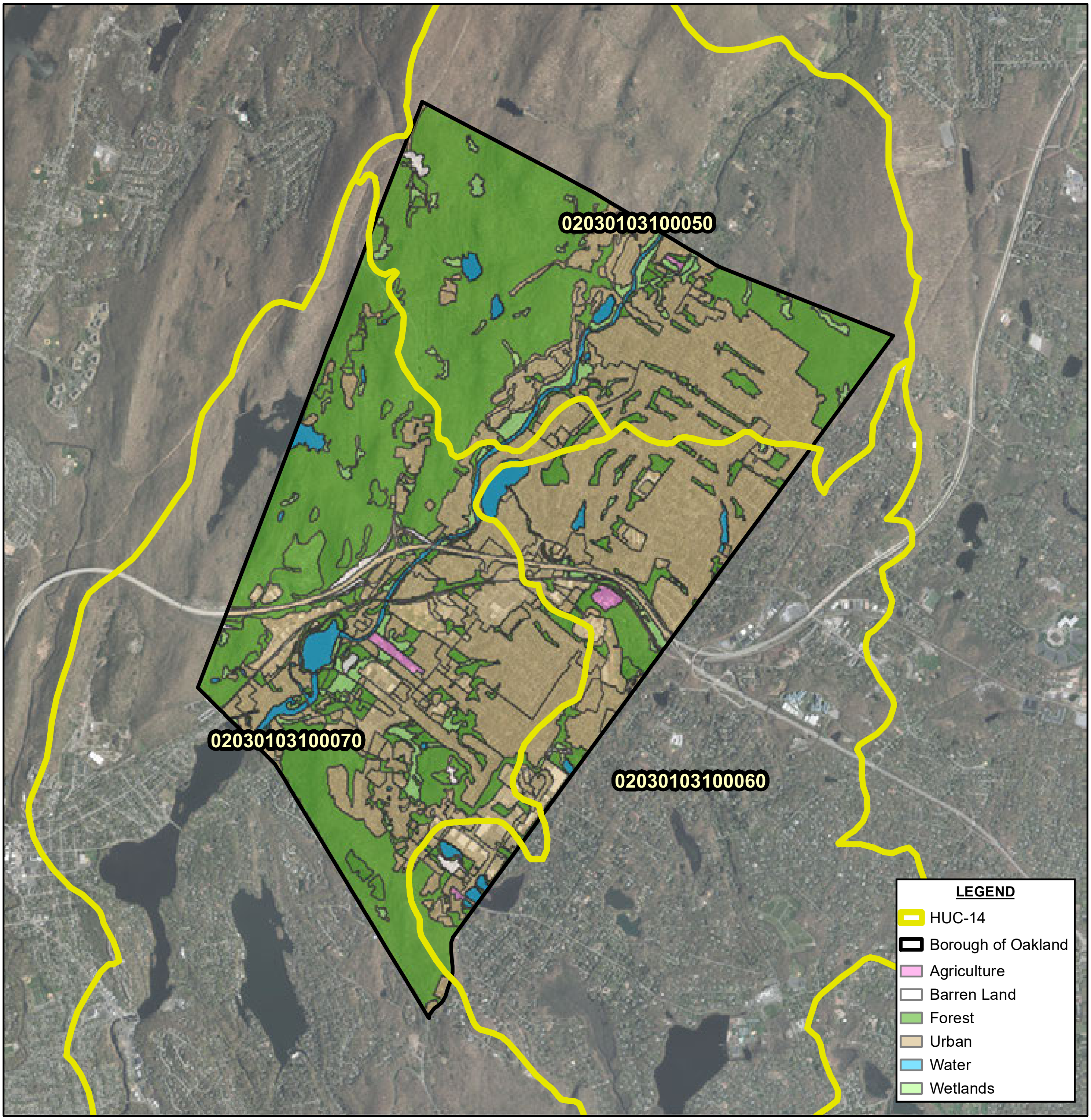
FIGURE 3: PLANNING AREA MAP
WATER USE AND CONSERVATION MANAGEMENT PLAN
ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY | NEW JERSEY

DR. BY: JMW	SCALE: 1 IN = 4,000 FT	JOB NO. OK-1684
CKD. BY: GD	DATE: SEPTEMBER 2020	FIGURE 3



SOURCE: NJDEP LAND USE/ LAND COVER 2015 DATA LAYER

NORTHING: 799,445
EASTING: 564,852

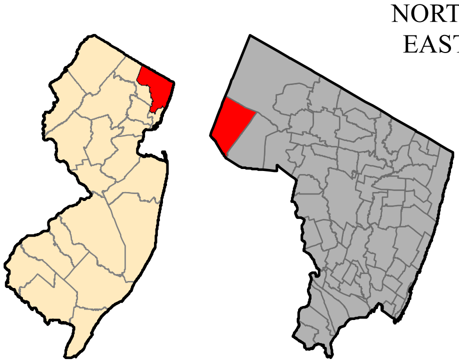


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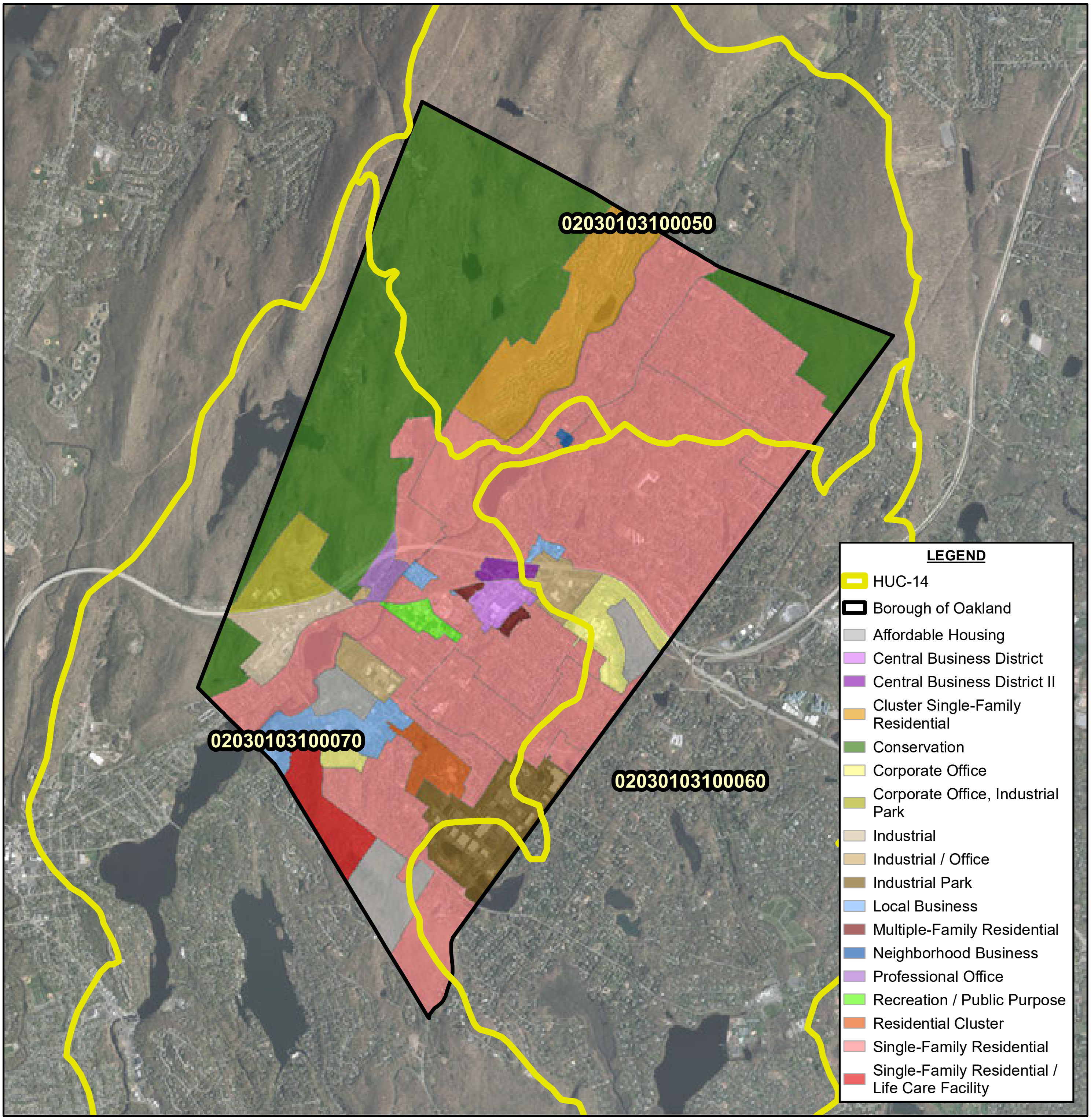
FIGURE 4: LANDUSE MAP

WATER USE AND CONSERVATION MANAGEMENT PLAN

ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY | NEW JERSEY

DR. BY: JMW CKD. BY: GD	SCALE: 1 IN = 4,000 FT DATE: SEPTEMBER 2020	JOB NO. OK-1684 FIGURE 4



SOURCE: OAKLAND ZONING BOUNDARIES DATA LAYER (2015)

NORTHING: 799,445
EASTING: 564,852

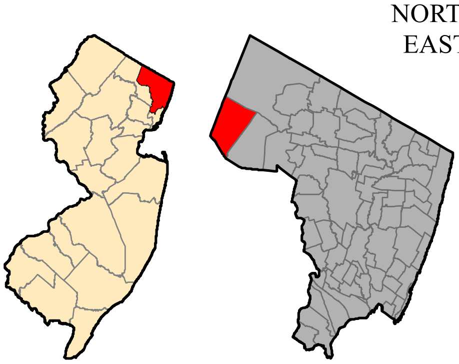


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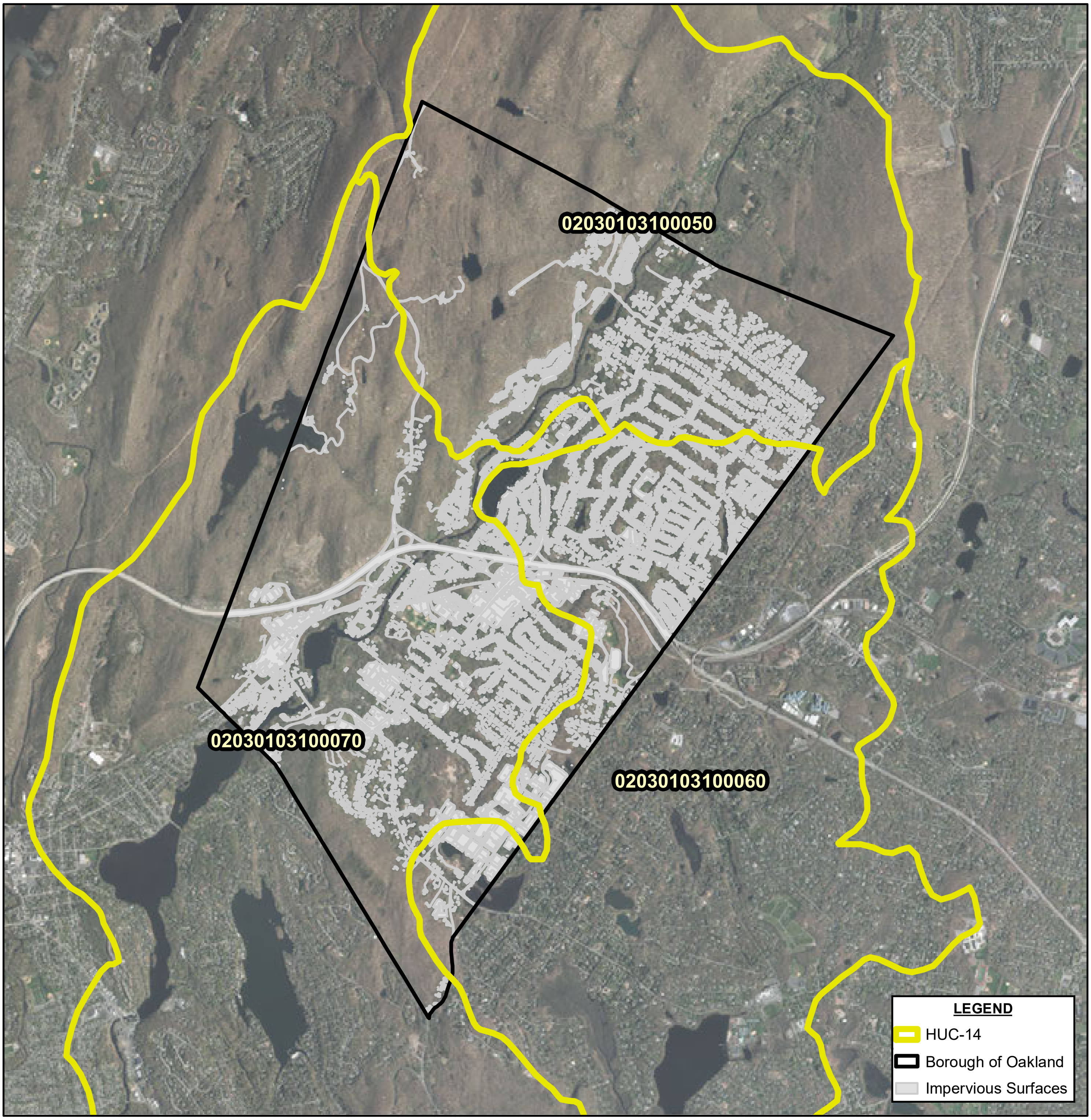
FIGURE 5: ZONING DISTRICTS MAP

WATER USE AND CONSERVATION MANAGEMENT PLAN

ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

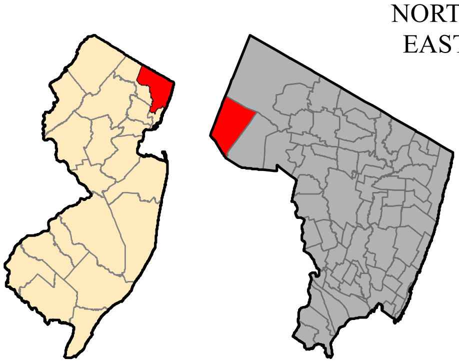
BERGEN COUNTY | NEW JERSEY

DR. BY: JMW	SCALE: 1 IN = 4,000 FT	JOB NO. OK-1684
CKD. BY: GD	DATE: JULY 2021	FIGURE 5



SOURCE: NJDEP IMPERVIOUS SURFACES DATA LAYER

NORTHING: 799,445
EASTING: 564,852



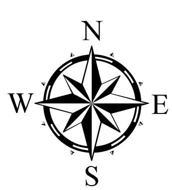


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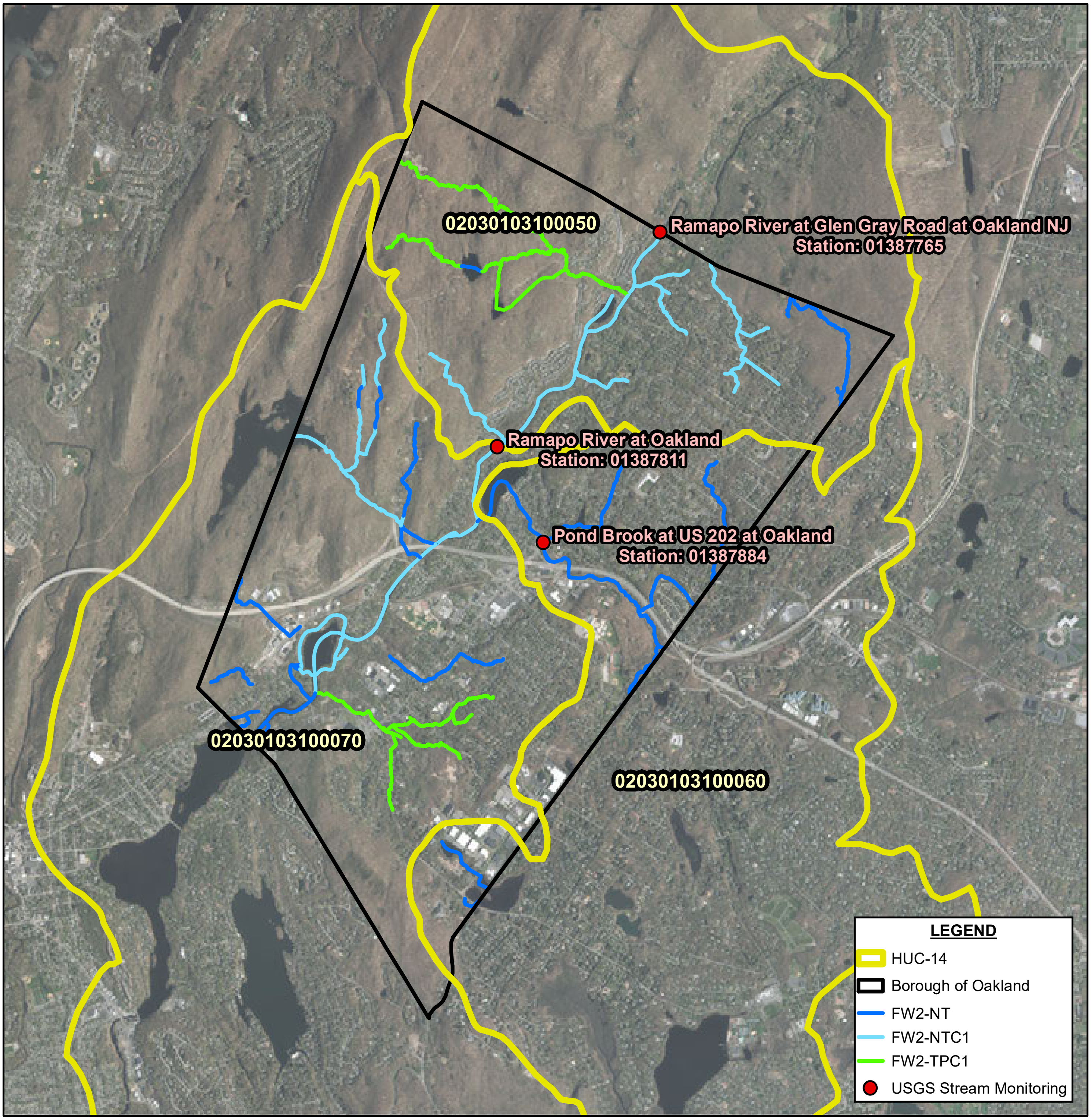
FIGURE 6: PERCENT IMPERVIOUS MAP
WATER USE AND CONSERVATION MANAGEMENT PLAN
ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

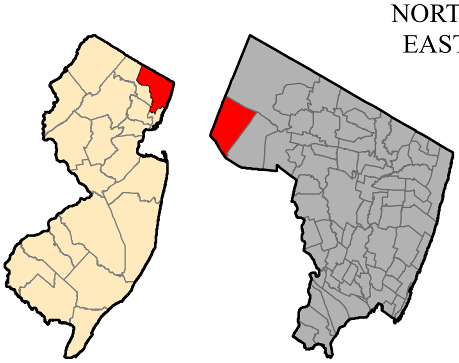
BERGEN COUNTY | NEW JERSEY

DR. BY: JMW	SCALE: 1 IN = 4,000 FT	JOB NO. OK-1684
CKD. BY: GD	DATE: SEPTEMBER 2020	FIGURE 6



SOURCE: NJDEP SURFACE WATER QUALITY STANDARDS DATALAYER

NORTHING: 799,445
EASTING: 564,852



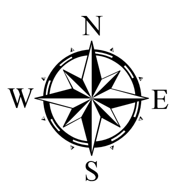


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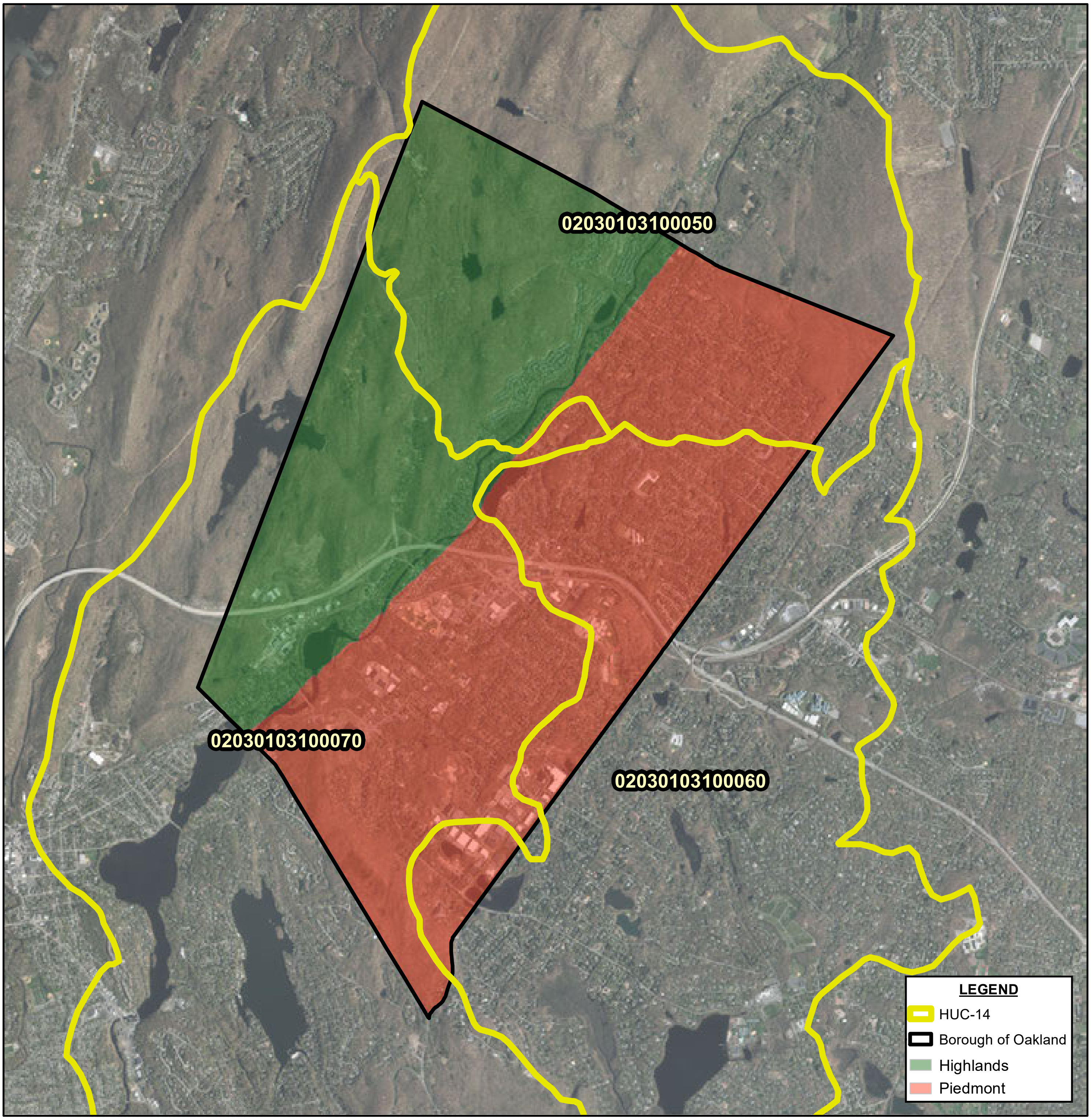
FIGURE 7: HYDROLOGIC FEATURES MAP

WATER USE AND CONSERVATION MANAGEMENT PLAN

ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

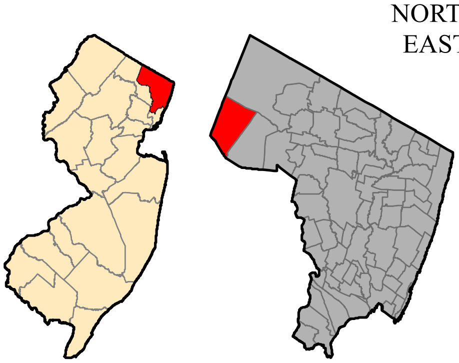
BERGEN COUNTY — NEW JERSEY

DR. BY: JMW	SCALE: 1 IN = 4,000 FT	JOB NO. OK-1684
CKD. BY: GD	DATE: AUGUST 2020	FIGURE 7



SOURCE: NJDEP PHYSIOGRAPHIC PROVINCES DATA LAYER

NORTHING: 799,445
EASTING: 564,852



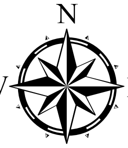


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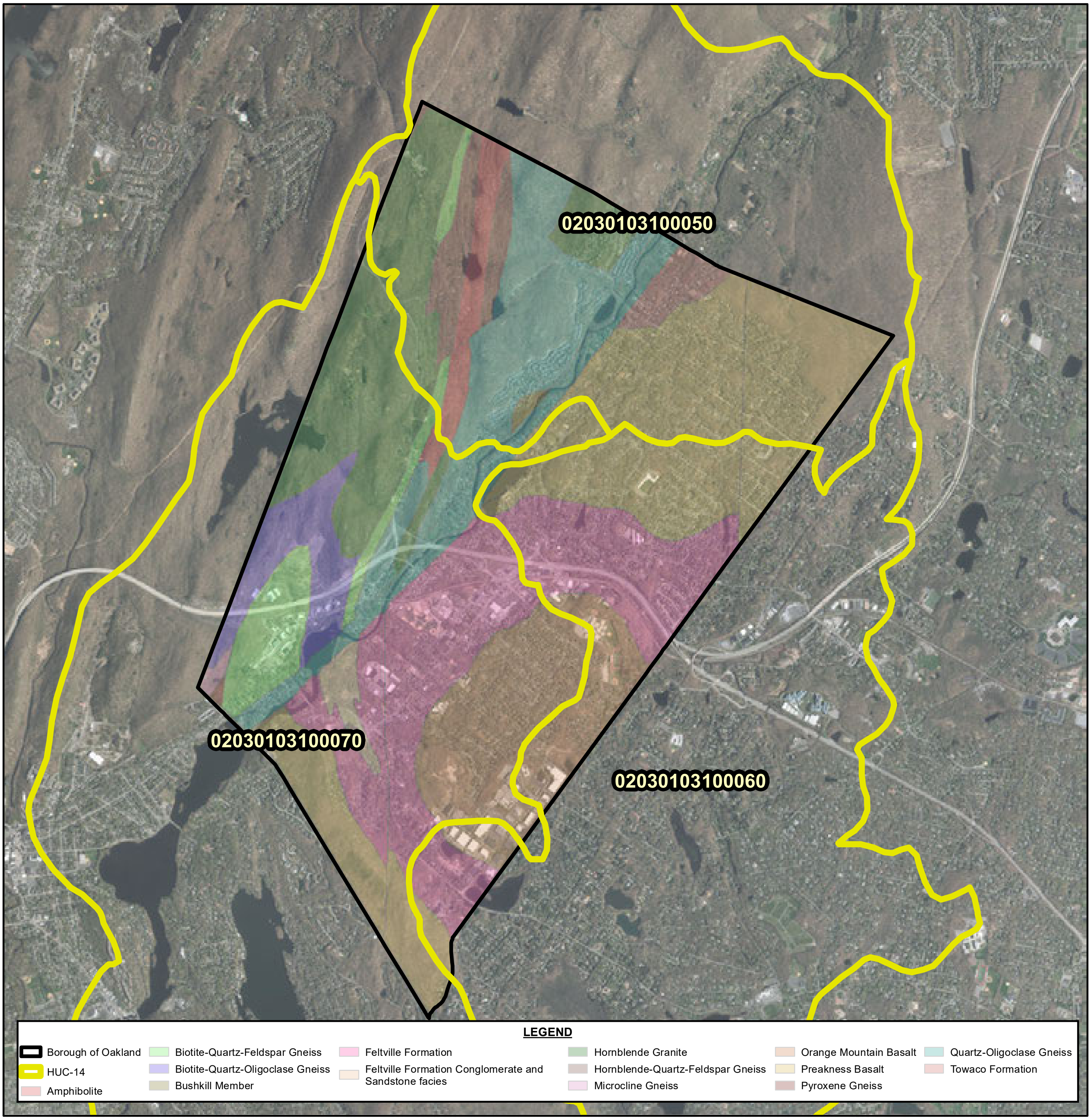
FIGURE 8: PHYSIOGRAPHIC PROVINCES MAP

WATER USE AND CONSERVATION MANAGEMENT PLAN

ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY — NEW JERSEY

DR. BY: JMW	SCALE: 1 IN = 4,000 FT	JOB NO. OK-1684
CKD. BY: GD	DATE: AUGUST 2020	FIGURE 8



SOURCE: NJDEP BEDROCK GEOLOGY DATA LAYER

NORTHING: 799,445
EASTING: 564,852

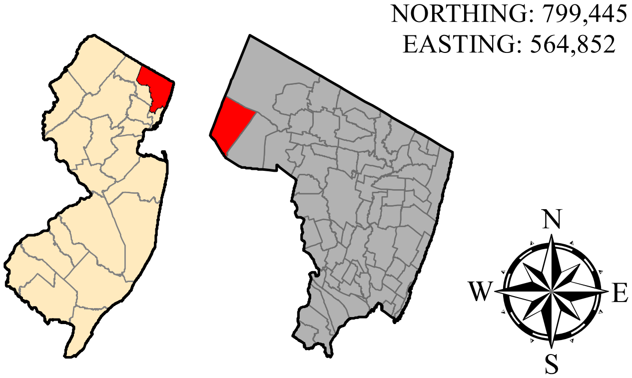


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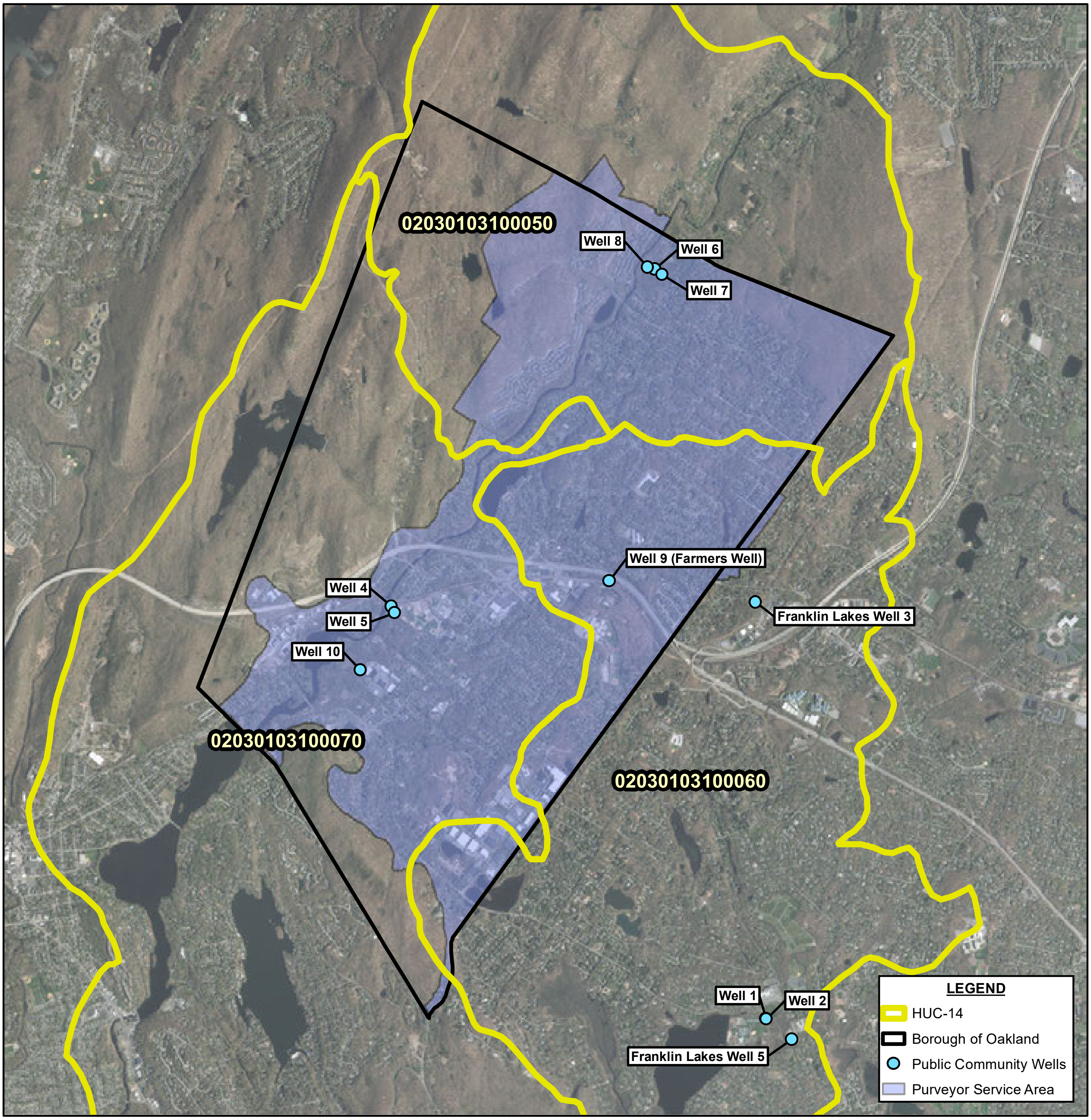
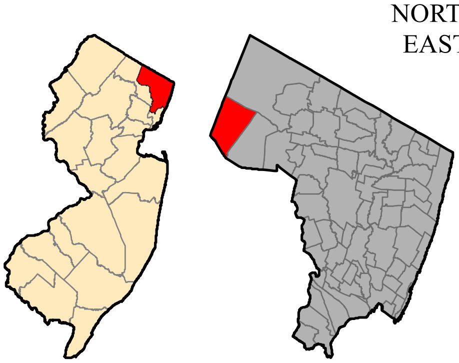
FIGURE 9: BEDROCK GEOLOGY MAP
WATER USE AND CONSERVATION MANAGEMENT PLAN
ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY NEW JERSEY

DR. BY: JMW	SCALE: 1 IN = 4,000 FT	JOB NO. OK-1684
CKD. BY: GD	DATE: AUGUST 2020	FIGURE 9



SOURCE: NJDEP PUBLIC COMMUNITY WATER SUPPLY WELLS DATA LAYER



NORTHING: 799,445
EASTING: 564,852

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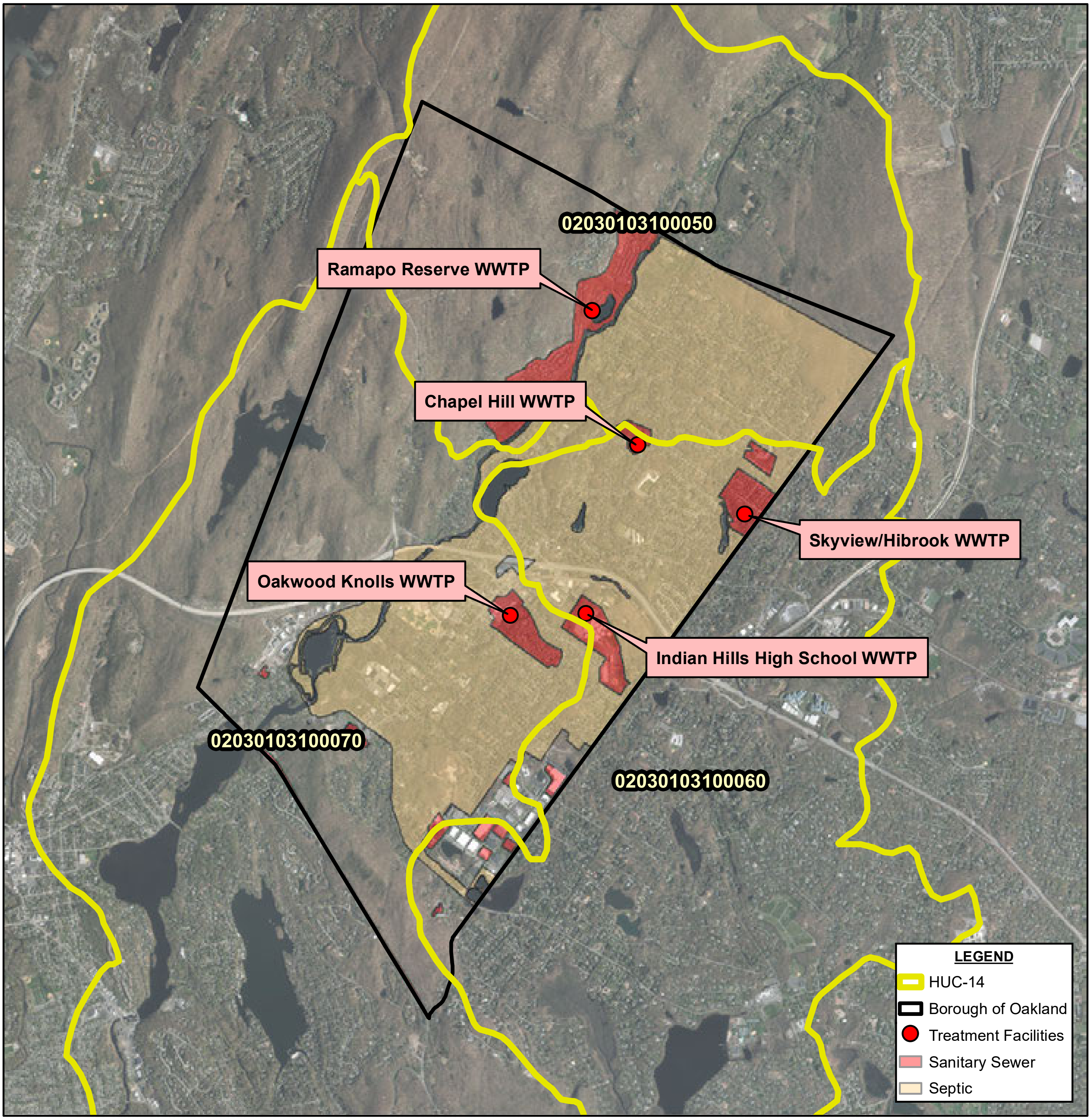
FIGURE 10: PUBLIC COMMUNITY WELLS MAP
WATER USE AND CONSERVATION MANAGEMENT PLAN

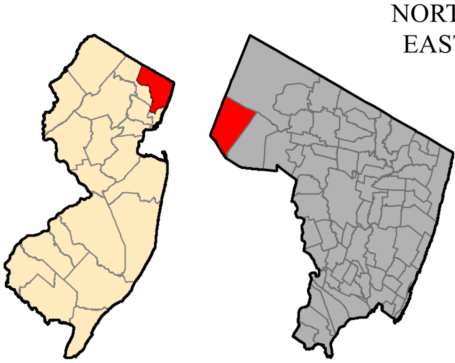
ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY — NEW JERSEY

DR. BY: JMW CKD. BY: GD	SCALE: 1 IN = 4,000 FT DATE: AUGUST 2020	JOB NO. OK-1684 FIGURE 10



SOURCE: OAKLAND SANITARY TREATMENT FACILITIES DATA LAYER



NORTHING: 799,445
EASTING: 564,852

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FIGURE 11: SEWER SERVICE AREA MAP

WATER USE AND CONSERVATION MANAGEMENT PLAN

ONE MUNICIPAL PLAZA
BOROUGH OF OAKLAND

BERGEN COUNTY | NEW JERSEY

DR. BY: JMW CKD. BY: GD	SCALE: 1 IN = 4,000 FT DATE: AUGUST 2020	JOB NO. OK-1684 FIGURE 11

PLANNING BOARD
BOROUGH OF OAKLAND RESOLUTION
ADOPTING THE HIGHLANDS COUNCIL
WATER USE AND CONSERVATION
MANAGEMENT PLAN AS A SUB-ELEMENT
OF THE CONSERVATION PLAN OF
OAKLAND'S MASTER PLAN

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

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

WHEREAS, the Planning Board through its Engineer, John Yakimik of Boswell Engineering, presented and discussed the WUCMP at its duly-noticed public meeting held on August 12, 2021; and

WHEREAS, copies of the WUCMP were made available for review by the public at least 10 days prior to August 12, 2021 and adequate notice of the meeting advising that the WUCMP was on the agenda for discussion and the public was given the opportunity to attend and comment; and

WHEREAS, during his presentation to the Planning Board, John Yakimik highlighted the following:

1. In order for the Borough to eliminate individual sanitary disposal (septic) systems and provide an on overall collection system, they needed to develop a WUCMP as a requirement of the Council.
2. The overall plan for the sewer collection system is to take water within Oakland's topographic basin and transfer it to the Northwest Bergen County Utilities Authority

(NBCUA) Wastewater Treatment Plant (WWTP) in Waldwick and within a different basin without causing detrimental effects to the water supply within the Oakland basin.

3. The main objective of the WUCMP is to identify and provide a framework to reduce and where feasible eliminate surface and ground water deficits by identifying strategies that can help mitigate these deficits, focusing on water supply source areas.

4. The WUCMP utilizes and evaluates hydrological units (watersheds) or HUC14's and subwatersheds. The Borough of Oakland WUCMP encompasses three (3) subwatersheds, identified by 14-digit numbers and are commonly known as the Ramapo River from Bearswamp Brook to Crystal Lake Bridge ("Upper Ramapo"), Ramapo River below Crystal Lake Bridge ("Lower Ramapo") and Pond (Allerman) Brook.

5. That the WUCMP determined that there is a water deficit in the Borough but that deficit can be reduced by following certain strategies proposed by the WUCMP such as Water Bill Structure/Comparison Irrigation System Design, Leak Detection and Repair, Rate Structure, Assisted Infiltration/Enhanced Recharge, and Stormwater Ordinance.

6. That if these strategies are followed, the WUCMP estimates that approximately 51,500 gallons of water per day can be saved.

7. That there was a minor revision to the WUCMP in August 2021 pertaining to the finale tract. A statement was added that the proposed Fanale Development may help with Oakland's water deficit since the Development will be supplied by water from the Suez Water Company which provides water to the adjacent town of Franklin Lakes.

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

WHEREAS, the Planning Board has determined that it is in the best interest of the Borough to implement the WUCMP in order to eventually eliminate septic systems and provide an overall collection system.

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

BE IT FURTHER RESOLVED that the adoption herein of the said Water Use and Conservation Management Plan shall be subject to the review and approval of the New Jersey Highlands Council as mandated by the Highlands Council Regional Master Plan.

The Planning Board voted to adopt the proposed Water Use and Conservation Management Plan as a Sub-Element of the Conservation Plan of Oakland's Master Plan on August 12, 2021 by the following vote:

Name	Motion	Second	Yes	No	Abstain	Absent	Ineligible
John Morris						X	
Lee Haymon						X	
Eric Kulmala			X				
Sandra Coira		X	X				
Thomas Connolly	X		X				
Joseph Marscovetra			X				
Michael Rose						X	
Mayor Linda Schwager			X				
Thomas Potash			X				
Gregory Liss			X				
Andrea Levy			X				

APPROVED:

PLANNING BOARD OF THE BOROUGH OF OAKLAND

Kathlyn Gurney

KATHLYN GURNEY, Secretary

THOMAS POTASH, Chairman

G:\Oakland Planning Board\WUCMP\Resolution.docx