SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

2015

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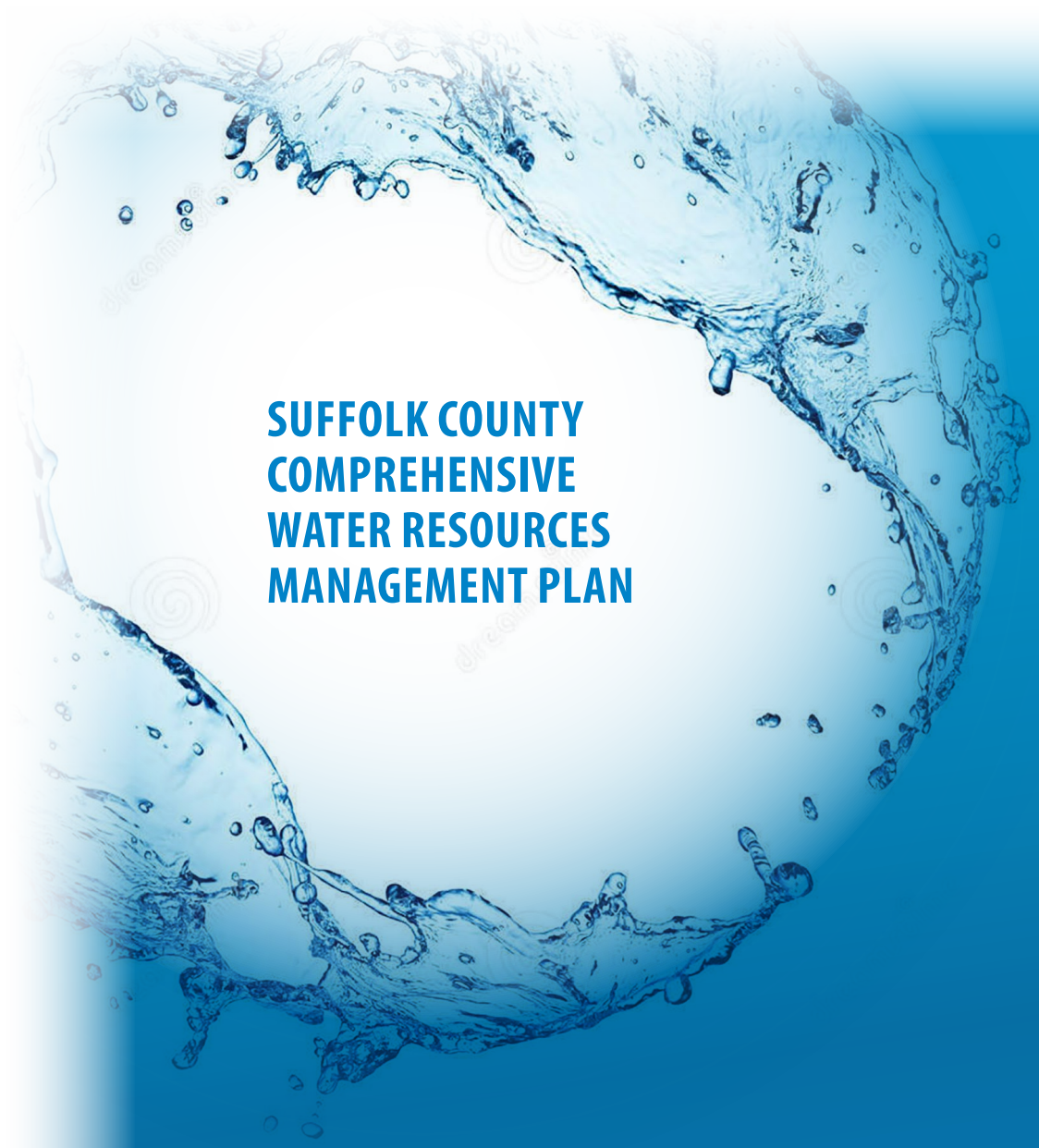

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Appendix E Summary and Basis of Water Quality Parameters Analyzed by the Suffolk County Department of Health Services Public & Environmental Health Laboratory as Compared with Those Regulated in Drinking Water & Analyzed by Other Agencies (March 2015)

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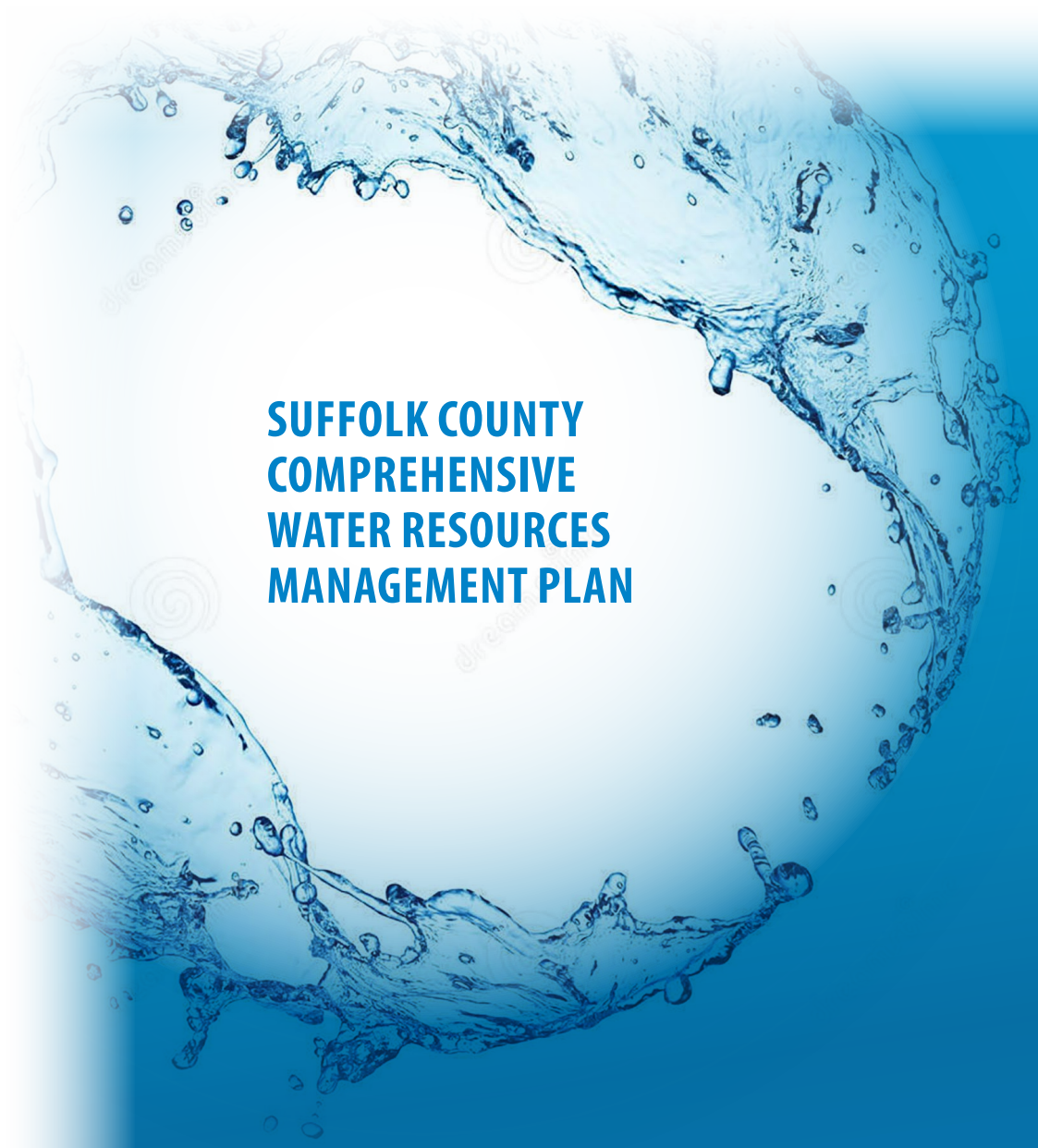
Appendix G Contaminant Fact Sheets

Appendix H Suffolk County Community Water Supplies

Appendix I Suffolk County Sewage Treatment Plants

Appendix J Advanced Wastewater & Transfer of Development Rights Tour Summary

Appendix K Key Performance Indicators



SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Executive Summary

Executive Summary

Introduction

Water is the single most significant resource for which Suffolk County bears responsibility. As the impact of Superstorm Sandy underscored, more than at any time in our history, we are obliged to come to terms, in every sense, with the water that surrounds us. Suffolk County's water quality is at a tipping point. We face an alarming trend in the quality of the water our families drink, compounded by impairment of many bodies of water in which our families play. Moreover, the source of these impairments has demonstrably degraded the wetlands that serve as our last line of natural defense against storm surge.

While today our drinking water generally meets quality standards, elevating levels of contaminants raise serious concern. Many of our rivers, estuaries and bays are impaired as result of eutrophication. Nitrogen, which primarily spews from residential septics and cesspools, as well as fertilizer, are the principal culprits that spur hypoxia, harmful algal blooms, diminution of sea and shellfisheries, and degradation of our protective natural infrastructure– wetlands and seagrass beds that act as wave and storm surge buffers [1] [2]. Sea level rise, which also contributes to marshland degradation, is projected to raise groundwater levels, increasing vulnerability to saltwater infiltration, and further compromising on-site wastewater treatment infrastructure largely composed of cesspools and septic tanks.

Perhaps nowhere have we seen the impact of nitrogen pollution in more stark terms than the Great South Bay. At one time, this bay produced more than half the clams eaten in our country. However, over the past quarter-century, the clam harvest in the Great South Bay has fallen by 93 percent, destroying an entire industry which once accounted for 6,000 jobs. While clams were once over-harvested, they have largely failed to recover due to recurrent brown tides fed primarily from nitrogen from septic systems and cesspools. We must

---

[1] Deegan LA, Johnson DS, Warren RS, Peterson BJ, Fleeger JW, Fagherazzi S, and Wollheim WM (18 Oct 2012) "Coastal Eutrophication as a Driver of Salt Marsh Loss" *Nature* : doi:10.1038

[2] Anderson ME, McKee Smith J, Bryant DB, and McComas, RGW. (Sept 2013), "Laboratory Studies of Wave Attenuation through Artificial and Real Vegetation" USACE, "It is generally acknowledged that vegetated coastal features such as wetlands can reduce the effects of surge, waves, and tsunami propagation."

decide if this type of impaired surface water body will be our region's future or if we can restore our bays to health.

In advance of the release of the 2015 Suffolk County Comprehensive Water Resources Management Plan ("Comp Plan"), this Executive Summary Update is spotlighting the Comp Plan's critical findings, and relevant post-Superstorm Sandy considerations, in order to spur a critical public dialogue about the scope of the problem and begin to frame near-term solutions. While many environmental issues related to groundwater and surface waters have arisen since the previous Plan (1987), one elemental condition has remained constant: the vast majority of Suffolk residents rely on on-site wastewater disposal systems that discharge to groundwater. In addition, fertilizer use, industrial and commercial solvents, petroleum products, pesticides and a host of other manmade contaminants have had profound and long-lasting impacts on groundwater quality, as well as on fresh surface waters and coastal marine waters into which groundwater and stormwater runoff discharge.

In the face of sea-level rise and extreme weather events, Suffolk County is compelled to devise the means and methods to live and thrive with the water beneath, by and around us.

Critical Findings

*"We have a million and a half people, **approximately 74%,** or roughly a million people, who are **not sewered**. This is probably the only place in the world with that large a density in this tight a space where the waste is going into a sole source aquifer immediately beneath us that we're drinking, and this is **a big concern**."*[3]

Downward Trajectory in Groundwater Quality:

1. Nitrogen is public water enemy #1, as **nitrate contamination** from unsewered housing and fertilizer use poses a threat to both drinking water supplies and coastal marine habitat and resources. Nitrogen-induced nutrient loading and eutrophication can lead to many negative impacts on estuarine environments including harmful algal blooms (HABs), hypoxia [little or…], and even anoxia [no oxygen];

2. Volatile organic chemicals (VOCs), another **priority contaminant group**, derived from commercial, industrial, and consumer use,

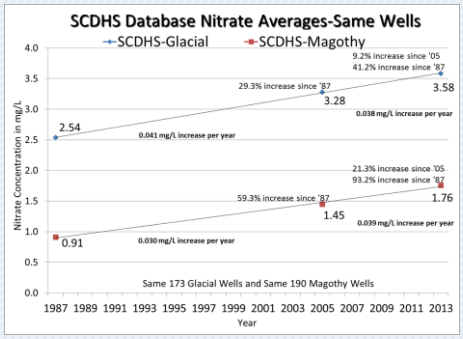
[3] Dawydiak, Walter, Acting Director Environmental Quality, Suffolk County Department of Health Services. Testimony to Health Committee of SC Legislature, March 6, 2012

impacting large portions of the aquifer, public water supply and private wells;

3. Pesticides pose a threat, especially to private wells in agricultural areas; and,

4. Pharmaceuticals and personal care products are an **emerging concern**.

Public Water Supply Well Nitrate Trends (1987-2013)



- Nitrogen pollution continues to worsen
- The rate of degradation has not declined; it appears to have accelerated in the Magothy aquifer
- Nitrogen levels in public supply wells are still generally good for drinking water, but unacceptable for surface waters

Surface Water Impairments:

5. Due to excess coliform bacteria and nitrogen, **many of the water bodies surrounding Suffolk County have been designated as impaired by the New York State Department of Environmental Conservation** (NYSDEC). In fact, the vast majority of Long Island's 60-mile long South Shore Estuary Reserve was declared impaired by the NYSDEC in 2010.

6. **Brown tide** algae invasions have been plaguing Long Island estuaries for nearly a quarter of a century, according to Dr. Chris Gobler of Stony Brook's School of Marine & Atmospheric Sciences (SoMAS), **obliterating a shellfish habitat** that once provided one half of all hard clams for the nation.

7. There was an 18-36% **loss of tidal wetlands** between 1974 and 2001 according to NYSDEC.[4]

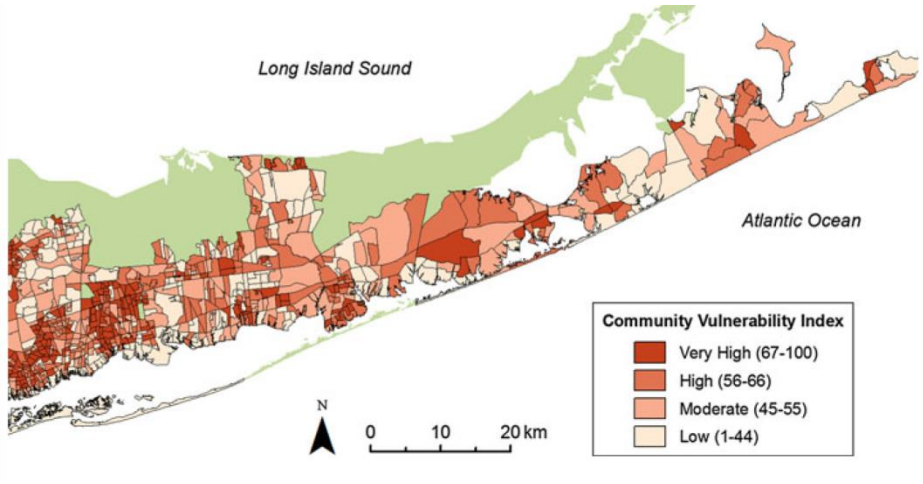
8. The NYS Seagrass Taskforce estimates that the 200,000 acres of seagrass in Long Island's bays and harbors in 1930 have shrunk by nearly 90% to 22,000 acres.

9. The Forge River in Moriches is "the worst case of anoxia (absence of oxygen) I have seen," states Dr. Larry Swanson, Associate Dean of SoMAS.

*The costs of redressing water-related issues are significant; the economic consequences of not doing so are **potentially devastating in property values alone**. Then there is Long Island tourism, producing revenues of $4.7B/yr, with approximately 28% of visitors – 5.1M/yr – visiting parks and beaches.*[5] *"Coastal habitats shield people and property from sea-level rise and storms," reducing*

[4] Discrete marsh trends show even higher rates of loss in other areas (TNC).
[5] Trust for Public Land, "The Economic Benefits and Fiscal Impact of Parks and Open Space in Nassau and Suffolk Counties, New York," 2010 accessed at http://cloud.tpl.org/pubs/ccpe--nassau-county-park-benefits.pdf

their exposure by half, according to marine ecologists at Stanford Woods Institute for the Environment.[6, 7]



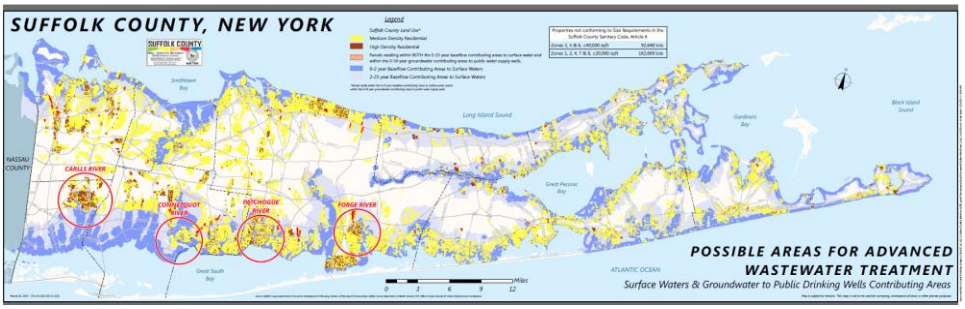
The Community Vulnerability Assessment Tool (NOAA) identifies block groups that are at most risk, assessing damages resulting from a category 3 hurricane (gray) compounded 0.5m sea-level rise (black), + values of tidal marshes.[6]

Nitrogen from Unsewered Areas

Suffolk County, with a population larger than 11 states and a region that derives its drinking water from the ground, must pay particular attention to the 360,000 sub and non-performing septic/cesspools in Suffolk, accounting for well over 74% of the homes. They are particularly problematic in areas with high water tables and in close proximity to surface waters. When flooded or submerged in groundwater, septic systems do not function as designed and they fail to adequately treat pathogens. Excess nitrogen from sewage threatens our valuable natural resources, coastal defenses, and human health.

[6] Arkema, K, "Coastal habitats shield people and property from sea-level rise and storms," Nature Climate Change, July 2013

[7] Shepard, C, et al, "Assessing future risk: quantifying the effects of sea level rise on storm surge risk for the southern shores of Long Island, New York," Nat Hazard 2011: 727-745.



Map of 0-25 Year Baseflow Contributing Areas to Surface Waters

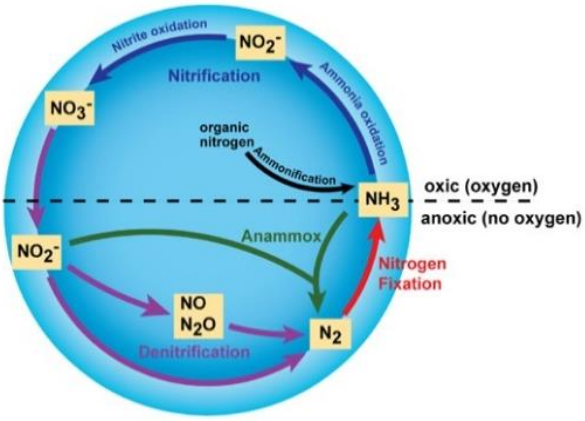
Characteristics of Unsewered Areas in Suffolk County, N.Y.			
	Unsewered Residential Parcels		
	Total	Medium Density (> 1 to < 5 d.u./acre)	High Density *(≥ 5 d.u./acre)*
0-25 Year Baseflow Contributing Areas to Surface Waters	155,939	121,843	34,096
0-50 Year Estimated Groundwater Travel Time to Public Water Supply Wells	55,169	43,967	11,202
≤ 10 Feet Depth to Groundwater	38,143	25,914	3,288
≤ 10 Feet Depth to Groundwater AND either 0-25 Surface Water or 0-50 Groundwater Public Wells Contributing Areas	30,250	21,309	8,941

Suffolk County has identified priority high density (greater than 5 homes per acre) and medium density (1 to 5 homes per acre) residential subregions within the contributing areas with the following characteristics:

1. With a depth to groundwater of 10 feet or less; and/or
2. Contribute to an area that is listed as a 303(d) impaired water body.

Contaminant	Manmade Sources
Nitrogen pollution is increasing in our groundwater	**360,000 septic and cesspools**
• While 83% of all community supply wells had nitrogen concentrations less than or equal to 6 mg/L in 2013, there were large changes in nitrogen levels in all of Suffolk County's groundwater aquifers. Nitrate concentrations in the Upper Glacial aquifer **rose by over 40%** between 1987 and 2013 while levels in the Magothy aquifer, a deeper aquifer, **rose by over 80%.** The observed rate of increasing nitrates was generally linear in the Upper Glacial aquifer between 1987 to 2005 and 2005 to 2013, but the trend increased slightly in the Magothy aquifer between 2005 and 2013 as compared to the rate of increase observed between 1987 and 2005 in the same subset of public supply wells.	30,250 homes with septic systems or cesspools are within the 0-25 year contributing area to surface water and have less than 10 feet separating their systems from the water table
• Nitrate levels in nearly 25 percent of the private wells sampled between 2007 and 2013 exceeded groundwater management zone target levels of 4 and 6 mg/L. Nitrate levels in approximately 7 percent of the samples collected from 2007 through 2013 exceeded 10 mg/L. In some agricultural areas, nitrate levels in private wells can still exceed 20 mg/L.	
• Parts of Suffolk County's groundwater exceeds maximum containment levels caused by unsewered, subsized lots, especially in Huntington, Smithtown and northern Brookhaven, with nitrate levels ranging from 8 mg/L to 12 mg/L in Magothy wells in Northport and East Northport.	
• All 3 major estuaries in Suffolk County are suffering from dissolved oxygen impairments as well as recurring Harmful Algal Blooms, some toxic to humans, diminishing the County's wetlands, which act as a second line of defense for storms.	**80% of all fertilizer purchased in Suffolk is for non-farm, residential uses**
• Wetlands have been scientifically proven to reduce vulnerability from storm surge, reducing wave height by 80% over short distances. Waves lose energy as they travel through vegetation.	
• Losses of healthy salt marsh have accelerated in recent decades. The NYSDEC estimates that an 18-36% loss in tidal wetlands in the Great South Bay occurred between 1974 and 2001. In 2010 the NYSDEC declared the vast majority of Long Island's South Shore Estuary Reserve system, stretching more than 60 miles, an "impaired water body" (under section 303(d) of the Clean Water Act). NYSDEC identifies nitrogen from wastewater as a reason for this unfortunate designation and states that cesspools, septic systems, and sewage treatment plants cause eutrophication, resulting in lower water oxygen levels and persistent algal blooms. According to researchers Kinney and Valiela[1], **69% of the total nitrogen load for the Great South Bay is from septic systems and cesspools**.	25,905 tons of fertilizer were purchased as non-farm uses in 2012, representing 16% of all fertilizer purchased statewide
• Excessive nitrogen has been shown to have a direct effect on seagrass by promoting growth of microalgae which shade it and macroalgae which out-compete it. Thousands of acres have died off in Long Island's Eastern and South Shore estuaries. According to the NYS Seagrass Taskforce, historic photography and records indicate that there may have been as much as 200,000 acres of seagrass in 1930 in Long Island bays and harbors; only about 22,000 acres remain.	
• A few decades ago, half the clams eaten in this country came from Great South Bay. However, in the past 25 years, the hard clam harvest in Great South Bay has fallen by more than 93% to record lows, resulting in a loss of more than 6,000 jobs[1]. In the 1970s, bay-scallop fishery on Eastern Long Island and hard-clam fishery in the South Shore bays were the two largest in the U.S. The bay-scallop collapse was almost entirely due to the nitrogen-caused algal blooms. While hard clams were over-harvested in the 1970s and 1980s, they have failed to recover largely due to recurrent brown tides.	

Contaminant	Manmade Sources
Volatile Organic Compounds (PCE, TCE, TCA, and MTBE) • Approximately **22% of public water supply wells are treated** to remove low-level VOCs prior to delivery to customers. • The gasoline additive MTBE, banned in 2004, was detected in 5% of all public supply wells tested in 2013, down from 16% with detections in 2005. • Concentrations of dry cleaning and metal finishing solvents **doubled in a 25-year period**, impacting between three (PCE) and five (TCE) times the number of wells. • 70% of community supply wells are rated as high or very high for VOC contamination, due to the widespread use of VOCs.	Illegal discharges & spills, leaking underground storage tanks, septic systems, household cleaners, and banned chemicals travelling through the aquifer
Pesticides • Past agricultural practices have significantly impacted private wells on the East End, with **6.5% exceeding pesticide maximum contaminant levels.** • Pesticides were detected in approximately 16% of the public supply wells sampled between 1997 and 2014. • **Over 100 pesticide-related compounds** have been detected in Suffolk's groundwater. • 20% of drinking water wells tested between 1997 and 2012 had at least one pesticide detection.	Agricultural sector and homeowners
Pharmaceuticals and Personal Care Products • Detection of pharmaceuticals and personal care products, like ibuprofen, phthalates, and caffeine, have been found in about **2.5% of community public supply well samples**, and 5 to 10% of (shallower) non-community public supply and private well samples. • The presence of **1,4-dioxane**, an industrial solvent stabilizer and byproduct in personal care products, has been found in over 40% of the Suffolk County Water Authority's public supply wells. This **emerging contaminant** is likely a human carcinogen and is not removed with conventional treatment technologies.	Industry and homeowners



Nitrogen Bomb in Our Bays

Nitrogen is one of the primary nutrients critical for the survival of all living organisms. Since the mid-1900s, the impact of humans on the global nitrogen cycle via manufacture of fertilizers and burning of fossil fuels has substantially altered the amount of fixed nitrogen in the Earth's ecosystems. Some predict that by 2030, the amount of nitrogen fixed by human activities will exceed that fixed by microbial processes.[8] Nitrogen is arguably the most important nutrient in regulating primary productivity and species diversity in aquatic and terrestrial ecosystems.[9]

Much of the nitrogen applied to agricultural and urban areas ultimately enters rivers and coastal systems. In nearshore marine systems, elevated nitrogen can lead to anoxia or hypoxia (no or low oxygen), altered biodiversity, alterations in the food-web, and habitat degradation. One common consequence of increased nitrogen is proliferation of harmful algal blooms.[10] Toxic blooms of certain types of dinoflagellates have been associated with high fish and shellfish mortality. Absent such economically catastrophic impacts, elevated nitrogen can lead to changes in biodiversity, species composition and overall ecosystem function. It has also been suggested that alterations to the nitrogen cycle may lead to increased risk of parasitic and infectious diseases among humans and wildlife.[11] Moreover, increases in nitrogen in aquatic systems can lead to increased acidification in freshwater ecosystems.

- Nitrogen is released when microorganisms break down sewage, manures, decaying plants or fertilizers, millions of pounds of nitrogen are generated on Long Island each year. As Chris Gobler of the Marine Science Research Center at Stony Brook University points out, "and unfortunately most of that, as we all know, is not going to sewage treatment plants, but is going to septic tanks" and eventually seeping into groundwater and surface water, Gobler said. "**We do expect these numbers to rise.**"

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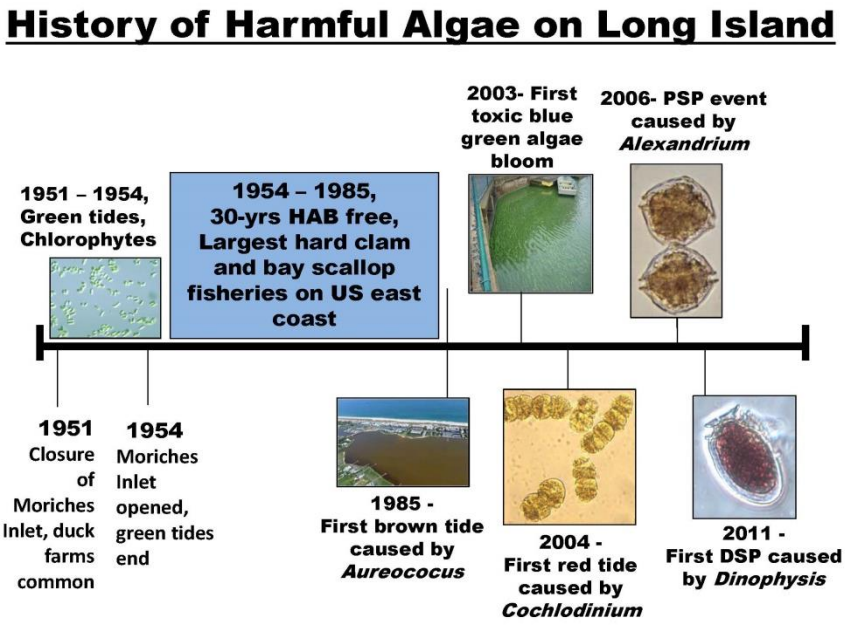
[8] Vitousek, P. M. *et al.* Human alteration of the global nitrogen cycle: sources and consequences. *Ecological Applications* **7**, 737–750 (1997).

[9] Vitousek, P. M. *et al.* Towards an ecological understanding of biological nitrogen fixation. *Biogeochemistry* **57**, 1–45 (2002).
[10] Howarth, R. W. Coastal nitrogen pollution: a review of sources and trends globally and regionally. *Harmful Algae* **8**, 14–20. (2008).
[11] Johnson, P. T. J. *et al.* Linking environmental nutrient enrichment and disease emergence in humans and wildlife. *Ecological Applications* **20**, 16–29 (2010).

- "The math, via nutrient budgets, that's been done – quantifying the precise amount of nitrogen in pounds per day from different sources including the atmosphere, fertilizers, septic tanks, cesspools, sewage treatment plants – clearly shows that the large majority is from cesspools and septic tanks, going from land into these **South Shore estuaries**," says Gobler. "The groundwater travels through the aquifer, it's going towards the bay. Tainted groundwater flows only a couple of feet a day. So, ironically, the bays may just now be getting hit with the effects of explosive development of the 1960s and '70s."



- Though submerged septic systems have not been thoroughly evaluated, such systems may very well diminish treatment of potentially pathogenic bacteria. "Excess nutrients (nitrogen and phosphorous) from both point and non-point sources from wastewater inputs can significantly impact surface water quality causing anoxia, hypoxia, eutrophication, nuisance algal blooms, dieback of seagrass and corals and reduced populations of fish and shellfish."[12]

[12] Paul, J.H., et al, "Rapid movement of wastewater from on-site disposal systems into surface waters in the Lower Florida Keys," Estuaries, Oct 2000, Vol23, Iss5, pp662-668.

	Suffolk County			New York State		
Year	Total Fertilizer	Farm	Non-Farm	Total Fertilizer	Farm	Non-Farm
2011	34,710.71	20.9%	79.1%	596,891.67	70.1%	29.9%
2012	32,432.19	20.1%	79.9%	590,819.23	72.7%	27.3%

2008-2012 Suffolk County non-farm fertilizer sales was 17.5% of NYS/Agriculture & Markets

- Though the element occurs naturally and is necessary for human health and plant growth, when ingested in high levels, it can deprive bodies of oxygen in blood. In infants, excess nitrogen in water used for formula preparation can lead to "blue baby syndrome," where the lack of oxygen turns the skin blue. In adults, high nitrogen levels, in severe cases, can lead to brain damage.

- Excess nitrogen is also harmful to coastal ecosystems. One important impact of nitrogen loading to coastal systems is low dissolved oxygen, or hypoxia. This occurs when decomposition processes outpace oxygen production and consume dissolved oxygen in the water column. Hypoxia can lead to fish kills and displace marine organisms, cause odors, alter sediment chemistry, and impact the food web.

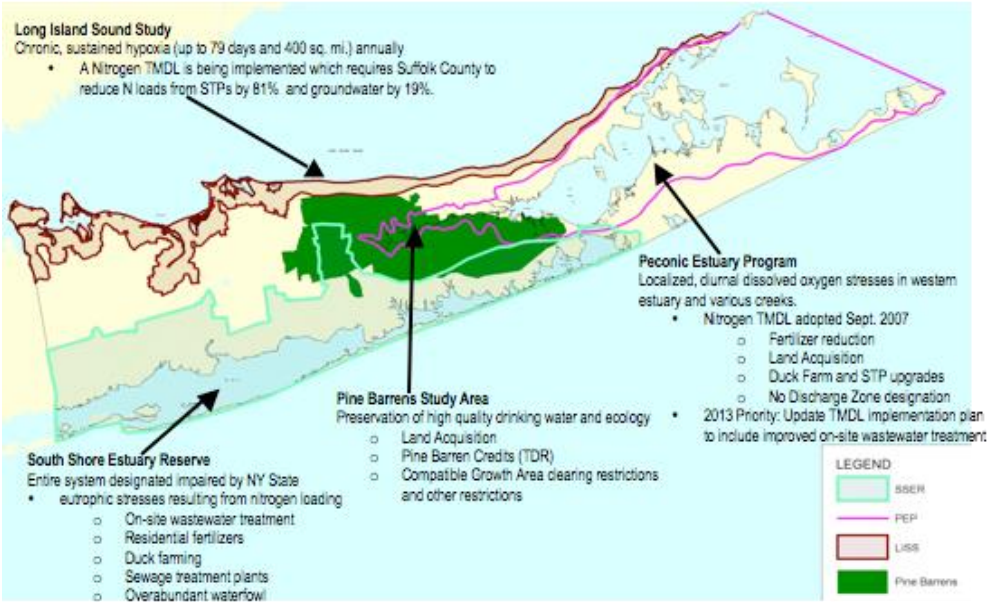
- In 2010 the NYSDEC declared the vast majority of Long Island's South Shore Estuary Reserve system, stretching more than 60 miles, an "impaired water body" (under section 303(d) of the Clean Water Act). NYSDEC identifies nitrogen from wastewater as a reason for this unfortunate designation and states that cesspools, septic systems, and sewage treatment plants cause eutrophication, resulting in lower water oxygen levels and persistent algal blooms throughout this important ecosystem.

- Note: Under the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet water quality standards. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

Waterbodies that are designated as impaired will remain on the list until a TMDL has been developed. Waterbodies that are designated as impaired but no longer require a TMDL (usually because a TMDL has been developed) will be listed on the All Impaired Waters List.

- Drinking water safety and prevention of hypoxia are only two reasons Long Islanders are concerned about nitrogen loading. Other important impacts include harmful algal blooms (HABs), declining populations of recreationally and commercially important fish and shellfish, and degradation of wetlands and seagrass - important natural defenses against storms.

- The recurrence of nitrogen-caused low oxygen conditions, are the reason many of Long Islands bays are considered "impaired" (under section 303(d) of the Clean Water Act). For this reason alone, federal and state policies have mandated that nitrogen loads be reduced in the Long Island Sound and Peconic Estuary.



The Tides Are Turning on Us[13]

- October 15, 2013 – Brown tide algae, the color of coffee, has returned to Long Island's South Shore with concentration 20x what is harmful to shellfish in central Great South Bay and is 4x in other parts of the Great South Bay. Chris Gobler says such algal blooms have been forming in South Shore bays for at least the past 25 years.

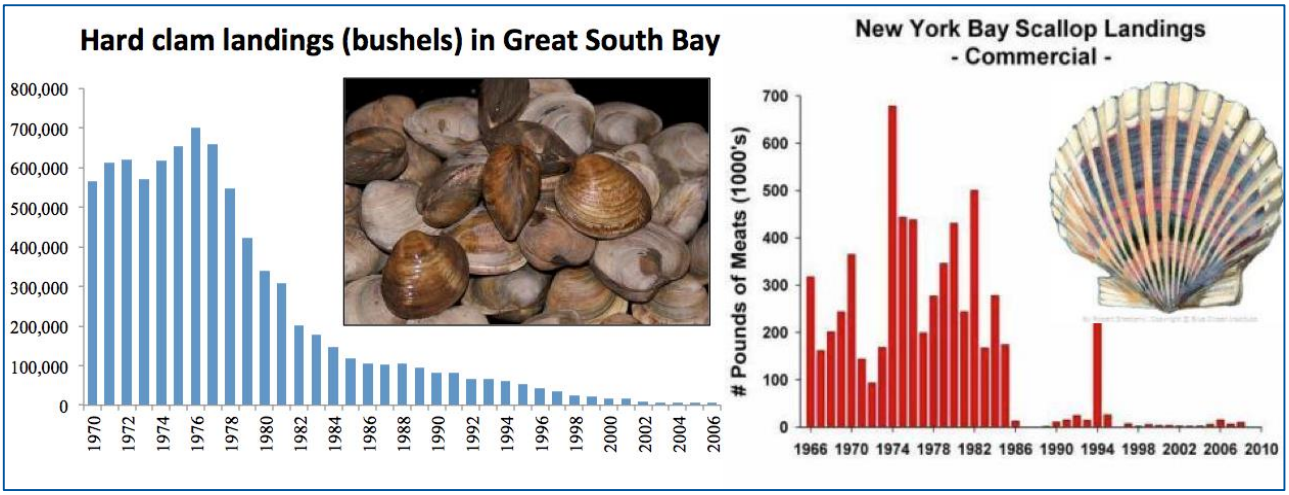
- Since the 1980s, the Brown Tide causing algae A. anophagefferens has plagued Long Island Estuaries, and has been implicated in the crash of the hard clam population in Great South Bay and the iconic bay scallop population in the Peconic Estuary. In effect, the fate of the shellfish population is forewarning for the surrounding ecosystem of eel grass and marsh, like the proverbial canary in the coal mine.

- Since this particular strain of algae, A. anophagefferens, can exploit either inorganic or organic nutrients, it can potentially out-compete other co-occurring phytoplankton under some circumstances. As A. anophagefferens is adapted to grow under low light conditions and can utilize the available dissolved organic nutrients, it proliferates as the waning algal bloom uses up the inorganic nutrients and shades the water column with its biomass.

- Note that the **primary source of dissolved inorganic nitrogen** to many of Long Island estuaries is in fact **groundwater underflow**.

[13] http://www.seagrant.sunysb.edu/articles/t/brown-tide-research-initiative-what-s-new is the source for all material in this section

Reduced groundwater underflow combined with an organically enriched environment provide ideal conditions for the brown tide, allowing it to out-compete other species that rely on inorganic nutrients alone and higher light levels for photosynthesis.



- When hard clam populations were at their peak in Great South Bay in the 1970s, it has been estimated that the entire volume of Great South Bay was "filtered" through the benthic shellfish once every three days. With the dramatic decline in the hard clam population of Great South Bay, by 1993 the estimated time to filter the bay increased to once every 25 days. Field and laboratory results confirm the importance of these benthic filter feeders in helping to control *A. anophagefferens* populations. In tank experiments, under certain conditions, water filtration by hard clams prevented *A. anophagefferens* from blooming. These results suggest that the reduction in benthic filter feeders, such as hard clams, has caused a shift of the dominant grazers on phytoplankton from benthic filter feeders to the zooplankton grazers in the water column. Accordingly, a combination of a healthy population of benthic filter feeders and pelagic grazers could potentially control *A. anophagefferens* abundance and help prevent a brown tide.

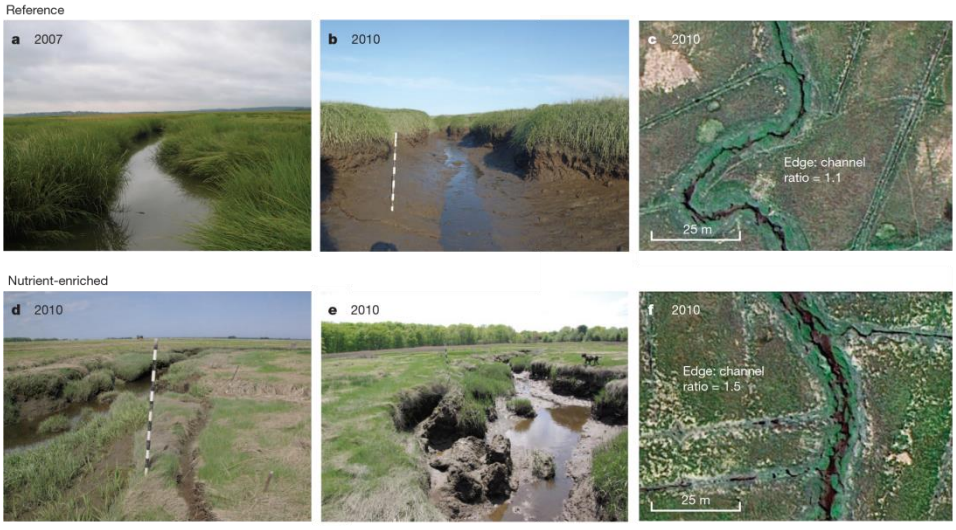
- The red-tide, or **rust tide** organism ***Cochlodinium*** has appeared in Long Island waters every year since 2004, with an earlier than usual appearance in 2013. The Department of Environmental Conservation reported a fish kill at Cases Creek in Aquebogue on Aug. 2, finding killifish, snappers, and black sea bass, all with a coating of "orange slime." Gobler said, "Prior research in my lab has

demonstrated that these blooms are made worse by increased nitrogen into these bays."

- The **red-tide** algae, *Alexandrium*, produces saxitoxin, which causes *Paralytic Shellfish Poisoning,* resulting in numbness and tingling in the face and extremities, followed by headache, dizziness, nausea and a loss of coordination; more severe paralysis, respiratory failure and death can occur (NYSDEC). Saxitoxin accumulates in the tissues of molluscan shellfish, posing a human health threat which causes shellfish beds to be closed to fishing, and income to be lost. Blooms of this species began to occur annually in north shore bays on Long Island, but now regularly impact eastern and south shore bays including Mattituck Creek, Sag Harbor Creek, and Shinnecock Bay as well.

- The algae *Dinophysis* produces okadaic acid, which causes *Diarrhetic Shellfish Poisoning* resulting in gastro-intestinal symptoms which can be dangerous or even lethal in high-risk populations. This algae has also expanded its range on Long Island in recent years and has occurred in record concentrations in western Peconic tributaries.

- Another group of harmful algae, Cyanobacteria, have created harmful blooms with increasing frequency and extent in Suffolk County's fresh waters.



Why Are Protective Salt Marshes Falling Apart?

Too Many Nutrients[14]

- NYS 2100 Commission's report: **"Tidal wetlands can protect coastal communities** from storm damage by reducing wave energy and amplitude, slowing water velocity, and stabilizing the shoreline through sediment deposition."

- A 2013 report by the US Army Corps of Engineers concluded that **vegetated coastal features** such as marshlands **can reduce the effects of surge, waves**, and tsunami propagation.[15] Researchers have concluded that coastal wetland vegetation serves as a natural defense system against storm surges and waves along coastal regions, reducing wave height by 80% over short distances. Waves lose energy as they travel through vegetation.[16,17]

- Salt marshes are among the most biologically productive ecosystems on Earth and they perform many ecosystem services that are highly valued by society. "Salt marshes are a critical interface between the land and sea," Woods Hole scientist Linda Deegan says. "They provide habitat for fish, birds, and shellfish; protect coastal cities from storms; and they take nutrients out of the water coming from upland areas, which protects coastal bays from over-pollution."

- Losses of healthy salt marsh have accelerated in recent decades, with some losses caused by sea-level rise and development. The NYSDEC estimates that there was an **18-36% loss in tidal wetlands** in the Great South Bay between 1974 and 2001.[18] As the only South Shore bay with major riverine input, Great South Bay's living resources have been significantly affected by diminished tributary water quality.

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[14] Deegan LA, Johnson DS, Warren RS, Peterson BJ, Fleeger JW, Fagherazzi S, and Wollheim WM (18 Oct 2012) "Coastal Eutrophication as a Driver of Salt Marsh Loss" *Nature*: doi:10.1038.

[15] Anderson ME, McKee Smith J, Bryant DB, and McComas, RGW. (Sept 2013), "Laboratory Studies of Wave Attenuation through Artificial and Real Vegetation" USACE, "It is generally acknowledged that vegetated coastal features such as wetlands can reduce the effects of surge, waves, and tsunami propagation."

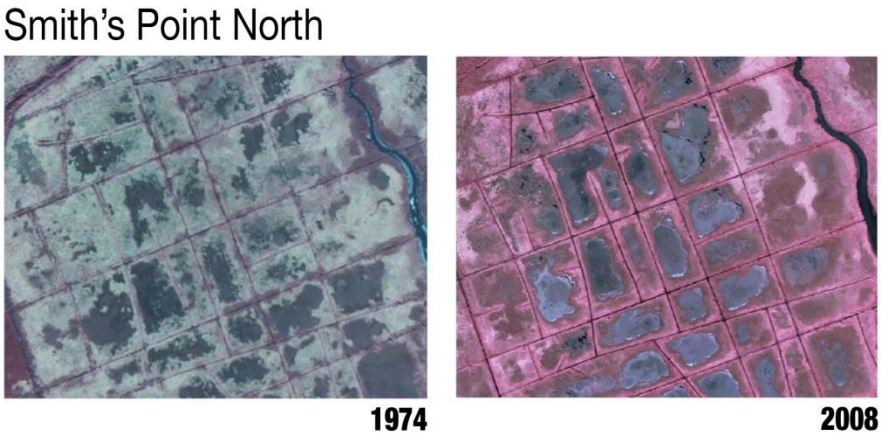
[16] Jadhav, Ranjit and Chen, Qin, "Field Investigation of Wave Dissipation Over Salt Marsh Vegetation During Tropical Cyclone" Coastal Engineering, 2012

[17] Ysebaert, T, Yang, S.,Zhang, L., He, Q., Bouma, T., Herman, P. "Wave Attenuation by Two Contrasting Ecosystem Engineering Salt Marsh Macrophytes in the Intertidal Pioneer Zone" Society of Wetland Scientists 20 Sept 2011

[18] http://www.dec.ny.gov/lands/31989.html

- Based upon 36 years of nutrient enrichment in replicated field experiments, a team of scientists from Louisiana State University's Department of Oceanography and Coastal Sciences, the Coastal Systems Program at the University of Massachusetts-Dartmouth, and the Woods Hole Oceanographic Institution drew the following conclusions: "Enrichment reduces organic matter belowground and may result in a significant loss in marsh elevation equivalent to about half the average global sea level rise rates. Sustaining and restoring coastal emergent marshes is more likely if they receive less, not more, nutrient loading.... The salt marshes most vulnerable to changes in elevation will be those organic-rich salt marshes at the low end of their elevation range and exposed to relatively high nutrient loading.... An example of this situation might be in [neighboring] Jamaica Bay, New York, an estuary that has lost much of its salt marsh to fragmentation, and has had significant marsh dieback (near complete loss of vegetation in salt marsh parcels, with subsequent erosion and down-estuary transport of sediment away from the marsh platform).[19,20]

- Marsh loss through expansion of unvegetated pannes is a widespread phenomenon especially prevalent in northeast estuaries. As these unvegetated areas expand, the vegetated area of marsh and the delivery of ecosystem services from these marshes, like coastal protection from storm surges, are also lost.



[19] Turner, R. E. et al. Salt marshes and eutrophication: an unsustainable outcome. Limnol. Oceanogr. 54, 1634–1642 (2009).
[20] Hartig, E. K., et al. Anthropogenic and climate-change impacts on salt marshes of Jamaica Bay, New York City. Wetlands 22: 13–31. (2002)

- According to Coastal Resilience 2.0, a project of The Nature Conservancy, from '74-'08 Smith's Point marsh diminished by 28.31% and Gardiner Park by 33.67%.

- Excessive nitrogen has been shown to have a direct effect on seagrass by promoting growth of microalgae which shade it and macroalgae which out-compete it. Thousands of acres have died off in Long Island's Eastern and South Shore estuaries. According to the NYS Seagrass Taskforce, historic photography and records indicate that there may have been as much as **200,000 acres of seagrass in 1930** in Long Island bays and harbors; only about **22,000 acres remain**.

- Global decrease in estuarine and coastal ecosystems (ECEs) is known to affect at least three critical ecosystem services (Worm et al. 2006): the number of viable (non-collapsed) fisheries (33% decline); the provision of nursery habitats such as oyster reefs, seagrass beds, and wetlands (69% decline); and filtering and detoxification services provided by suspension feeders, submerged vegetation, and wetlands (63% decline). The loss of biodiversity, ecosystem functions, and coastal vegetation in ECEs may have contributed to biological invasions, declining water quality, and decreased coastal protection from flooding and storm events.[21]

- Like wetland systems, seagrass beds dampen wave energy and stabilize sediment, protecting Long Island's coastal communities from the impact of storms and flooding. "Larger seagrass bed width in the direction of wave propagation results in higher wave attenuation, and relative wave attenuation increases as incoming wave height increases…. A few authors have postulated that seagrass beds could reduce the energy that reaches shorelines, and potentially protect shorelines from being eroded"[22]

- Wetlands and seagrass beds are also critical to the resiliency of Long Island's marine food web to the impacts of storms and climate change, and ecological threats like eutrophication and harmful algal blooms. By providing the nursery habitat necessary for reproduction of key species at the base of the food web, these habitats are essential to the success of recreationally and commercially important finfish and shellfish.

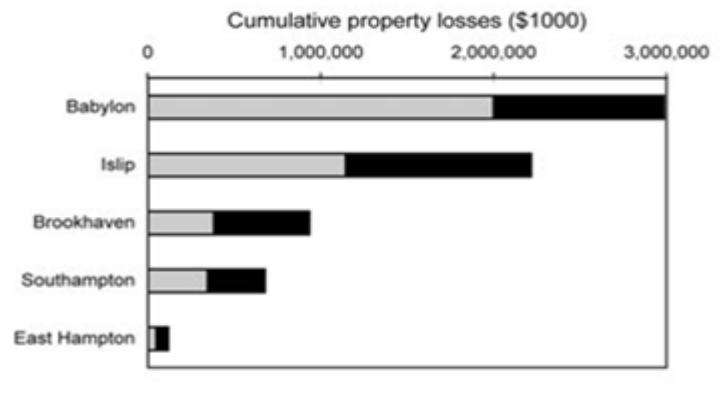
[21] Barbier EB, et al. "The value of estuarine and coastal ecosystem services." Ecol Monogr 2011;81:169–193.
[22] Chen S-N,et al. "A nearshore model to investigate the effects of seagrass bed geometry on wave attenuation and suspended sediment transport." Estuaries Coasts 2007;30:296–310.

- Coastal wetlands reduce the damaging effects of hurricanes on coastal communities by absorbing storm energy in ways that neither solid land nor open water can. The mechanisms involved include decreasing the area of open water (fetch) for wind to form waves, increasing drag on water motion and hence the amplitude of a storm surge, reducing direct wind effect on the water surface, and directly absorbing wave energy. Since marsh plants hold and accrete sediments, often reduce sediment resuspension, and consequently maintain shallow water depths, the presence of vegetation contributes in two ways: first by actually decreasing surges and waves, and also by maintaining the shallow depths that have the same effect.[23]

- "Coastal habitats – such as seagrasses, kelp forests, coral reefs, mangroves, wetlands, and dunes – can provide protection from erosion and inundation due to storm surge. Loss of these nearshore habitats can have dire implications, including damage to coastal infrastructure, private property, and loss of human life…. Existing coastal habitat protection laws aimed at reducing eutrophication of receiving waters also keeps in check those same biophysical processes that exacerbate ocean acidification." [24]

- "The number of people, poor families, elderly and total value of residential property {exclusive commercial} that are most exposed to hazards can be reduced by half if existing coastal habitats remain fully intact. Coastal habitats defend the greatest number of people and total property value in Florida, New York and California…. Large expanses of coastal forests and wetlands, oyster and coral reefs, dunes and seagrass beds (Supplementary Fig. S4) are critical for protecting the eastern seaboard…. Variation among counties in the value of property now protected by coastal habitats is substantial, ranging from US$0 (for example, Jefferson, Florida), to more than US$20 billion in ***Suffolk*** and Kings, New York." - Arkema, Katie K, et al, "Coastal habitats shield people and property from sea-level rise and storms," Nature Climate Change, July, 14, 2013.

[23] Costanza R, et al. "The valueofcoastalwetlandsforhurricaneprotection." Ambio 2008;37:241–248.
[24] Ruckelhaus, M, et al, "Securing ocean benefits for society in the face of climate change," Marine Policy, Jan 6, 2013



The Community Vulnerability Assessment Tool (NOAA) identifies block groups that are at most risk, assessing damages resulting from a category 3 hurricane (gray) compounded .5m sea-level rise (black),[25] + values of tidal marshes.[26]

Case #1: The Forge River

"It's the worst case of anoxia [absence of oxygen] I have seen."

-Larry Swanson, coastal oceanographer, Marine Science Research Center, (New York Times, 2/28/08)

"The **Forge River** has been a distressed estuary since the early part of the 20th century. Extensive duck farming in the 20th century along the banks of the Forge River and high density residential development contributed to the high-nitrogen sediment load that remains. Residential development booms in the Mastic Beach area in the early 20th century and on the peninsula in the mid-20th century added thousands of onsite wastewater treatment systems (cesspools and septic

"Assessing future risk: quantifying the effects of sea level rise on storm surge risk for the southern shores of Long Island, New York," Nat Hazard 2011: 727-745.

[26] Bromberg, K, et al, "Centuries of human driven change in salt marsh ecosystems," AnnRvw Mar Sci 2009; 1-117-141.

systems) inside the Forge River watershed. Residents of the Forge River watershed continue to report **malodorous conditions and fish kills** while local scientists report hypoxic and anoxic conditions that are inhospitable to aquatic life.

"Nitrogen loading, in order of quantity delivered to the estuary, is from residential septic systems, the duck farm, private treatment plants, release from the sediments, residential and agricultural fertilizer use, and to a lesser extent atmospheric deposition and stormwater. The Characterization report concludes that the severe dissolved oxygen depletion in the Forge River is primarily due to algal blooms fed by exceptionally high nitrogen. The majority of the nitrogen entering the estuary is from groundwater that is years or tens of years old and therefore reflects historic inputs. Groundwater continues to receive nitrogen from septic systems and fertilizer use. Dense algal blooms will recur annually, particularly during the summer, as long as new and historic nitrogen loading and circulation remains unchanged…. The **Forge River has a history of water quality impairments** and has experienced chronic hypoxia and fish kills. In 2006, using methodology established by the Federal Clean Water Act, the river was categorized as a waterbody that did not meet water quality standards, and was placed on **New York State's "303(d) list**." – Cameron Engineering & Associates, LLP & CH2MHill, Forge River Watershed Management Plan, March 2012.

"The sheer volume of groundwater that feeds the Forge River and its tributaries, especially in high-density areas, delivers a tremendous nitrogen load, likely far more than, say, a concentrated amount from a point-source discharge" -Robert Waters, supervisor, Suffolk County Department of Health Services' Bureau of Marine Resources (2/28/08).

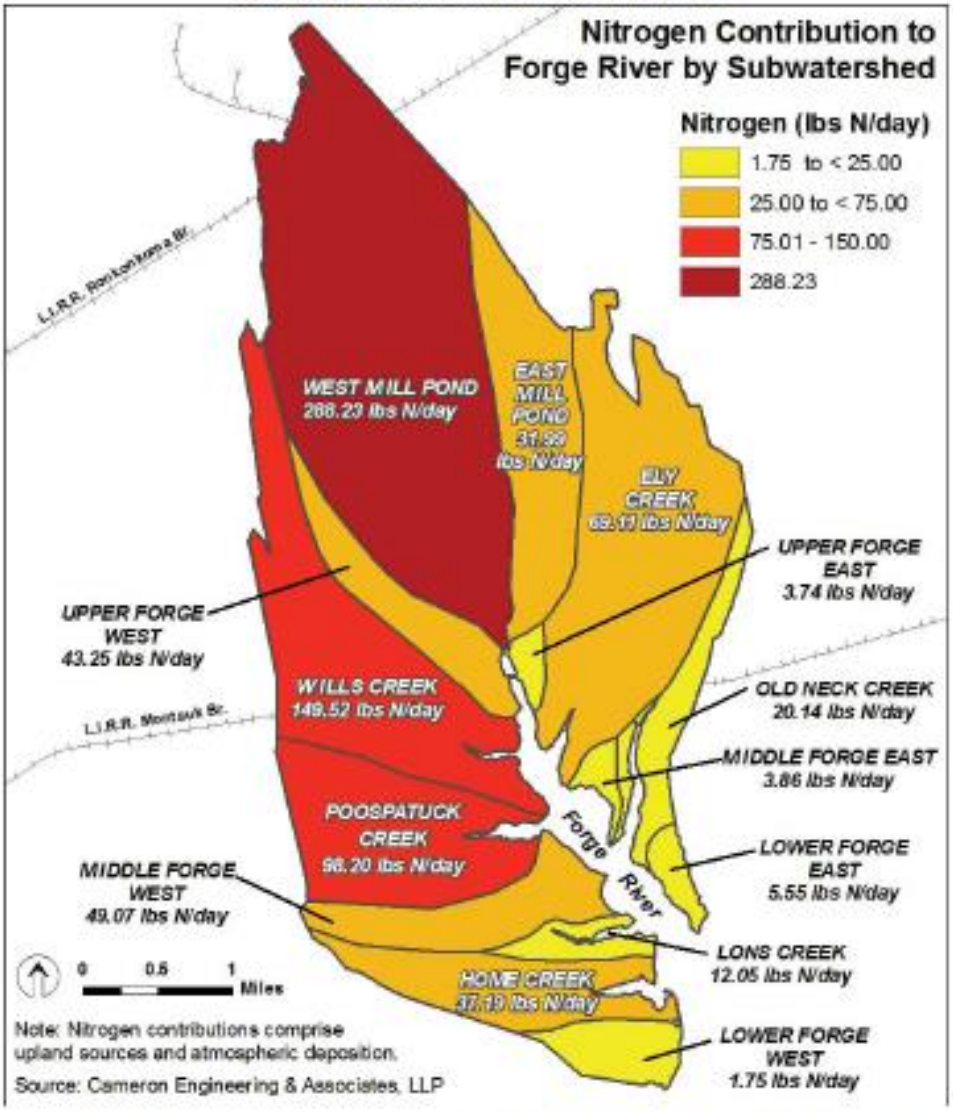
"The eastern boundary of the study area consists of the Forge River and its tributaries. The River is an estuary that has been identified as an impaired water body and is included in the New York State Department of Environmental Conservation (NYSDEC) 303 (d) list for pathogens, nitrogen and dissolved oxygen/oxygen demand. Incorporation of the densely developed residential area in the western part of the Forge River watershed to **the potential Sewer District boundary provides a significant environmental benefit** which helps to satisfy the stakeholder goals associated with improving the water quality of the Forge River."

"Many homes close to the estuary are at elevations so low that there is little unsaturated soil between the on-site system and groundwater. Here there is no opportunity for soil bacteria or roots to act on the nitrogen prior to its release to groundwater and then the estuary. Several hundred homes are less than nine feet

above groundwater, the minimum currently required by the County for on-site wastewater treatment systems (p. 11-54).

"If groundwater nitrogen were significantly reduced, algal blooms would be less frequent and less intense. Less intense and fewer algal blooms would reduce the deposition of organic matter to the sediments. Activity by aerobic sediment bacteria would slow, releasing less nitrogen back to the water table. Anaerobic bacteria located deeper in the sediment where oxygen is depleted, would denitrify remaining organic material and release nitrogen to the atmosphere. Reducing groundwater nitrogen inputs to the estuary is one of the most effective ways to improve water quality in the Forge River (p. 11-57)."

Figure 11-40. Nitrogen Contributions by Subwatershed



Note: The Jurgielewicz Duck Farm ceased operations just prior to the publication of this report. Nitrogen loading will be re-calculated as part of the formulation of the TMDL without the input from the duck farm.

Water Resource Management Plan Goals

The goals and objectives summarized on **Table ES-1** are targeted to protect and improve ground and surface water quality in the coming years, recognizing that maintenance of these invaluable resources is vital to the health and economic well-being of Suffolk County residents, and to enable provision of a healthy and safe supply of potable water to County residents through 2030. Although it is acknowledged that full achievement of these goals within the next twenty years may not be realized, the recommendations presented in this document provide the framework for continued improvement of the County's water resources and provision of a reliable, high quality potable supply for future generations.

The goals and objectives are consistent with County policy declarations that are articulated in the Suffolk County Sanitary Code:

...§760-701: *" The designated best use of all groundwaters of Suffolk County is for public and private water supply, and of most surface waters for food production, bathing and recreation .... it is hereby declared to be the policy of the County of Suffolk to maintain its water resources as near to their natural condition of purity as reasonably possible for the safeguarding of the public health, and to that end, to require the use of all available practical methods of preventing and controlling water pollution from sewage, industrial and other wastes, toxic or hazardous materials, and stormwater runoff" and*

760-401: " the policy of the County of Suffolk is to protect the groundwater to insure the availability of an adequate and safe source of water supply for generations to come by: enforcing the local, state and federal laws regulating water supply; promoting the extension of public water supply to all areas of the County; maintaining a process of groundwater planning; carrying out research and development in the field of alternatives to community water supply; and by promoting education and acceptance of the importance of groundwater management and protection."

Table ES-1
Groundwater Resource Management Goals

GOAL 1: *All groundwater shall be in compliance with the stricter of New York State Ambient Groundwater standards and guidance values or Maximum Contaminant Level Goals (MCLGs) to the greatest extent feasible and practical. Water quality that is better than the existing standards should be preserved, to the greatest extent feasible and practical.*

GOAL 2: *Nitrogen loading should be reduced to the greatest extent feasible and practical for the protection of current and future drinking water supplies and to restore/maintain ecological functions of streams, lakes, estuaries and marine waters. Arrest and reverse the trend of increasing nitrogen concentrations in ground and surface waters to the greatest extent feasible and practical by decreasing the nitrogen loading from septic systems and fertilizers.*

GOAL 3: *Concentrations of other regulated and unregulated contaminants in groundwater should be minimized to the greatest extent feasible and practical, to protect current and future drinking water supplies and to restore/maintain ecological functions of streams, lakes, estuaries and marine waters. Reduce the discharge of volatile organic compounds and other regulated and unregulated contaminants to groundwater.*

GOAL 4: *Land use patterns should be consistent with the protection of the County's groundwater and surface water resources, including the protection of existing and future drinking water supplies.*

GOAL 5: *Groundwater quality and quantity should be maintained to protect and preserve the County's drinking water supply and natural resources.*

GOAL 6: *Groundwater levels should be maintained to protect and preserve the long term sustainability and ecological functions of existing surface water resources.*

GOAL 7: *Existing programs to monitor, prevent contamination of, and manage Suffolk County groundwater resources should be enhanced and improved to provide the data and programs necessary to protect the groundwater resource that provides the County's drinking water supplies, and to provide the information necessary to develop a long term approach to mitigate expected impacts of sea level rise upon existing infrastructure.*

Drinking Water Supply Goals

GOAL 1: *All County residents should have access to safe potable water that is in compliance with drinking water MCLs, USEPA health advisories and New York State guidance levels.*

GOAL 2: *A community public water supply should be available to all Suffolk County residents.*

GOAL 3: *Residential and commercial irrigation should be managed to reduce peak demands on water supply infrastructure.*

EXECUTIVE SUMMARY

Surface Water Resource Management Goals

***GOAL 1**: Surface water quality should be in compliance with New York State ambient water quality standards and guidance values for surface waters, and support human health, aquatic life and recreational and aesthetic values in accordance with their best usage classifications*

***GOAL 2:** Groundwater nitrogen inputs to the County's surface waters should be reduced, consistent with the goals of the Long Island Sound Study (LISS), Peconic Estuary Program (PEP) and the South Shore Estuary Reserve (SSER) programs – to protect, preserve and restore the estuaries for long term sustainability of the resource.*

***GOAL 3:** Ground and surface water nitrogen management plans and water quality management plans should be integrated to minimize the impacts of VOCs, pesticides, pathogens and inorganics on human health and the ecology of Suffolk County's wetlands and aquatic ecosystems.*

***GOAL 4:** Harmful algal blooms resulting from water quality impairments from groundwater and storm water discharges should be identified and prevented, and monitored and managed to minimize impacts.*

***GOAL 5:** Existing programs to monitor, prevent contamination of, and manage the County's surface water resources should continue to be strengthened to provide the information necessary to protect, preserve and restore the County's surface water features for long term sustainability.*

Wastewater Management Goals

***GOAL 1**: Improve groundwater quality to maintain a potable water supply to serve existing and future populations by reducing effluent nitrogen loads from existing and future onsite sewage disposal systems and sewage treatment plants.*

***GOAL 2:** Improve surface water quality to increase coastal resiliency and rehabilitate and maintain a vibrant coastal ecosystem by improving dissolved oxygen levels, reducing harmful algal blooms, and controlling nutrient levels through the reduction of effluent wastewater nitrogen loads from existing and future onsite sewage disposal systems and sewage treatment plants.*

***GOAL 3:** Reduce and/or eliminate the impacts of pharmaceuticals and personal care products from wastewater effluent for increased public health and marine life protection.*

***GOAL 4:** Provide development opportunities for continued economic growth to support future population growth while limiting wastewater nitrogen discharge.*

***GOAL 5:** Improve operations and maintenance of onsite sewage disposal systems and sewage treatment plants to maintain compliance with effluent nitrogen limit and achieve more stringent goals where feasible and appropriate to protect ground/surface waters.*

***GOAL 6:** Provide funding sources to the residents of Suffolk County to permit affordable upgrades to existing onsite sewage disposal systems or connection to community sewers.*

***GOAL 7:** Promote the reuse of effluent wastewater for irrigation and grey water uses to preserve the volume of potable groundwater water supply to serve anticipated future population growth.*

Source Water Assessments

Recognizing that activities in a water supply's source water area have a significant potential to affect quality of the potable supply, the New York State Department of Health (NYSDOH) directed the development of Source Water Assessments for all public supply wells that existed in Suffolk County in 2003.

As part of this project, updated source water assessments were completed for all existing and planned community supply wells identified by Suffolk County water suppliers. The source water assessments have three major components:

- *Use of three dimensional groundwater flow and contaminant transport models to delineate the area contributing recharge to each well (source water area), and to estimate the time of travel from the water table to the well screen;*
- *Use of GIS and extensive databases to identify the prevalence of each contaminant category within the source water area, based upon land uses and the presence of potential point sources of contamination;*
- *Evaluation of the susceptibility of each well to potential contamination, based upon contaminant prevalence, contaminant fate and transport characteristics, and travel time to the well screen.*

Groundwater Quality

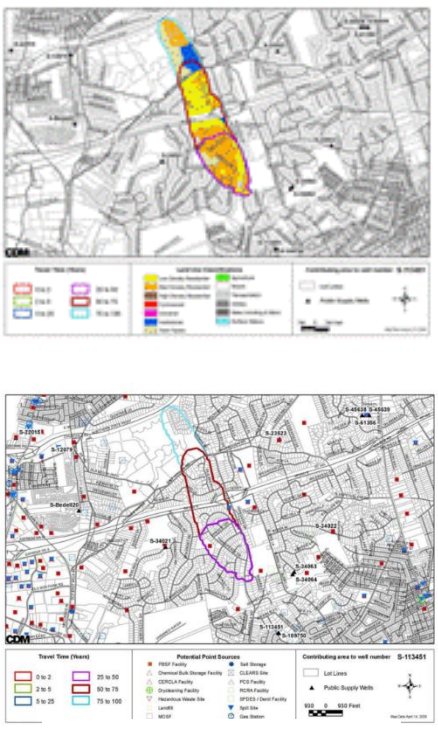
Groundwater throughout most of the County is of generally very high quality In fact, the ***1987 Comp Plan*** identified only four inorganic constituents chlorides, sulfate, iron and manganese – that exceed drinking water standards in native groundwater in some parts of the aquifer system. Although Suffolk County's 1.5 million residents live directly above the sole source aquifer, the quality of the County's groundwater remains remarkably good due to the concerted efforts of water resource managers. Nevertheless, review of water quality data reveals that concentrations of many contaminants introduced to the groundwater by human activity have increased over the past 25 years since the ***1987 Comp Plan*** was completed.

Suffolk County has long recognized that land uses and activities occurring above ground can have a direct impact upon groundwater quality, as recharging precipitation can transport dissolved contaminants from materials used, stored or disposed of at the ground surface down through the unsaturated zone to the underlying aquifer. The sands, silts, gravels and clays that make up the unsaturated zone and the aquifer system function as a large sand filter that has helped to limit the impact of many of these contaminants on groundwater quality. While implementation of regulations and management activities protecting groundwater quality have been effective in reducing the impacts of human development, the continued effects of overlying land uses on groundwater quality in the County are evident.

New York State Department of Environmental Conservation (NYSDEC) has established groundwater quality criteria for over one hundred contaminants, and improved analytical capabilities allow detection of hundreds of additional contaminants, at increasingly lower concentrations. This study focused on contaminants that have been identified in Suffolk County groundwater – nitrate, which has long been identified as the inorganic parameter causing the most widespread concern; volatile organic compounds (VOCs) and pesticides, which have previously been identified as a serious threat to groundwater quality, and additional contaminants of concern, whose occurrence and health impacts are still being studied, such as perchlorate and pharmaceuticals and personal care products (PPCPs).

A comparison of water quality data collected from community supply wells that were sampled in both 1987 and in 2013 reveals that concentrations of nitrate are increasing in all three aquifers, as a result of sanitary wastewater discharges and fertilization practices. A comparison of average nitrate concentrations from all community supply wells that existed in 1987 and in February 2013 shows that nitrate concentrations, on average, have increased

more than 1 mg/L in the Upper Glacial aquifer and about 0.76 mg/L in the Magothy 6 mg/L in 83 percent of all community supply wells in 2013. Less than one percent of all raw water samples collected from community supply wells exceeded the 10 mg/L drinking water Maximum Contaminant Level (MCL). Private well sample results showed that almost one third of the private wells tested contained less than 1 mg/L nitrate, approaching native groundwater quality, and nitrate concentrations in nearly 75 percent of the private wells were less than or equal to 6 mg/L. However, nitrate levels in nearly ten percent of the 9,473 private wells sampled between 1997 and 2013 exceeded the 10 mg/L MCL; these impacted wells were primarily located in agricultural areas of the north and south forks and in pockets of the more densely developed unsewered areas of the north and south shores. In summary, while groundwater throughout most of the County continues to comply with the nitrate MCL, the data indicates that the quality of the aquifer has been particularly evident in the shallow zones of the aquifer that are utilized by private wells.

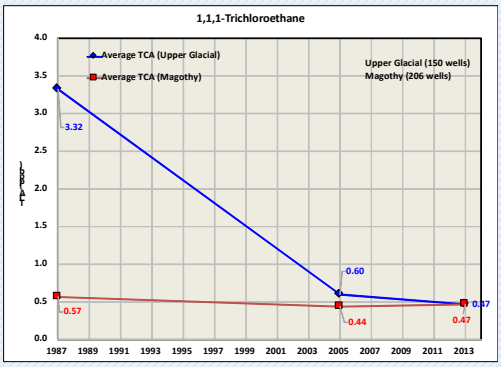


SCDHS routinely tests groundwater for over 90 VOCs including four of some of the most commonly detected in the County (tetrachloroethene or PCE; trichloroethene or TCE; 1,1,1-trichloroethane or TCA, and MTBE). Increased detections of VOCs throughout the County, albeit at low concentrations, indicate widespread use and release to the environment. Isolated areas of higher levels of VOC contamination are associated with industrial, commercial, transportation or institutional land uses.

The data shows that PCE has not been detected in about 92 percent of the supply wells sampled from 2009 through 2013, and PCE levels in raw water samples collected from over 98 percent of the supply wells tested remain below the drinking water standard of 5 µg/L. However, a comparison of PCE levels in wells that were sampled in both years indicates that PCE was detected in over three times as many wells in 2013 as in 1987 and average PCE concentrations doubled in the same set of Upper Glacial and Magothy wells.

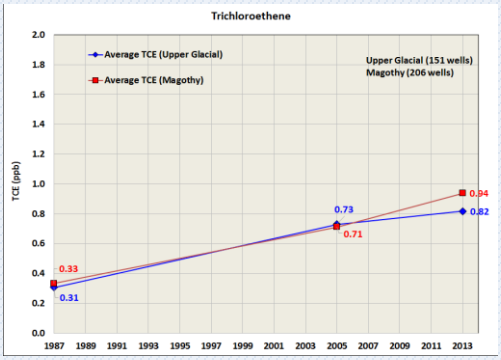
Source Water Assessments Used Computer Models, Land Use Data, Potential Point Source Locations, and Contaminant Fate and Transport Characteristics to Assess the Susceptibility of Each Community Supply Well to Contamination.

1,1,1-TCA Concentrations in Public Supply Wells 1987-2013



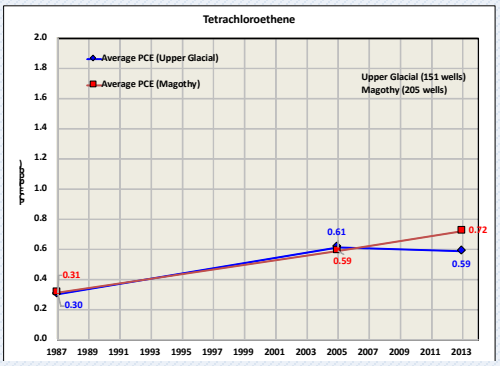
- 1980:Banned as cesspool additive
- 1996:US manufacturing ban
- Concentrations and the # of impacted wells have decreased in both aquifers

TCE Concentrations in Public Supply Wells 1987-2013



- # of impacted wells more than doubled
- Average TCE concentrations have nearly tripled in both aquifers

PCE Concentrations in Public Supply Wells 1987-2013



- The # of impacted wells doubled
- Average PCE concentrations approximately doubled in both aquifers

The analysis of TCE identifies a similar trend of increasing detections. Although TCE was not detected in over 90 percent of the wells tested in 2013, and concentrations in over 98 percent of supply wells remained below the drinking water standard of 5 µg/L, TCE was detected in more wells – and at higher average concentrations – in 2013 than in 1987. Average TCE concentrations nearly tripled from 0.31 µg/L to 0.80 µg/L in the 160 upper glacial public supply wells that were sampled in both 1987 and 2013. Average TCE concentrations also nearly tripled from 0.33 µg/L to 0.93 µg/L in the same 211 Magothy wells sampled in both 1987 and 2013.

A completely different trend was observed for 1,1,1-TCA, a chemical previously used as an additive in cesspool cleaners prior to a 1980 ban in Suffolk County, and a chemical which also received a domestic manufacturing ban under the United Nations Montreal Protocol in 1996. Resultant reductions in the release of this contaminant from the bans resulted in marked improvement in water quality for this contaminant. Although very low levels of TCA were reported in all aquifers; TCA levels and the number of impacted wells have declined since the last assessment was performed in 2005. All but two public supply wells, one Upper Glacial and one Magothy, met the drinking water standard of 5 µg/L based on testing in 2013. Average TCA concentrations decreased from 3.16 µg/L to 0.47 µg/L in the 159 public supply wells screened in the upper glacial aquifer that were tested in both 1987 and 2013. Average TCA concentrations in the Magothy supply wells tested from both years also decreased, although not as dramatically, from 0.57 µg/L to 0.47 µg/L.

The former gasoline additive MTBE, which has been banned in New York State since 2004, also experienced fewer detections in public and private supply wells. In 2005, MTBE was detected in 16% of the public supply wells sampled and in 2013 the number of detections dropped to only 49 public wells or about 5% of the wells sampled. The presence of MTBE was detected in almost 10 percent of the private wells SCDHS tested from 1997 through 2007, and 1.4% exceeded the drinking water standard of 10 ppb. In 2013, MTBE was detected in less than 5% of raw groundwater samples collected from all supply wells, marking a significant improvement.

Pesticides also continued to be detected in groundwater downgradient of agricultural areas. In recent years, extensive investigations conducted by SCDHS, including sampling of public, private and monitoring wells, have identified the presence of over 100

Suffolk County Public & Environmental Health Laboratory Highlights

Types of Samples Analyzed:

- Public & private drinking water
- Groundwater monitoring wells
- Bottled water
- Creeks, lakes, etc.
- Bathing beaches, bays, etc.
- Sewage
- Hazardous waste (contaminant investigations & clean-ups)

Major Accomplishments:

- Approximately 60,000 tests performed annually
- The only lab on Long Island approved to test drinking water for radionuclides
- First lab to detect the gasoline additive MTBE in potable water
- Developed an analytical method for the analysis of the herbicide Dacthal
- Nationally known as first lab to detect carbamate pesticides in drinking water on Long Island
- The only lab on Long Island analyzing for Brown Tide using an approved method
- Analytical capability to test for 150 pesticides and metabolites, more than any other laboratory on Long Island

Goals:

- Increase drinking water analytical capability from 298 to ~380 contaminants
- Contaminants of interest include: PPCP's, pesticides, radionuclides, and 1,4-dioxane

pesticide-related compounds in Suffolk's groundwater. SCDHS found at least 141 community supply wells (approximately 16 percent of the wells sampled) were impacted by pesticide-related contaminants during the period from 1997 through July 2014.

Emerging Environmental Issues

New, more sophisticated analytical techniques have enabled the County to detect the presence of contaminants at parts per trillion levels, much lower concentrations than could previously have been identified. SCDHS has closely monitored available information on emerging contaminants and has analyzed thousands of samples from community, non-community and private wells over the last decade. SCDHS monitoring has identified the presence of trace levels of PPCPs in about 2.5 percent of the samples collected from community supply wells and in an average of 6 to 10 percent of the samples collected from the shallower non-community and private wells. As new information on the detection, fate and transport characteristics, or potential effects of PPCPs is published nearly every day, SCDHS continues to monitor the literature and regulatory initiatives to assess the need to respond to any potential public health concerns. SCDHS must continue to monitor and prepare for emerging and evolving environmental issues such as Unregulated Contaminant Monitoring Rule compounds including 1,4-dioxane and pharmaceuticals and personal care products, soil vapor intrusion, composting, microplastics, and septage management.

Most PPCPs are not currently monitored – and in fact, cannot be monitored at this time. There are potentially hundreds, if not thousands of PPCPs and their metabolites and breakdown products that may be released to the environment. It should not be necessary to monitor for all of these parameters, however the subset of compounds with potential human-health impacts that ultimately should be monitored has not yet been identified. In addition, analytical methods to detect the extremely low levels of some PPCPs and their metabolites that may exist in the environment are not yet available. While analytical protocols to detect some PPCPs have been developed, cost effective methods to rapidly detect the presence of many of the other compounds that may be present have not.

SCDHS is currently in the process of developing the analytical capability to test for 1,4-dioxane in anticipation of a specific federal and/or state drinking water standard. This is considered an emerging contaminant of concern and the chemical is currently regulated as an Unspecified Organic Contaminant in drinking water at 50 µg/L in New York State. 1,4-dioxane has been used as a solvent stabilizer and is present as a byproduct in personal care products such as shampoos and cosmetics. Based on a preliminary evaluation, 1,4-dioxane

appears to be of particular concern in Suffolk County due to the presence of historic sources, groundwater plumes, and the nature of the sandy, sole source aquifer. As of the October 2014 United States Environmental Protection Agency (USEPA) data release from nationwide public water supply monitoring in 2013 and 2014, 31 out of the 40 public water suppliers in New York State with detections of 1,4-dioxane were on Long Island. The highest concentration thus far of 1,4-dioxane in a public water supply throughout the nation was also on Long Island. Suffolk County's largest water supplier, SCWA, has detected this contaminant in approximately 40% of their public supply wells at concentrations of up to 15.2 µg/L.

Microplastics are another emerging contaminant being studied by SCDHS. These are plastic particles, usually made of polyethylene or polypropylene, and less than 5 millimeters in any one direction. Microplastics or microbeads are commonly found in personal care products such as toothpaste, creams, lotions and cosmetics. They have been in use by manufacturers of these products for approximately 10 years. Microplastics can be released to the environment by sewage treatment plants which discharge to surface waters. These tiny plastic particles can then adhere to toxic chemicals such as poly aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), etc. and bioaccumulate in animals upon ingestion. There are many alternatives available to manufacturers including rice, seeds, salt, sugar, bark, cornmeal, oats and shells.

Groundwater Quality and Land Use

Compared to many sources of water supply throughout the country, Suffolk County's groundwater supply remains for the most part, a high quality source of potable water, despite the impacts of the 1.5 million people who live in the watershed. The combined efforts of programs to protect the aquifer system at the federal, state, county and town levels have been very successful in controlling the impacts of development on groundwater - although the continual gradual decline of groundwater quality indicates that additional efforts are required.

As part of this study, the County's calibrated groundwater models were used to delineate the ground surface area contributing recharge or source water for each of the County's 704 existing and planned community supply wells, shown on **Figure ES-1**. The contributing area maps are used frequently by SCDHS as a water resource management tool in evaluating potential receptors from known or suspected contamination, during the review of applications for wastewater management systems, and during evaluation of the transfer of development rights. Using Geographic Information Systems (GIS), these contributing areas were overlain upon land use mappings provided by the SCDEDP as well as

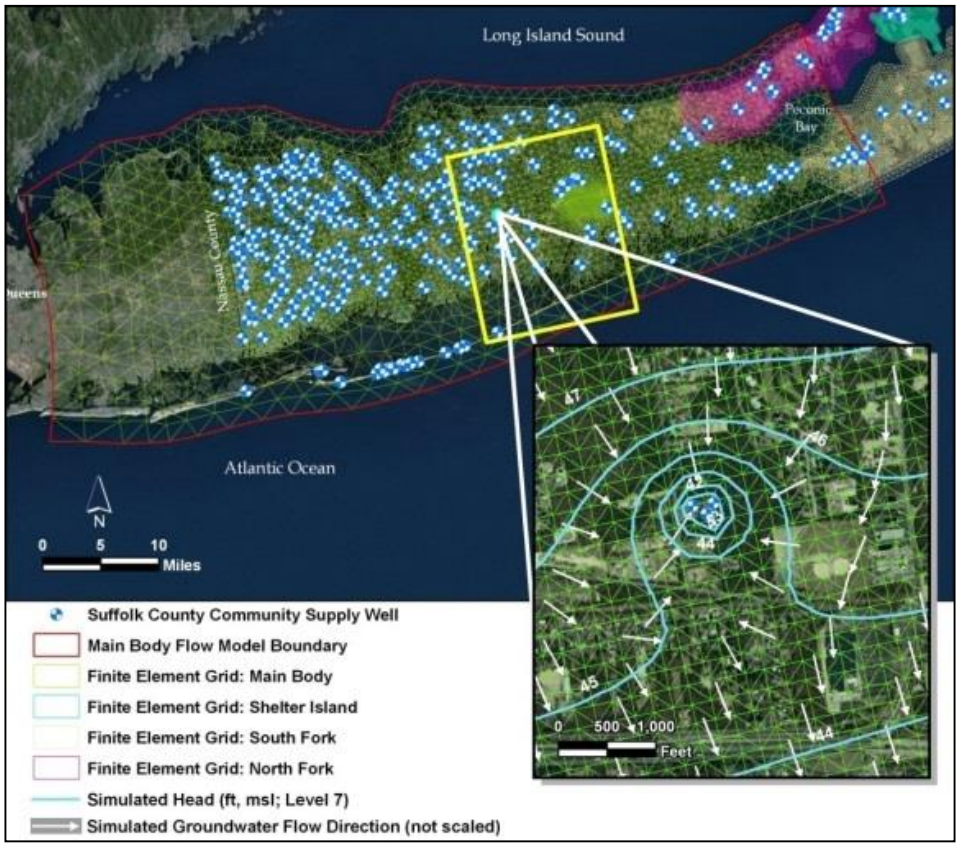
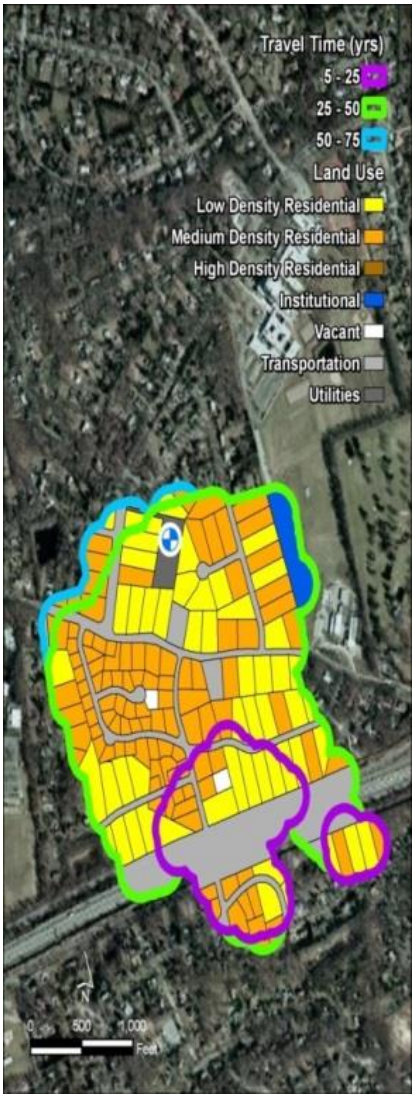


Figure ES-1 Calibrated three-dimensional groundwater and salt water intrusion models were used to develop source water assessments for each community supply well, to help to understand the relationships between land use and groundwater quality and groundwater and surface water resources.

mappings of potential point sources of contamination developed from databases maintained by SCDHS, NYSDEC and the United States Environmental Protection Agency (USEPA). These potential point sources are facilities or properties that have the potential to release contamination to groundwater based on knowledge of the materials used, stored, or disposed of on-site. Based upon the fate and transport characteristics of contaminants commonly associated with the land use types and facilities present within each well's contributing area, and the simulated time of travel from the water table to the supply well's screen, each public supply well's susceptibility to contamination by microbials, nitrates, VOCs and pesticides was assessed and documented.



Historical land uses within a community supply well's contributing area and travel times from the water table to the well screen were used to relate land use to groundwater quality.

The susceptibility ratings resulting from the updated source water assessment analyses show that the majority of Suffolk County community supply wells are vulnerable to nitrate contamination; this demonstrates a need for additional groundwater protection measures. Due to the widespread use of VOCs in the County, the susceptibility of nearly seventy percent of community supply wells is rated as high or very high for contamination by VOCs. Susceptibility to pesticides is rated at low to medium throughout most of the County, except on the North Fork, where community supply wells are highly or very highly susceptible to pesticide contamination introduced to the aquifer by the agricultural lands present. Because it takes years – or decades in some cases – for recharging groundwater to reach a supply well screen, historical land uses can also have a significant impact upon water quality at a well. The relationship between historical land use types within supply well contributing areas and well water quality was also evaluated as part of this study.

On a County-wide basis, sanitary wastewater disposal and fertilization are the two most significant sources of nitrogen loading to the groundwater system. Sanitary wastewater management is one of the most important groundwater resource protection issues facing Suffolk County in both existing developed areas and in currently undeveloped areas. Prior to extensive development, private wells were used to withdraw potable supply from the aquifer; most of the water withdrawn was returned to the aquifer system via on-site cesspools or septic systems. The recharging sanitary wastewater introduced nitrogen and bacteria to the aquifer system, but this was successfully diluted by the greater volume of recharging precipitation and did not cause widespread impacts. Eventually, the sanitary wastewater recharged by more and more residents exceeded the assimilative capacity of the resource in densely developed areas, causing noticeable impacts to the aquifer, drinking water supply, and surface water ecology, and prompting implementation of wastewater collection and treatment systems.

Recognizing the impacts that densely developed unsewered areas have on groundwater and surface water quality, Suffolk County has implemented sanitary sewering programs, and through Article 6 of the County Sanitary Code, established maximum allowable residential densities of one acre in Groundwater Management Zones (GMZ) III, V and VI and ½ acre in GMZs I, II, IV, VII and VIII for new developments that do not include wastewater treatment and disposal facilities. Water quality data and groundwater model simulations show that unsewered areas where property sizes are smaller than one acre are likely to cause groundwater nitrogen concentrations that exceed GMZ target levels of 6 mg/L. Water quality data and groundwater modeling also show that property sizes of ¼ acre or smaller significantly increase the risk of exceeding the 10 mg/L nitrate MCL as shown by **Figure ES-2**. These model

An evaluation of the impacts of historical land use and nitrate concentrations revealed that:

- *Nitrate levels were lowest in wells with contributing areas comprised primarily of open space.*
- *Nitrate levels in wells with sewered contributing areas were lower than nitrate levels in unsewered areas.*
- *Groundwater nitrogen levels increase in unsewered areas as housing density increases.*
- *Wells with contributing areas that comply with the density requirements established by Article 6 of the County Sanitary Code complied with target nitrate concentrations.*
- *Agriculture remains a major source of nitrate contamination, particularly on the North Fork; nitrogen loadings are crop-specific.*

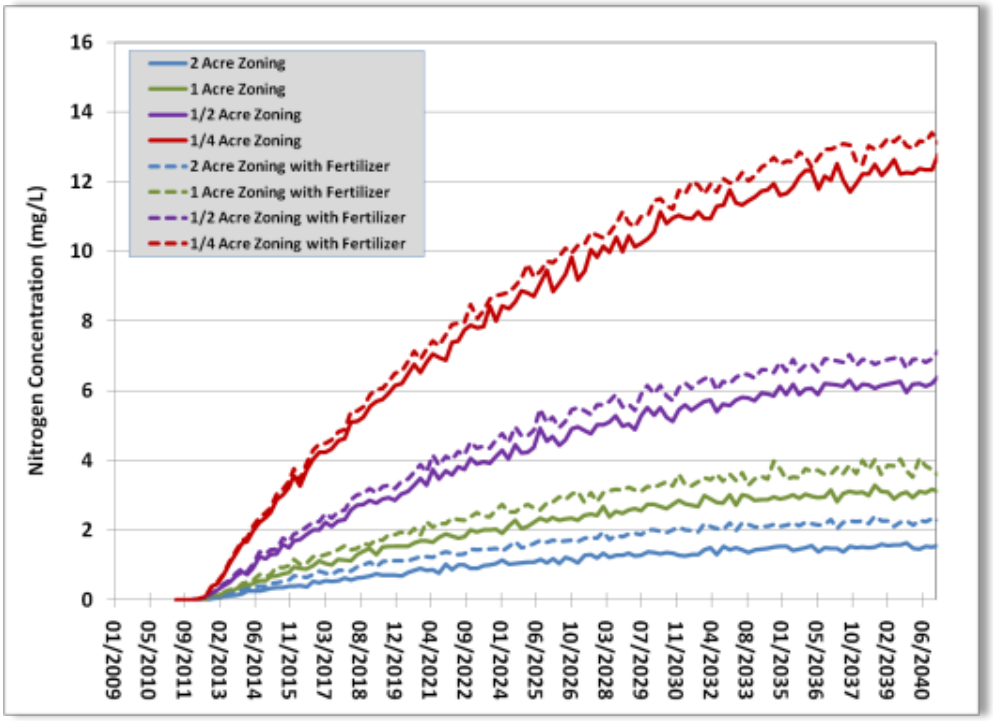


Figure ES-2 Groundwater models were used to assess the impacts of hypothetical unsewered residential areas of various densities upon nitrate concentrations in downgradient groundwater.

simulations of nitrogen levels are higher than previously planning studies because roadways (which would have covered twenty to twenty-five percent of the land area) were not incorporated into the evaluation. Incorporation of roadways would have reduced the overall nitrogen load included in the model, as well as the resulting nitrate concentration.

Data provided by the SCDEDP shows that over sixty percent of residential parcels in the County are less than or equal to the minimum ½ acre size required by Article 6, and indeed, many existing residences with on-site wastewater disposal systems had already been constructed on smaller parcels prior to 1980 when Article 6 was enacted. The observed nitrogen levels in groundwater, which have continued to increase since the ***1987 Comp Plan***, result from a combination of the Article 6-compliant and the older non-compliant parcels.

Sources of VOC contamination can include both point sources, such as leaking underground storage tanks, illegal discharges and spills, and non-point sources such as septic system discharges. Relating the presence of VOCs in groundwater to overlying land use is not straightforward, given the widespread

Prior to extensive development, precipitation infiltrating down through the ground surface travelled through the aquifer system to discharge to one of the County's streams, or to one of the surrounding salt water bodies. In fact, approximately 95 percent of stream baseflow was derived from groundwater.

Although water supply pumping, sanitary wastewater management and stormwater management have all modified the County's predevelopment water budget, groundwater continues to be a significant source of baseflow to streams and wetlands, and discharges millions of gallons to coastal waters each day. Consequently, groundwater quality can have a significant impact upon surface water quality.

use of VOCs, the detections of low levels of VOCs in shallow groundwater throughout the County, and the myriad of potential pathways by which low levels of the contaminants can be introduced to the aquifer system. Water quality data has revealed that the highest levels of VOCs are found in wells with industrial, commercial, transportation or institutional uses within their source water areas. Nevertheless, low levels of VOCs were widely detected in groundwater throughout the County, indicating a more widespread low-level source of the observed contaminants, such as residential septic systems. Before targeted recommendations to reduce the release of VOCs to the County's groundwater can be developed, a better understanding of the potential sources of the observed contamination is required.

SCDHS has been a pioneer in the investigation of pesticide impacts to ground and surface waters. The results of their early investigations led to expanded pesticides monitoring in Suffolk County and throughout the nation, to the ban of some pesticides found to leach to groundwater, and to changes in the federal and state pesticide registration processes to prevent similar contamination from occurring. Pesticide contamination in Suffolk County is primarily associated with agricultural land use.

The public health implications of low concentrations of PPCPs in water are only now being studied and are not yet well understood. PPCPs in groundwater are of most concern in densely developed unsewered areas where sanitary wastewater is discharged directly to the ground via on-site septic systems, cesspools or leaching fields. SCDHS continues to assess the potential presence of PPCPs in groundwater, and monitors literature and regulatory initiatives pertaining to potential public health implications.

Surface Water Quality

Suffolk County's surface waters are renowned for their beauty and their ecological, recreational and economic significance. Both the Long Island Sound and the Peconic Estuary have been federally designated as estuaries of national significance; two of the County's south shore beaches were included on Dr. Stephen P. Leatherman's (a.k.a. Dr. Beach) 2010 list of the "Top 10" beaches in the United States, and the County's streams, harbors and estuaries have great ecological value and significance. The Long Island Sound (LIS), Peconic Estuary and South Shore Estuary Reserve (SSER) have been the subjects of focused studies for years; the LIS Comprehensive Conservation and Management Plan (CCMP), the Peconic Estuary Program (PEP) CCMP and the SSER Comprehensive Management Plan (CMP) all identify a number of strategies and recommendations to improve water quality, reduce use

impairments, and protect and restore habitat and ecosystems in the marine systems and the fresh surface waters that feed them.

This Plan focused on the water quality of the County's fresh surface water features, particularly as they are impacted by the quality of groundwater baseflow. **Figure ES-3** below illustrates the relationship between groundwater and stream baseflow.

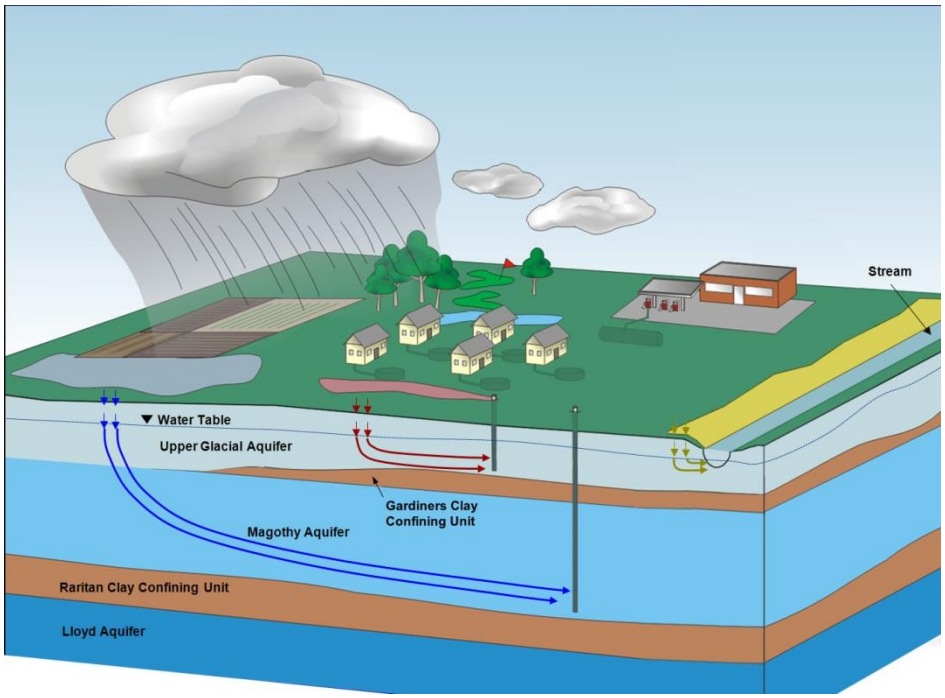
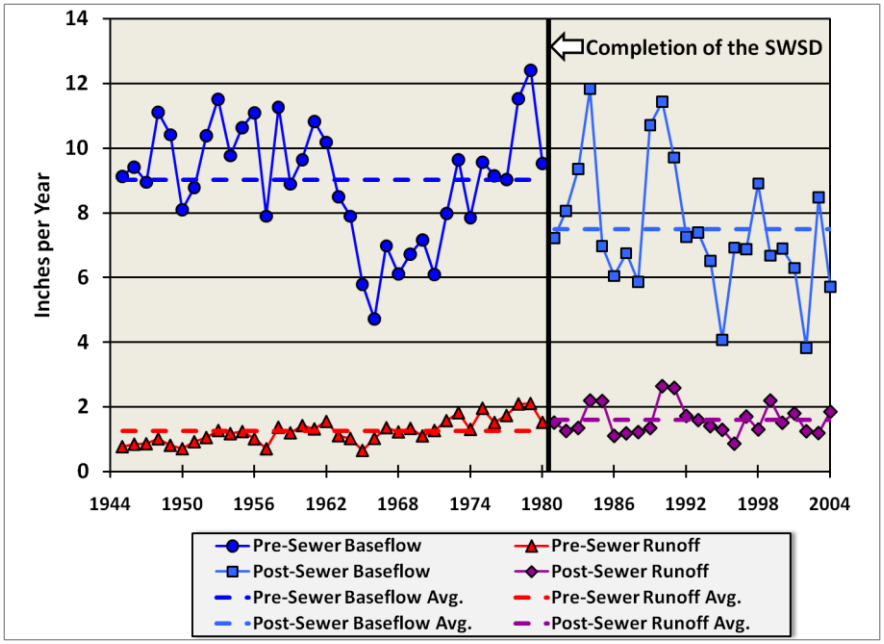


Figure ES-3 Hypothetical watershed showing how land use can affect groundwater and surface water quality

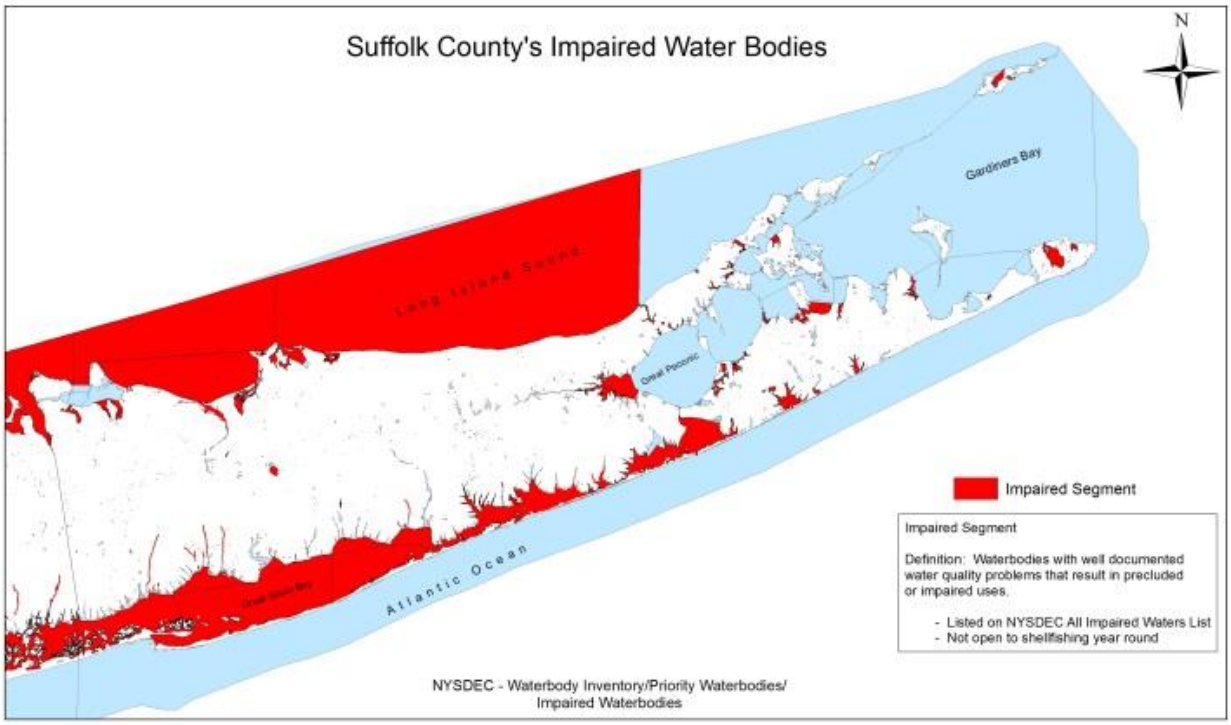
Within Suffolk County, New York State has classified more than 200 freshwater streams and ponds, identified over 50 coastal plain ponds distinguished by ecological communities that support rare and unusual plant species, and regulates over 1,050 freshwater wetlands covering nearly 24,000 acres (NYSDEC, 2006). Only 31 of the fresh water bodies are included on the NYSDEC *All Impaired Waters List*– although this is an indication that the quality of most streams, lakes, and ponds supports their best use, Suffolk County's largest lake (Lake Ronkonkoma) is designated as impaired. NYSDEC has identified pathogens, metals, dissolved oxygen, phosphorus, ammonia, pesticides and silt/sediment as the primary contaminants causing impairment of the fresh surface waters, and storm water runoff as the source of these

contaminants. A review of water quality data characterizing twelve of the larger fresh streams in the County revealed that streams in the more densely developed western part of the County showed higher levels of VOCs than streams located further to the east, and that pesticides were primarily detected in streams in the agricultural eastern areas of the County. In general, as would be expected based upon their properties, VOCs have a lower rate of detection, and lower reported concentrations, in surface waters than in groundwater. Levels of MTBE, the most frequently detected VOC, appeared to be declining in recent years, probably because sale of gasoline containing MTBE as an additive has been prohibited in New York State since 2004.



Even after sanitary sewering was completed in the County's Southwest Sewer District, groundwater baseflow is the major source of streamflow.

The coastal waters bordering Suffolk County are impacted to varying degrees by contaminants introduced by point and primarily, non-point sources. Of the 38 classified saline waters in Suffolk County including the Long Island Sound and those that discharge to the Long Island Sound, 19 are identified as impaired according to the NYSDEC's *All Impaired Waters List*. This includes a large portion of the Long Island Sound as well as all of the county's north shore harbors (Huntington Harbor, Centerport Harbor, Northport Harbor, Nissequogue River, Stony Brook Harbor, Port Jefferson Harbor, Mt. Sinai Harbor and Mattituck Creek). Of the 120 classified saline waters included in



Quick Facts:

- *The SCDHS's Bureau of Marine Resources has been conducting water quality monitoring of the County's estuaries since the 1970's.*
- *Presently, routine monitoring is performed at over 200 stations from all 3 main estuaries (SSER, LIS, Peconic Estuary).*
- *Approximately 10,000 water quality samples are collected annually.*
- *Over 190 Bathing Beaches are monitored under §6-2 of the NYS Sanitary Code to ensure compliance with water quality standards.*

the Peconic Estuary, 41 are identified as impaired the largest of which include Flanders Bay and Reeves Bay. Of the 73 classified saline waters along the south shore including Great South Bay, the Atlantic Ocean, and those that drain to either of these waters, 33 are considered to be impaired. This includes, but is not limited to, the large bays along the south shore of the County (all of Great South Bay, Moriches Bay and Shinnecock Bay). The estuary programs have demonstrated that nutrients (particularly nitrogen) and pathogens are primarily responsible for use impairments and for stressing the living marine resources.

Within the Suffolk County watershed area, nonpoint sources are the major contributors of nutrients and pathogens. Recommendations identified by each of the estuary programs focus on reducing nitrogen loading from sanitary wastewater and fertilization, implementation of best management practices (BMPS) to improve stormwater quality, and open space preservation to improve water quality and reduce impacts on the ecology of Suffolk County's coastal waters. The cumulative impacts of these stresses on the overall health of the aquatic ecosystem are not well understood. Little is also known about the impact of emerging contaminants such as PPCPs on the marine resources; the cumulative impacts of pesticides and PPCPs on the aquatic ecosystems have not yet been well defined, and are currently under study.

Non-point source contributions of nutrients, pathogens and other contaminants have been identified as the primary causes of surface water quality impairments in Suffolk County. Groundwater continues to provide close to ninety percent of baseflow to most streams in the County, and groundwater discharge is one primary source of nutrient loading to fresh and coastal surface waters. The groundwater models were used to delineate the land surface area contributing groundwater baseflow to the County's streams and coastal waters at time of travel intervals ranging from less than one year to fifty years as shown by **Figure ES-4.** Understanding the land use types within

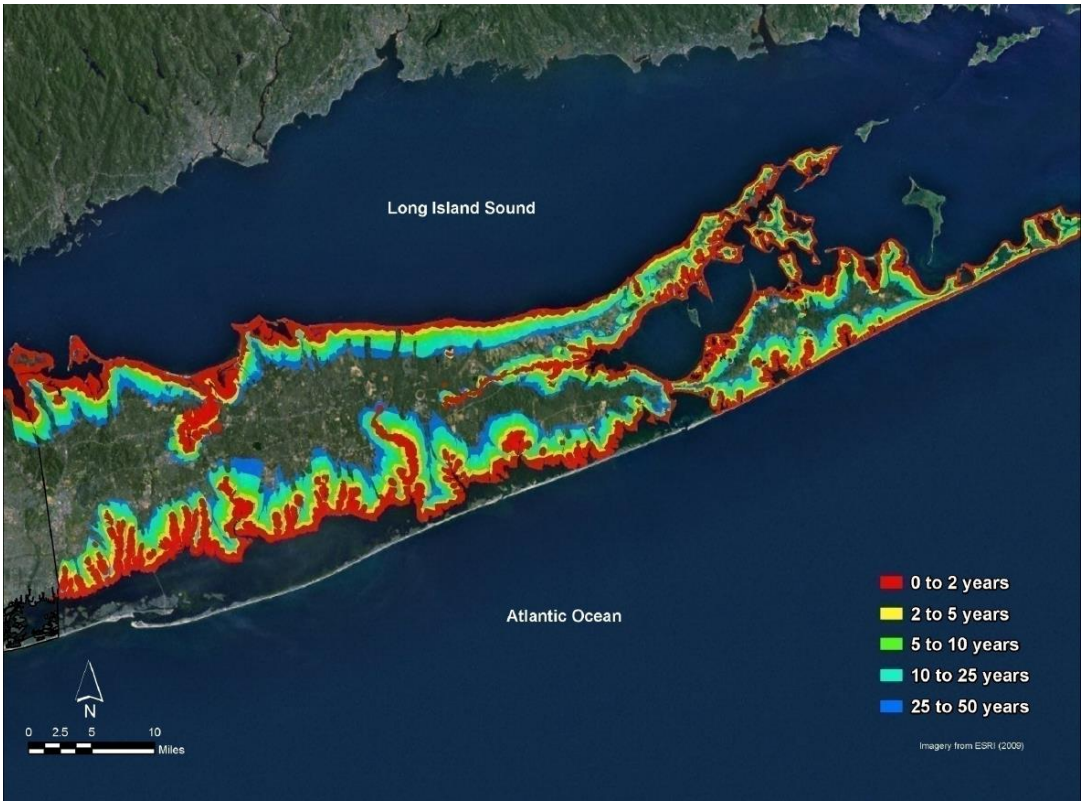


Figure ES-4 Precipitation falling upon the ground surface in the highlghted areas travels through the aquifer system to discharge to County streams, harbors, and other coastal waters. The time that it takes the water to travel from the water table to surface water discharge provides an indication of the time it will take for the effects of management actions to be reflected in the surface water quality.

the groundwater contributing areas to a stream can help to identify the sources of any observed contamination and to guide identification and evaluation of management options to improve water quality, as illustrated by **Figure ES-5.**

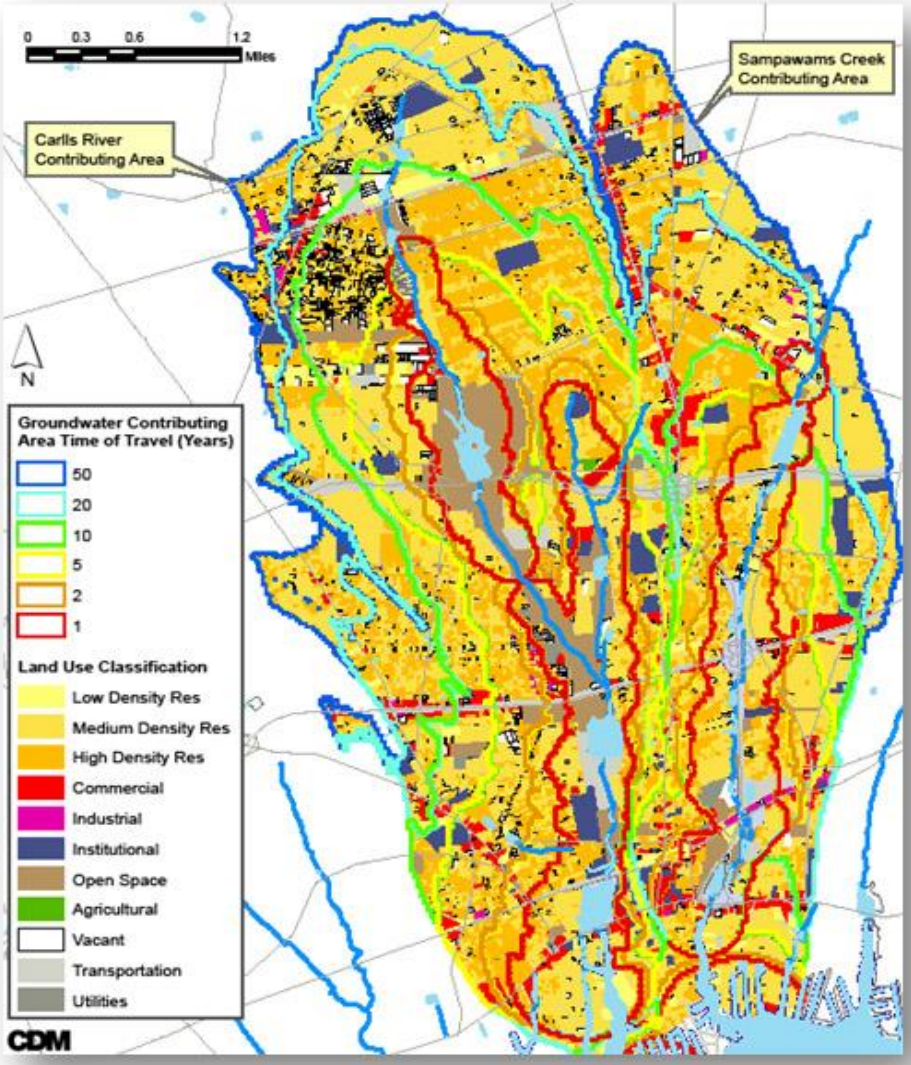


Figure ES-5 *The delineation of groundwater contributing areas to the County's surface waters has aided in the understanding of the impact of land use types on surface water quality and will help select and prioritize management and protection alternatives.*

Management actions implemented to reduce nutrient and contaminant loads to groundwater within the areas contributing to the County's surface water features will reduce these non-point source loads to the surface waters. Protecting the quality of recharge in these areas will help to protect and improve surface water quality. Based on estimated travel time from the water table to surface water discharge, it may take years for the benefits of improved water quality to be fully realized.

Groundwater Quantity

Suffolk County's extensive and productive aquifer system that provides the sole source of potable water supply for the County's 1.5 million residents has been studied for decades. All of the County's groundwater originates as precipitation that recharges the island - the County is fortunate to receive an annual average of approximately 48 inches of precipitation, relatively evenly distributed throughout the year. While the amount of precipitation that recharges the aquifer varies by season and location, on average, it is estimated that approximately 50 percent of the precipitation recharges the aquifers to provide an annual average of approximately 1367 million gallons each day of recharge to the aquifer system. The calibrated Main Body, North Fork, South Fork and Shelter Island groundwater models were used to develop water balances to better understand the County's aquifer system and to begin to assess the magnitude of the impacts that could result from predicted increases in sea level for long term planning purposes.

The water balances compared aquifer conditions that would have existed at the turn of the century prior to extensive development to current conditions, including contemporary levels of public water supply pumping and the operation of stormwater and wastewater management facilities. Long term average recharge rates were based on precipitation records obtained from gages at Mineola, Brookhaven National Laboratory, Riverhead and Bridgehampton. Recent levels of public water supply pumping assigned in the model simulations were based on the average annual pumping rates used for the Long Island Source Water Assessment Program evaluations (SWAP, 2003).

The predevelopment and present day water balances are summarized by **Figure ES-6**.

Under predevelopment conditions, precipitation, the only source of recharge to the groundwater system, traveled down through the aquifer system, until it was ultimately discharged to surrounding coastal waters, either as stream baseflow or as underflow. Construction and operation of sanitary sewering systems that discharge to surface waters results in a net loss of groundwater from the aquifer system, and a potential reduction in the local water table elevation. Because groundwater provides the baseflow for the County's fresh surface water features, sanitary sewering with surface water discharge can also result in a loss of stream baseflow.

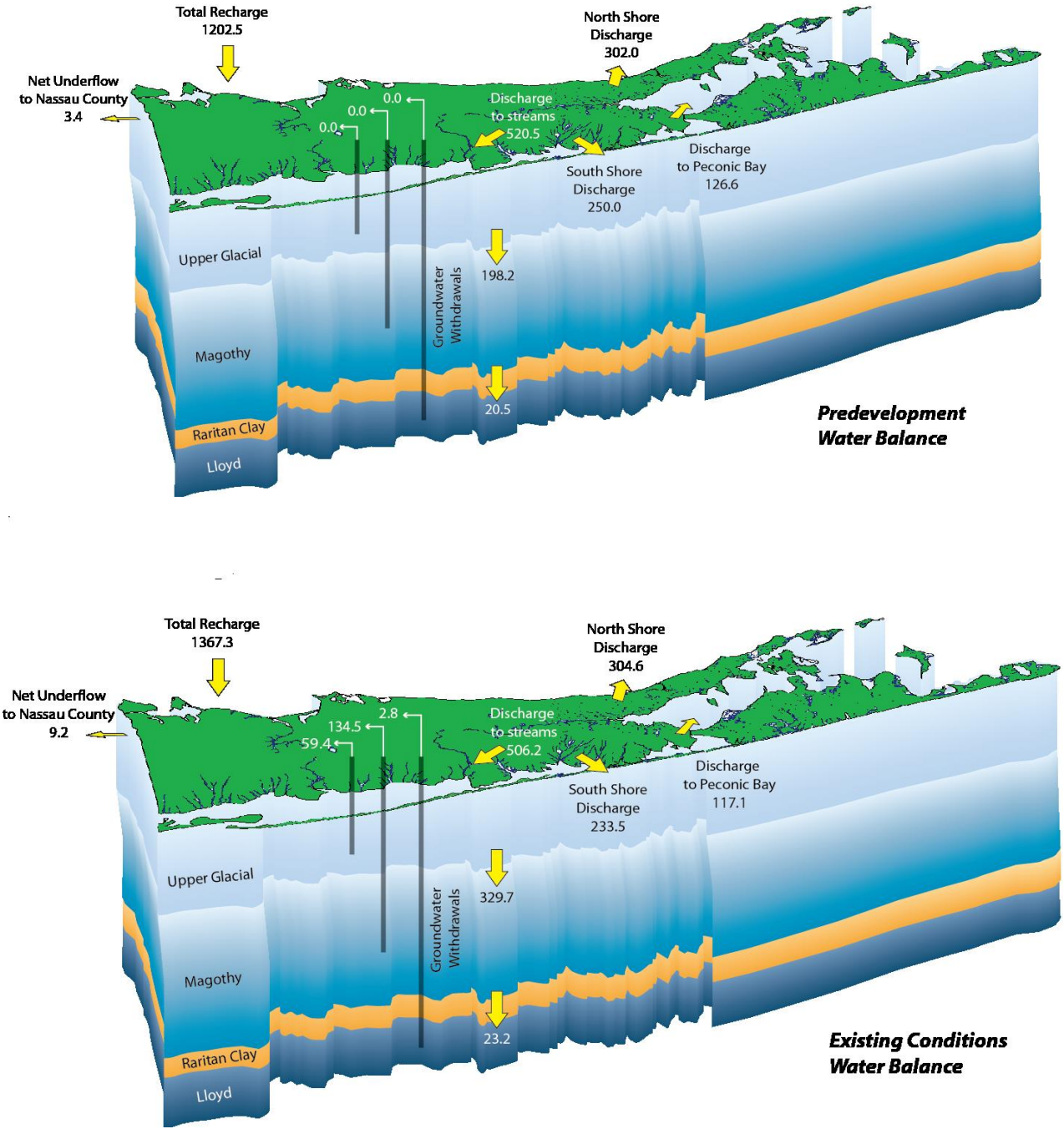


Figure ES-6 – Predevelopment and Present Day Water Balances (All flows in million gallons per day)

The construction of stormwater recharge basins in many parts of the County has increased recharge during the growing season, so that on an annual basis, recharge to the aquifer is actually slightly higher than during pre-development conditions.

The water balances confirm that on a County-wide basis, the aquifer system can sustain current and projected rates of water supply pumping. A comparison of pre-development and current water balances also identifies a net loss of baseflow to area streams and to coastal areas in those parts of the County where water supply pumping is not returned to the aquifer via on-site septic systems or small sewage treatment plants discharging to recharge beds. Suffolk County has evaluated the impacts of sanitary sewering in the Southwest Sewer District (SWSD) on streams and wetlands areas within that district. Potential impacts of development on streams, ponds, wetlands and inter-tidal areas are best considered on a localized basis, considering area water supply pumping, development, and stormwater and sanitary wastewater management approaches.

Sea Level Rise

Sea level rise will compromise over 82,000 unsewered parcels in Suffolk County within this century

- *Almost 25% of the 360,000 currently unsewered parcels in Suffolk*
- *They comprise the majority of the 150,000 sensitive, unsewered parcels in the 25-year travel time to surface waters*
- *This estimate is more than double the previously identified number of potentially compromised parcels (~40,000)*

In the past, sea level had been rising along the East Coast at a reported rate of between 0.34 and 0.43 inches per decade (**Climate Risk Information**, 2009). Over the past century, the rate of sea level rise has been increasing, with the average rate since 1900 now at 1.2 inches/decade. Global warming is predicted to further accelerate the rate of rising sea level, both as a result of the expansion of the warming oceans, and as a result of ice melt. Rapid ice melt scenarios incorporated into other model simulations predict even more significant increases in sea level in the coming years.

The Main Body flow model, and the North Fork, Shelter Island and South Fork salt water intrusion models were used to project the impacts of sea level rise of 34 inches from 2014 to 2100 on the groundwater table. This estimate was selected as the mid-range of "business as usual" (e.g., no reduction in greenhouse gas emissions) projections by Stony Brook University researchers Minghua Zhang, et al in 2014 for the New York Resiliency Institute for Storms and Emergencies. Projections of climate change models vary widely – predicting sea level increases of 12 inches (based on greenhouse gas mitigation) to as much as 75 inches by the end of the century.

The Plan depicts the projected groundwater table elevation depicted in 2035, 2050 and 2100 assuming a linear rise in sea level from present day to 2100. The models show that the impacts of sea level rise on the groundwater table are moderated on the south shore where groundwater baseflow to the numerous

streams and wetland areas is anticipated to increase in response to the rising groundwater table. The exception is on the Barrier Island where groundwater discharges at the surface in many areas.

The impacts of rising sea level are predicted to be more significant on the forks and Shelter Island. For example, over most of the South Fork, the projected increase in water level elevation varies from 1 to 2.5 feet, and the impact is markedly more extensive than projected for the main body of the County. Similar results were projected by the North Fork and Shelter Island models. The simulated rise in the freshwater/saltwater interface position was also assessed for the North and South Forks and Shelter Island; localized increases in the elevation of the saltwater interface will result in a reduction in the thickness of the freshwater aquifer systems.

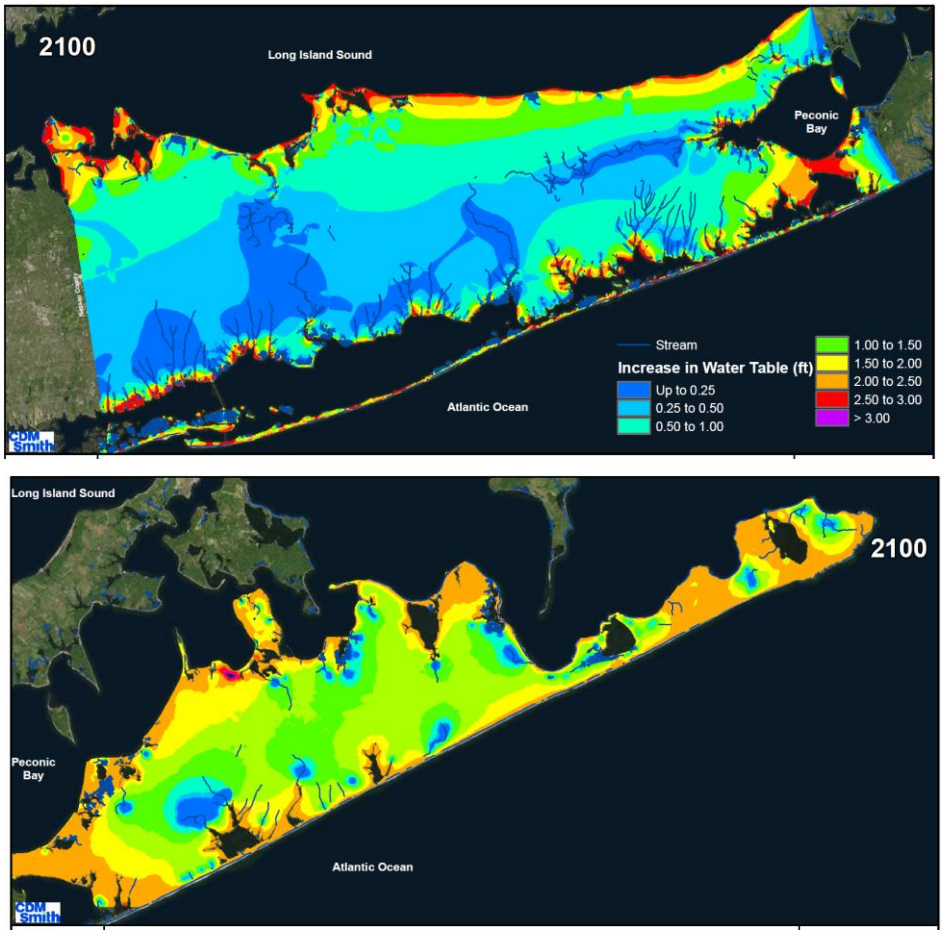


Figure ES-7 The predicted impacts of a 34" rise in sea level on the groundwater table on the main body of Suffolk County and on the South Fork

In the coming decades, Suffolk County will need to address the impacts of projected increases in sea level elevation. Over 56,000 parcels, over fifteen percent al or potentially compromised on-site septic systems. This will only be exacerbated by sea level rise when substantially all of these parcels will be affected by a 1 to 2 foot rise in groundwater. In addition, it is projected that another 26,000 unsewered parcels will be impacted by the end of the century based on the modeled 34" sea level rise.

While there are many uncertainties associated with the impacts of climate change, published research and the results of Global Climate Models consistently indicate that sea level will continue to rise at an accelerated pace. Additional evidence indicates that precipitation is increasing in this part of the world, and that the number of extreme precipitation events is also increasing in the northeastern United States, including Suffolk County. Sea level rise may have profound impacts on low lying coastal areas, particularly along the south shore and on the forks, with significant implications for infrastructure such as stormwater and wastewater collection and disposal systems and water supply. The impacts of sea level rise and more frequent extreme precipitation events should be monitored so that wastewater and stormwater runoff management strategies can be developed if required. The impacts of sea level rise on the location of the saltwater interface must also be monitored and addressed from a water supply perspective. Extreme precipitation events will exacerbate existing drainage problems; reliable solutions can only be developed based upon data characterizing the magnitude of increased water levels and flows.

Drinking Water Supply

From a County-wide water quantity perspective, Suffolk County's aquifers can readily provide the average annual 292 million gallons per day (mgd) required to satisfy projected future (2030) water supply demands. However, as additional wells are sited to meet projected future needs, the effects of water supply pumping on groundwater-fed streams, ponds and wetlands must be considered, and in localized coastal areas, projected water supply demands may exceed the capacity of the limited shallow fresh water aquifer. From a water quality perspective, most untreated groundwater in the County continues to comply with existing drinking water quality criteria, and community supplies are treated to remove the low levels of VOCs or other contaminants that source water monitoring may identify. Community supplies currently provide potable water to more than 87 percent of Suffolk County residents; approximately 72 percent of the population is served by the SCWA. Community supplies are generally the best means of providing a reliable supply of potable water that complies with all applicable drinking water criteria or MCLs.

Several potential issues of concern that affect some residents' access to a reliable and safe supply of water have been identified. These concerns result both from the ability of the aquifer resource to supply sufficient water that complies with all applicable drinking water criteria, and the ability of existing infrastructure to meet water supply demands, now and in the future.

Resource Constraints

Two areas of the County where existing groundwater quality has affected the ability to utilize the existing groundwater supply have been identified during this study:

- Northport and East Northport, where nitrate levels measured in untreated water from existing SCWA Magothy wells have ranged from 8 mg/L to 12 mg/L, and
- Southold, where the extent of the shallow aquifer is limited by underlying and surrounding salt water, and where agricultural contaminants such as nitrates and pesticides have caused widespread groundwater contamination.

Infrastructure Limitations

Infrastructure limitations also affect the reliable provision of potable supply. Customers of some smaller, aging community and non-community supply systems would be served more reliably by a larger community supplier such as the SCWA. A GIS analysis completed as part of this study concluded that approximately 45,000 private wells continue to provide potable supply to Suffolk County residents. Shallow private wells are more susceptible to contamination from near surface activities and are not tested with the same frequency as community supply wells; in fact less than 2 percent of private wells are tested by the SCDHS each year. A sampling effort conducted by the SCDHS between 1997 and 2006 found that almost 10 percent of the samples collected from private wells exceeded the drinking water standard for nitrate and approximately seven percent showed VOCs above 5 µg/L.

While there are adequate supplies to meet all existing and projected potable water needs on a Countywide basis, existing infrastructure in some parts of the County is not adequate to respond to the increased water supply demand resulting from the early morning use of automatic irrigation systems during hot, dry summer periods, as illustrated during the summer of 2010. Community supply pumping during the winter months has only increased by approximately 15 mgd since 1987, while pumping during the summer has increased by 100 mgd or more. Much of this increase is attributed to the installation and use of automatic irrigation systems.

Wastewater Management Quick Facts:

Onsite Sewage Disposal Systems (OSSDS)

- *The #1 pollutant affecting Suffolk County's water resources is wastewater nitrogen*
- *Approximately 74% of SC is unsewered utilizing OSSDS*
- *There are an estimated 360,000 OSSDS located in SC*
- *Prior to 1972, block cesspools were the minimum required method of OSSDS for single-family homes*
- *After 1972, basic OSSDS for single-family homes, consisting of a 900 gallon septic tank and precast leaching pools*
- *An estimated 252,530 existing OSSDS pre-date the requirement for a septic tank*
- *Approximately 209,000 existing OSSDS are located in identified priority areas*
- *SC is evaluating the effectiveness of innovative alternative onsite wastewater treatment systems (I/A OWTS) for single-family dwellings to reduce wastewater nitrogen to 19mg/l through a County Sponsored demonstration project*
- *4 manufacturers (Norweco, Busse, Orenco Systems, and Hydro-Action) have agreed to install a total of 19 I/A OWTS within SC for the demonstration project (Systems to be installed in 2015)*

Projected water supply demands for the year 2030 were based on population projections provided by the SCDEDP and provision of community supply to all residents currently using private wells. Considering peak water supply pumping demands that are based on existing observed peak demand factors, the 2030 projections indicate that additional wells will be required in most Towns in the County. In fact, over one hundred new supply wells would be required in the County based upon projection of current peak water demand patterns. Alternatives to provide potable water to County residents, considering treatment, conveyance from the Pine Barrens, and conservation were identified and evaluated.

Wastewater Management

An estimated 69 percent of the total nitrogen affecting our ground and surface water supplies emanates from wastewater, specifically onsite sewage disposal systems.[27] Approximately 74 percent of Suffolk County is unsewered utilizing onsite sewage disposal systems with limited ability to reduce wastewater nitrogen.[28] There are approximately 360,000 onsite sewage disposal systems located in Suffolk County with approximately 209,000 of these systems located in identified priority areas meeting the following criteria[28]:

- Areas in the 0-50 year contributing zone to public drinking water wells fields
- Areas in the 0-25 year contributing zone to surface waters
- Unsewered parcels with densities greater than what is permitted in Article 6 of the Suffolk County Sanitary Code
- Areas located in an area where groundwater is less than 10 feet below grade

In 1958 the first SCDHS onsite sewage disposal Standards went into effect, requiring block cesspools for single-family homes. Up until 1972 these cesspools (AKA leaching pools) were permitted to be installed without a septic tank.

[27] [27]IBM Smarter Cities Challenge Report. Suffolk County, NY, United States. August 2014

[28] [28] SCDEDP, 2014

Wastewater Management Quick Facts Continued:

Wastewater Treatment Plants and Sewering

- *As of 2013, Suffolk County has 197 operational wastewater or sewage treatment plants (STPs)*
- *171 of the STPs are designed to remove nitrogen from the wastewater (Effluent Total Nitrogen 10 mg/l or less)*
- *14 STPs discharge directly to surface waters*
- *The 2013 average effluent total nitrogen for the tertiary plants in Suffolk County was 8.7 mg/l*
- *The last major expansion of sewers in Suffolk County was the creation of the Southwest Sewer District completed in the early 1980's*
- *There hasn't been a sewer expansion project similar to the magnitude of the Southwest Sewer District in Suffolk County in over 30 years.*
- *In 2014, Suffolk County received a $383 million funding award from New York State to install sewers and connect approximately 10,000 properties to sewers*

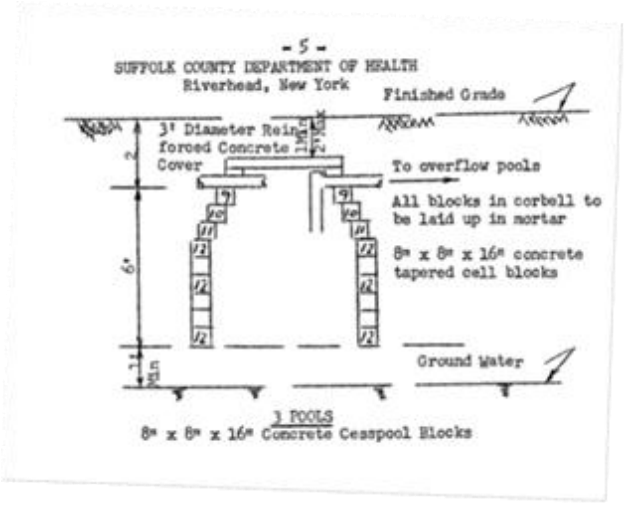


Figure ES-8 Block Leaching Pool Detail from SCDHS Residential Standards Prior to 1972

It has been estimated 252,530[28] of the 360,000 existing onsite sewage disposal systems pre-date the requirement for a septic tank. In 1972, the standards were revised to require basic treatment for single-family homes, consisting of a 900 gallon septic tank and precast leaching pools. The addition of septic tanks provides a small degree of wastewater nitrogen removal.

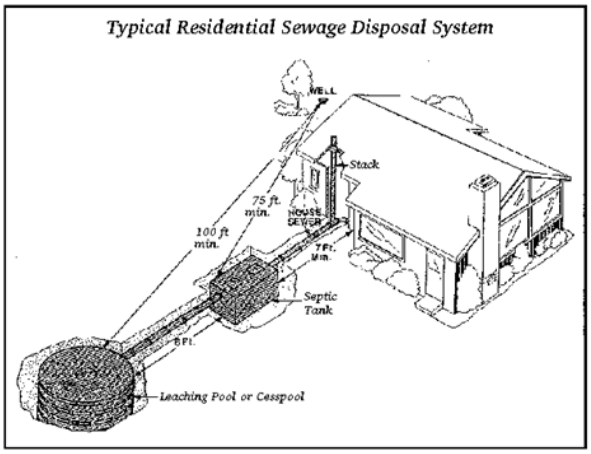


Figure ES-9 Typical Onsite Sewage Disposal

Currently, nitrogen discharge from onsite wastewater treatment systems is regulated by lot size through the implementation of the Suffolk County Sanitary Code Article 6. Based on differences in regional hydrogeological and groundwater quality conditions, Article 6 delineated boundaries of the eight Groundwater Management Zones (GWMZ) for protection of groundwater quality. The Goal of creating the GWMZ was to limit groundwater nitrogen to

Wastewater Management Quick Facts Continued:

Emerging Contaminants of Concern in Wastewater

- *A variety of Contaminants of Emerging Concern (CECs), including pharmaceuticals and personal care products (PPCPs) have been detected in wastewater*
- *Many CECs can be removed from wastewater*
- *The primary mechanisms of removal/transformation of CECs are sorption and biodegradation*
- *The aerobic conditions that exist in most wastewater treatment processes are required for degradation of most PPCPs*
- *Minimal PPCP degradation occurs under anaerobic (e.g., septic tank) conditions*
- *Some PPCPs have breakdown products that are more harmful than the original compounds.*
- *Removal of PPCPs in the tertiary wastewater treatment process that remove nitrogen are more efficient than secondary treatment*
- *Removal of PPCPs by I/A OWTS has been found to be comparable to the removal in an activated sludge wastewater treatment process*

4 mg/l in GWMZ III, V, and VI and to 6 mg/l in the remaining zones. Many areas of Suffolk County were built before the Article 6 density restrictions or prior to conventional treatment system requirements. It is these many homes and businesses that are contributing to the pollution of groundwater in Suffolk County as well as the surface waters and ecosystems of the County.

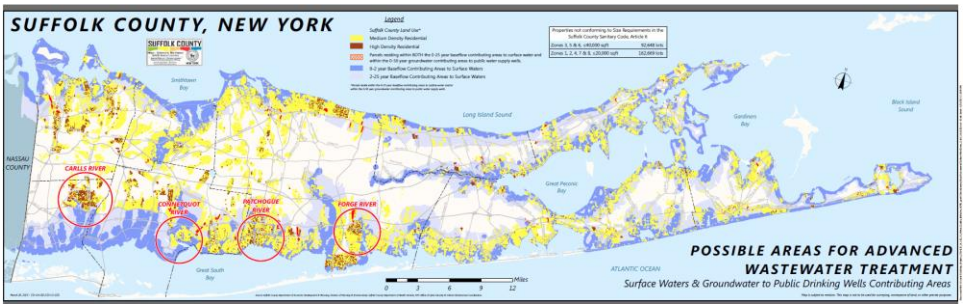


Figure ES-10 Map of Possible Priority Areas for Advanced Wastewater

Alternatively to meeting the density requirement of Article 6 of the Suffolk County Sanitary Code to protect water resources, connection to community wastewater treatment systems is an acceptable method of reducing nitrogen. Unfortunately only 26 percent of Suffolk County is connected to sewer systems. The last major expansion of sewers was the creation of the Southwest Sewer District and extension of sewers to existing homes and commercial buildings located within the district. This project was completed in the early 1980s and there has not been a sewer project of its kind in Suffolk County in over 30 years. Since the expansion of the Southwest Sewer District, most of the sewering that has taken place in Suffolk County is for the connection of new development. Evidence has shown that sewering can help reduce nitrogen loads to surface waters; for example the average nitrogen in the Carlls River located by the SWSD was 3.2 mg/l in the 1970s and in the 2000s dropped to 1.8 mg/l. After Super Storm Sandy impacted structures along our coastline in 2012, the need for increased wastewater treatment to reduce nitrogen was realized to improve our valuable water resources. Nitrogen from residential septic systems and cesspools, as well as fertilizer, are the principle culprits that spur hypoxia, harmful algal blooms, diminution of sea and shellfisheries, and degradation of our protective natural infrastructure – wetlands and seagrass beds that act as wave and storm surge buffers.[29,30] By reducing wastewater nitrogen through the use of increased wastewater treatment via sewering or

[29] Deegan LA, Johnson DS, Warren RS, Peterson BJ, Fleeger JW, Fagherazzi S, and Wollheim WM (18 Oct 2012) "Coastal Eutrophication as a Driver of Salt Marsh Loss" Nature : doi:10.1038

[30] Anderson ME, McKee Smith J, Bryant DB, and McComas, RGW. (Sept 2013), "Laboratory Studies of Wave Attenuation through Artificial and Real Vegetation" USACE, "It is generally acknowledged that vegetated coastal features such as wetlands can reduce the effects of surge, waves, and tsunami propagation."

Wastewater Management Recommendations:

Develop a Wastewater Management Plan to set nitrogen load reduction targets to meet water quality goals

Identify the means of sewage disposal on a parcel-by parcel basis to meet water quality goals

Revise Sanitary Code and sewage disposal construction standards to permit the use of I/A OWTS

Continue to investigate and implement new I/A OWTS technologies and STP technologies for increased removal of nitrogen and CEC's

Create a wastewater management district and responsible management entity to provide funding sources for upgrading and/or repairs of I/A OWTS and STP's, O&M tracking, performance tracking, education and outreach

Continue to perform sewering feasibility studies, and find funding sources to implement the sewering in the areas studied

Implement SPDES permit action limits that specify advanced treatment for new STPs located in sensitive areas such as 25-year travel times to surface waters and 50- year contributing areas to public supply wells to reduce nitrogen loading as compared with OSSDS at Article 6 allowable density

installation of innovative/advanced onsite wastewater treatment systems, Suffolk County predicts improvement of our wetlands and seagrass beds to increase coastal resiliency during future storm surge events.

The first major sewer expansion in Suffolk County will occur through a funding reward of $383 million from New York State to install sewers and connect approximately 10,000 existing, developed properties to sanitary sewer systems. This will be the first major sewering based project within Suffolk County in more than 30 years. The goal of the project is to reduce nitrogen pollution to ground and surface waters to improve coastal resiliency against future storm events. The areas to be sewered will be:

(1) Mastic: Parcels in the Forge River area will be connected to a new sewer collection system that will flow to a new wastewater treatment plant located on municipal property near the Brookhaven Town Airport.

(2) North Babylon and West Babylon: Parcels in the Carlls River area will be connected to the SWSD.

(3) Great River: Parcels in the Connetquot River and Nicolls Bay area will be connected to the SWSD.

(4) Patchogue: Parcels in the Patchogue River area will be connected to the Patchogue sewer system within the Patchogue Sewer District.

An alternative means of combating wastewater nitrogen discharging from residential lots that do not have access to community sewers are Innovative/alternative onsite sewage disposal systems (I/A OWTS), which have been proven in other jurisdictions to reduce wastewater nitrogen to 19 mg/l or less. These types of systems are currently being evaluated by the County to reduce nitrogen discharges from on-site wastewater treatment systems. These types of systems would replace conventional onsite sewage disposal systems. In 2014, Suffolk County began its first demonstration project for I/A OWTS and anticipates implementing a program permitting the use of I/A OWTS by the end of 2015. The demonstration project is intended to provide field-testing and technology verification to determine if a particular I/A OWTS can function effectively in Suffolk County. Four (4) manufacturers (Norweco, Busse, Orenco Systems, and Hydro-Action) have agreed to install a total of nineteen (19) systems within Suffolk County for the demonstration project.

Another means of treating wastewater to reduce nitrogen in areas where centralized sewers are not feasible is the creation of decentralized community

sewer systems. Decentralized community sewer systems normally serve small communities. Suffolk County is evaluating and promoting the creation of decentralized community systems for communities that utilize wastewater treatment systems approved for use under the SCDHS Commercial Standards Appendix A for flows up to 15,000 gpd (30,000 gpd with modifications to SCDHS Commercial Standards Appendix A or an SCDHS variance). These systems are normally package wastewater treatment plants which are substantially or entirely below grade, with enclosed process tanks that qualify for reduced separation distances of 75' to property lines and habitable structures when an aerosol emissions and odor removal system is installed. Currently, SCDHS has approved seven (7) Appendix A treatment technologies for use in Suffolk County. Suffolk County plans on funding a pilot program to determine the feasibility of retrofitting pre-existing communities served by onsite sewage disposal systems with decentralized community sewer systems to reduce existing wastewater nitrogen loads to improve water quality.

In addition to nitrogen removal, anticipated rising groundwater and sea level elevation are of concern. Leaching pools are required at a minimum to be 2 feet above the groundwater table. Updated sea level rise projections indicate sea level will rise approximately 24 to 34 inches by the end of the century. Therefore, Suffolk County should evaluate the minimum required separation distance between the bottom of leaching structures and groundwater by investigating alternative shallow leaching systems, which may also provide additional nitrogen removal.

Pharmaceuticals and personal care products (PPCPs) are becoming additional contaminants of concern in wastewater discharges based on their potential impacts to ground and surface water resources. In recent years, very low levels of PPCPs, also sometimes referred to as pharmaceutically-active compounds (PhACs) or organic wastewater contaminants (OWC), have been detected in the environment. As most pharmaceuticals are designed to be water soluble, and to be persistent long enough to serve their designated therapeutic purposes, they can be present in dissolved form in receiving ground and surface waters. PPCPs are continuously introduced into the environment by sewage treatment plants and by on-site wastewater disposal systems (e.g., septic tanks and leach fields) in unsewered areas. Advanced treatment units, whether sewage treatment plants or I/A OWTS, have shown evidence of removing emerging contaminates of concern but further research is required.

The implementation and creation of a wastewater management plan will help address Suffolk County's wastewater nitrogen problem by setting required nitrogen load reduction targets and/or ambient water quality nitrogen concentration targets to meet water quality goals. In addition, the plan shall

identify the means of sewage disposal on a parcel by parcel basis to meet nitrogen reduction targets. Possible treatment options are connection to an STP to meet wastewater effluent total nitrogen (TN) of < 10 mg/l, installation of an I/A OWTS to meet TN <19 mg/l, or installation of a conventional system to meet TN>19 mg/l. The County anticipates issuing an RFP in 2015 to select a consultant to assist the County in establishing watershed-specific nitrogen discharge standards and determining the means of sewage disposal on a parcel by parcel basis to meet water quality goals. To meet the nitrogen reduction requirements and permit I/A OWTS to be installed in areas where sewers are not available, the current Suffolk County Sanitary Code and SCDHS Onsite Sewage Disposal System Construction Standards must be revised in cooperation with NYSDEC and NYSDOH. These codes and standards will be revised to include the formation of an RME to oversee I/A OWTS and decentralized privately owned STP's, permit the installation of I/A OWTS, provide standard construction requirements for I/A OWTS, require property owners to certify their system at the time of transfer if feasible, etc. A wastewater management district and responsible management entity (RME) should be established per the revised Sanitary Code to provide funding sources for the upgrading and/or repairs of I/A OWTS, education and outreach, performance tracking, and O&M tracking. Education and outreach performed by the RME will target contractors, design professionals, and property owners. The wastewater management plan shall define when sewers should be extended in lieu of onsite sewage disposal systems.

Implementation*

The success or failure of implementing many of the action items identified in the attached table is contingent upon securing the necessary funding and the cooperation of many of the key stakeholders. Responsibilities for many of the management activities identified are currently shared by a number of agencies and partners on the federal, state, county, town and local levels. While Suffolk County may have the ability to exercise authority and implement many of the recommendations, it will be critical to develop and maintain a network of cooperative and willing partners to participate in the resource management efforts.

* A table of the Comprehensive Water Resources Management Plan key recommendations, action items, prospective owners and likely collaborators follows at the end of this section

Management Strategies

The following is a list of the key management strategies, tools, options, and rate determiners that must be considered before addressing some of the recommendations identified in the attached table:

- To assess the effectiveness of implementing management strategies it is critical to develop a comprehensive database and monitoring programs
- Engaging a diverse group of stakeholders and communities will play an important role in developing effective implementation strategies
- Establishing a responsible management entity (RME) and a County-wide wastewater management district is the recommended management model for oversight of advanced wastewater system infrastructure
- Identification of financial incentives and financing mechanisms are a rate determiner in implementing many of the recommendations
- Appropriate staffing levels to implement and oversee key programs must be identified and prioritized as resources allow

Recent Actions

Key action items that have already been implemented by the County as outlined in the attached table include:

- Selected innovative wastewater treatment companies and homeowners to participate in a septic demonstration program
- Initiated pharmaceutical and personal care product health care management and take back programs
- Implemented volatile organic chemical action plan including the hiring and training of dedicated staff to focus on inspecting and sampling priority sites
- Reestablished the stream and groundwater monitoring well network programs
- Joined forces and committed funding along with the east end towns, villages and the Peconic Estuary Program in an Inter-Municipal Agreement to implement water quality initiatives

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Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen	1.1 As a result of Superstorm Sandy in an effort to promote resilience create and/or expand sewer districts for existing communities identified as priority areas and upgrade current wastewater infrastructure	1	SCDPW	SCDEDP, SCDHS	a. Continue to undertake subregional sewer feasibility studies	Short term - On schedule	CP8134 Forge River; CP8139 Carll's River; CP8153 Smithtown/Kings Park; CP8156 Ronkonkoma Hub; CP8157 Connetquot River; CP8191 Center Moriches;CP8192 Flanders/Riverside	
			SCDPW	SCDEDP, SCDHS	b. Advance sewer expansion projects as funding becomes available	Continuous	$383 Million announced as of 2014	
			SCDPW	SCDHS, SCDEDP	c. Plan/Construct Bergen Point outfall replacement	Ongoing	CP8108 $207 million with a $12.5 million grant and $37.5 million loan from SRF	
	1.2 Develop a range of approvable advanced alternative on-site wastewater treatment options available for residential and non-residential applicants in Suffolk County. Gain acceptance and encourage participation	1	SCDHS and SCDPW	SCDEDP, NYSDOH, NYSDEC, USEPA, Towns	a. Assess innovative technologies in nearby states to initiate a County septic demonstration program	Completed; report available online		
					b. Select innovative wastewater treatment companies to participate in a septic demonstration program	Completed		
					c. Select homeowners to participate in a Septic Demonstration Program	Completed		
					d. Install 19 advanced on-site demonstration septic systems	Short term - On schedule	Manufacturers are funding system purchase, installation and maintenance	
					e. Develop demonstration program to evaluate efficacy of shallow narrow drainfields and vegetated wetlands.	Short term - On schedule	Suffolk County Septic/Cesspool Upgrade Program Grant Request	
					f. Monitor effectiveness of on-site demonstration septic systems	Short term - On schedule	SCDHS and SCDPW will perform sampling and analysis, respectively	Effluent nitrogen results
					g. Encourage the use of non-proprietary wastewater treatment systems through demonstration programs	Short term - On schedule	To be determined - could include Watershed Improvement Districts, State Revolving Loan Fund, NYS Water Quality Improvement Program, the Suffolk County Water Quality Protection and Restoration Program, a proposed Aquifer Protection Fee by the public water suppliers, and the Community Preservation Fund for the East End, if supported at the local and state levels	
					h. Develop SCDHS process to approve and permit I/A OWTS systems. Mandate maintenance contracts on all I/A OWTS	Short term - On schedule		
					i. Modify Sanitary Code and establish construction standards for I/A OWTS systems	Short term - On schedule		Results of pilot program
					j. Provide guidelines and train municipalities and private industry to install and maintain advanced onsite systems	Short term - On schedule		Results of pilot program, funding source
					k. Familiarize homeowners and towns on the operations and maintenance of advanced septic systems in comparison to existing septic systems with the goal of providing rationale for an RME.	Short term - On schedule		Public participation, funding
					l. Promote the installation of I/A OWTS systems (Appendix A) for commercial and multi-family development by providing financial incentives	Short term - On schedule		Funding
					m. Establish a database of onsite systems (current and new) to track installation, maintenance, inspection, and performance and use to guide identification of approvable technologies; in coordination with EPA	Short term, On schedule	Integrate with Capital Project 4081, Environmental Health Information Management System	County Funding of Capital Project, see data management below

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen		2	SCDHS	SCDPW	n. Continue to develop new standards for clustered decentralized systems and for flows ranging from 1,000 - 30,000 gpd.	Short term - On schedule		
		1	SCDHS	SCDEDP	o. Develop and implement a drainfield demonstration program providing alternatives to leaching pools	Short term - On schedule	Suffolk County Water Quality Protection and Restoration Program	
	1.3 Develop short term and long term water quality funding and financing mechanisms in partnership with federal, state, county and local agencies and private industry - short term activities may include voluntary homeowner upgrades and in the long term, possible mandatory upgrades that meet specific locational and environmental criteria	1	SCDEDP	SCDPW, SCWA, NYS EFC, USEPA, Towns, NY Works, LIRPC, TNC, CCE, LCV, Estuary Programs	a. Access all potential funding mechanisms, including financing mechanism for long term loans for homeowners, grant opportunities, aquifer protection fee, tax credits, insurance rate adjustments, public private partnerships, benefit assessments, user fees, tax credits, Finance Committee, etc.	Short term - On schedule	To be determined - could include Watershed Improvement Districts, State Revolving Loan Fund, NYS Water Quality Improvement Program, the Suffolk County Water Quality Protection and Restoration Program, the proposed Aquifer Protection Fee by the Suffolk County Water Authority, and for the East End the Community Preservation Fund if supported at the local and state levels	Available funding streams, investor interest, SCWA and homeowner participation
	1.4 Nurture the development of local industries to perform R&D and provide capital to address advanced wastewater treatment	1	SCDHS	SC DPW, SCDEDP, EPA , NYSDEC, LIREDC	a. Participate in the development of a regional (New England and coastal NY) data sharing agreement modeled after CBW data sharing agreement to streamline I/A approval processes	Medium - On schedule		Local industry interest
		1	Stony Brook University	SCDHS, SCDEDP, EPA , Southampton, NYSDEC, LIREDC	b. Participate in the creation of a Wastewater Institute at Stony Brook University	Medium - On schedule		
	1.5 Determine the range of technology options for advanced wastewater treatment by subwatershed to facilitate further prioritization for collective regional action	1	SCDHS	SCDHS, SCDEDP, SCDPW, USEPA, NYSDEC, NYSDOH, local stakeholders	a. Finalize RFP b. Engage stakeholders c. Identify priority subwatersheds d. Establish goals for nitrogen load allocation for watersheds, estuaries; Evaluate feasibility of enhancing effluent and review water quality goals e. Finalize methodology for parcel analysis for wastewater technology treatment options	Short term - On schedule		US EPA 3VS Systems Model NYSDEC nutrient criteria development, water body-specific TMDLs
	1.6 Evaluate the feasibility of updating the Sanitary Code to prohibit the "grandfathering" of State Pollutant Discharge Elimination System (SPDES) and/or SCDHS permitted sanitary flows that exceed and predate Sanitary Code density requirements on other than single-family residential lots, without the installation of an I/A OWTS or connection to sewers; review options to effect upgrades under ECL,NYCCR,SPDES	2	NYSDEC, SCDHS	SCDEDP, NYSDOH, local municipalities and stakeholders	a. Fund and conduct a feasibility study or health impact analysis of possible code changes	Short term - On schedule	Underway with existing staff and funding	

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen	1.7 Evaluate the feasibility of updating the Sanitary Code to prohibit the replacement of failed onsite wastewater technology (e.g., "replacement in-kind") without SCDHS approval.	1	SCDHS	SCDEDP, SCDPW, USEPA, NYSDEC, NYSDOH, Towns	a. Conduct a health impact analysis of possible Code amendments	Short term - On schedule	Health Impact Assessment funded by the US EPA	Stakeholder input
	1.8 Establish governance to enable the installation and compliance/performance monitoring of appropriate wastewater technology County-wide	1	SCDEDP	SCDPW, SCDHS, NYSDEC	a. Establish legal authority	Short term - On schedule		
					b. Establish wastewater management district			State approval
					c. Establish Responsible Management Entity to manage funding, implementation, operation and maintenance		Initial funding legislatively approved from the Suffolk County Water Quality Protection and Restoration Program	SCDPW, SCDHS, SCWA collaboration, see: http://www.werf.org/i/c/KnowledgeAreas/DecentralizedSystems/RMEsite/RMEs_2.aspx
					d. Staff Responsible Management Entity			Selected organizational approach
	1.9 Facilitate conditions for decentralized/virtual sewer districts, where appropriate with local neighborhood interest	1	SCDPW/ SCDHS	NYSDEC, SCDEDP, Towns, Stakeholders	a. Identify tax defaulted properties and develop siting standards for neighborhood sewage treatment plants	On schedule		
					b. Fund initial feasibility and engineering studies	Completed		
	1.10 Continue to maintain active oversight of existing STPs and operators to maintain compliance with effluent nitrogen limit; where possible and appropriate attain more stringent performance goals to protect groundwater and surface waters	1	SCDHS	NYSDEC	a. Continue monitoring and enforcement efforts	On-going, On schedule	Underway with existing staff and funding; continue to seek additional revenue streams	
			SCDHS	NYSDEC	b. Continue to evaluate new and improved technologies for nitrogen and PPCP removal	On-going, On schedule	Underway with existing staff and funding; continue to seek additional revenue streams	
	1.11 Continue to reduce nitrogen load from homeowner fertilizer application.	1	SCDEDP	SCDHS, PEP	a. Assess effectiveness of and potential improvements to Suffolk County Local Law 41-2007 to reduce nitrogen pollution by reducing use of fertilizer in Suffolk County. Suffolk County continues to use two and a half times the amount of residential fertilizer as any other county in NYS	Short Term, On schedule	Underway with existing staff and funding	Evaluation/documentation of effectiveness . Access and analyze additional public and private data on fertilizer inventory, revenue, and sales
		1	SCDEDP	SCDHS, PEP, NYSDEC, USEPA, CCE, municipalities	b. Enhance educational and advocacy efforts aimed at reducing the negative impacts of residential and commercial yard care (fertilizer and pesticides) on ground and surface water quality	Medium, On schedule	Suffolk County secured funding from NYSDEC for implementation in 2015	Funding
	1.12 Evaluate the feasibility of replicating the Riverhead Sewage Treatment Plant's initiative to re-use wastewater effluent for golf course irrigation countywide, where appropriate	2	SCDHS	SCDPW, NYSDEC	a. Conduct a feasibility study on implementing reuse at candidate sites	Short Term High Priority		Funding

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen	1.13 Work with agricultural community to reduce use and impacts of excess fertilization	1	SCDEDP	SCDHS, NYSDEC	a. Release updated Agricultural Stewardship Plan	Short term, On schedule		Funding
		1	SCDEDP	SCDHS, NYSDEC, PEP, NRCS, SCSWCD	b. Secure funding to implement the Agricultural Stewardship Plan, and continue to fund the CCE Agricultural Stewardship Program.	Short term, Continuous, On schedule		Funding
		1	Cornell Cooperative Extension	SCDHS, SCDEDP, NYSDEC	c. Provide technical staff to implement research, piloting, testing, reporting and education	Short term, Continuous, On schedule		Funding
		1	SCDEDP	Agricultural Stewardship Committee, NYSDEC, CCE, SCSWCD	d. Work with the agricultural community and other stakeholders to incentivize farmers, especially those participating in the County's purchase of development rights program, to implement BMPs to reduce nitrogen release to ground and surface waters.	Short term, Continuous, On schedule		
	1.14 Increase scavenger plant capacity to process waste from on-site system pump-outs	2	SCDPW		a. Evaluate capacity of existing facilities to receive and treat pump-out	Medium, On Schedule		Ability to expand existing capacity
	1.15 Seek ways to remediate existing nitrogen pollution and its impacts (see Coastal Resiliency & Surface Water Quality actions for more detail)	1	SCDHS	Estuary Programs, NYSDEC, SCWA, Scientists, Cornell Cooperative Extension	a. Continue to implement the Harmful Algal Bloom strategy, wetland stewardship, shellfish restoration; continue to support and fund the use, where appropriate, of marine plants and shellfish as biofiltration to reduce nitrogen in surface waters	On-going, On schedule		Funding, technology development, permitting, species selection for uncertified waters
		1	SCDEDP	Towns, NYSDEC	b. Mitigate the nitrogen and bacterial contribution from wildlife and pets by implementing public education and encouraging alternative population control measures	Short term, Not yet scheduled		
		2	USGS	SCDHS	c. Consider localized studies to evaluate nutrient flux from the sediments into the water column and evaluate sediment management options.	Medium, Not yet scheduled		
		2	SCDHS	NYSDEC and municipal partners	d. Encourage the development of pilot programs for the installation of permeable reactive barriers and other innovative in-situ water quality remediation techniques. Work to identify suitable locations for pilot installation, and support monitoring of effectiveness of nitrogen reduction	Short term, Not yet scheduled	Use existing resources and continue to seek supplemental funding sources	Suitable locations and technology effectiveness
		2	SCDHS	Towns, Villages	e. Consider changing densities in all hydrogeologic zones; evaluation of zone 4 would be the first priority, subject to cost benefit analysis	Short term, Not yet scheduled		Effectiveness of I/A OWTS

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
2.0 Volatile Organic Compounds (VOCs)	2.1 Implement VOC Action Plan	1	SCDHS		a. Identify and inspect high priority facilities (e.g., gas stations/dry cleaners)	Short term, Continuous, On schedule	$100,000 appropriated	Available funding
			SCDHS	NYSDEC, USEPA	b. Initiate enforcement activities to bring facilities into compliance and clean-up actions to address contaminant releases as necessary.	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Results of initial inspections
			SCDHS		c. Within an adaptive management framework, annually reassess inspection priorities, and continue to inspect the next category(ies) of high priority facilities. Based upon status and trends of VOCs detected in drinking water, refine monitoring and inspection strategies	Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources (see below)	
			SCDHS		d. Establish and apply a fee system to fund continued implementation of the inspection/compliance program.	Short term, On schedule		Number of facilities not in compliance with regulations/or with contaminant releases to the environment
			NYSDEC	USEPA	e. Develop and implement a Gas Station operator training/certification program	Medium term, Not yet scheduled		Available funding
			SCDEDP	SCDHS, SCLD	f. Continue to coordinate with Suffolk County Land Bank to identify, evaluate, and prioritize tax-defaulted environmentally contaminated properties	Short term, Continuous, On schedule	Use existing resources	Funding status for initial sites secured through EPA, NYS AG office and NYSDEC.
	2.2 Implement Reducing Toxics Capital Program	1	SCDHS		a. Develop approach to prioritize inspection of remaining 17,000 +/- facilities; consider prioritizing those within supply well contributing areas	Short term, On schedule	$100,000 from 1/4% Program	Available funding
			SCDHS	NYSDEC, NYSDOH	b. Inspect facilities in accordance with identified approach	Short term, Schedule under development	One full time equivalent person to begin implementation in 2016	Available funding
			SCDHS	NYSDEC, USEPA	c. Initiate enforcement/clean-up activities	Medium term, On schedule	Use existing resources and continue to seek supplemental funding sources	Available funding
			SCDHS	NYSDEC, USEPA	d. Continue to require that facility owners at VOC release sites perform soil vapor intrusion investigations where necessary and continue to identify new construction sites with soil vapor intrusion potential.	Short term, Continuous, On schedule	Underway with existing resources	Federal/state guidance, Town/village building codes
	2.3 Implement Remedial Actions	1	SCDHS	NYSDEC, USEPA	a. Initiate enforcement/clean-up activities, refer to Superfund as appropriate	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Available funding

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
2.0 VOCs	2.4 Increase awareness of harmful household products	1	SCDHS	SCDEDP, SCWA, SCDPW, USEPA, NYSDEC, NYSDOH	a. Continue to collaborate with other agencies, remain current on literature to identify bad actors and safer alternatives	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Availability of green alternatives, funding
			SCDHS	SCDEDP, SCWA, USEPA, NYSDEC, NYSDOH, Estuary Programs	b. Conduct public education and outreach to engage public and modify choices . Educate public about EPA Safer Choice labeling program and encourage consumers to adopt it	Short-term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Availability of green alternatives, funding
			SCDHS	NYSDOH, NYSDEC, Estuary Programs	c. Work with County and/or State Legislators to ban any harmful products/additives where viable alternatives are available and expand upon the Suffolk County's Green Clean Purchase program	Medium term, Not yet scheduled		Identification of harmful products with available alternatives, available funding
			SCDHS	Towns, SCDEDP, SCWA, NYSDEC, NYSDOH, USEPA, Estuary Programs	d. Increase awareness of and participation in Town STOP programs	Short-term, Continuous, On schedule		Convenience of/availability of Town programs, funding
	2.5 Implementation of sanitary sewering in priority areas	1	SCDPW	SCDEDP, SCDHS	a. Include areas with high priority facilities in areas to be served by sanitary sewers; see nitrogen recommendations	Medium term, Not yet scheduled		Available funding and competing priorities
	2.6 Continue to evaluate impact of cesspool additives	2	SCDHS		a. Monitor retailers and supply houses to identify drain cleaners and cesspool additives listing organic chemicals as ingredients, and work with companies that have not applied for product certification to remove the products from shelves, obtain certification of safety (if appropriate), or face possible fines.	Short term, Continuous, On schedule	Underway with existing resources	Identification of unregistered products containing organic chemicals

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
3.0 Pesticides	3.1 Work with Agricultural Community to Reduce Use and Impacts of Harmful Pesticides	1	SCDEDP	Cornell, SCDHS, NYSDEC, USGS	a. Update Agricultural Stewardship Program (also supports Nitrogen Recommendation 1.13 above)	Short term, On schedule		Funding
		2	SCDEDP	Cornell, SCDHS, NYSDEC, USGS	b. Establish Agricultural Stewardship Advisory Council	Short term, On schedule		Funding
		1	Cornell Cooperative Extension	SCDEDP, SCDHS, USGS	c. Continue to identify pesticides that are persistent/mobile and used on Suffolk County crops, and identify crop-specific integrated pest management or safer alternatives.	Short term, Continuous, On schedule		Funding, ability to identify more environmentally friendly alternatives, participation of the agricultural community
	3.2 Develop a comprehensive pesticide management strategy, incorporating SCDHS recommendations concerning establishment of a pesticide rating testing system that guides pesticide registration/re-registration and integrate into comprehensive lawn care management initiatives.	2	NYSDEC	SCDHS, CCE	a. Formally incorporate SCDHS into the pesticide registration process.	Short term, Not yet scheduled		NYSDEC priorities
		2	NYSDEC	SCDHS, CCE, USGS	b. Modify pesticide registration process to require piloting to assess leachability, mobility, persistence, toxicity or issue conditional registration with targeted monitoring until pesticide impacts are assessed. Work toward implementation of NYSDEC "Long Island Pesticide Pollution Prevention Strategy"	Short term, Not yet scheduled	NYSDEC, pesticide manufacturers	NYSDEC priorities, manufacturer participation
		1	NYSDEC	SCDHS, CCE, USGS	c. Initiate targeted monitoring in the event that a new pesticide is detected in groundwater and consider implementing use restrictions and/or re-registration requirements as appropriate. Work with collaborators to analyze for pesticides that PEHL can not analyze for	Short term, Continuous, On schedule		
	3.3 Increase public awareness of pesticide impacts and encourage use of safer replacements when possible.	1	NYSDEC	SCDHS, CCE, USGS	a. Outreach and education to engage public and modify choices. Enhance commercial applicator training	Short term, On schedule	Funded through NYSDEC	Ability to identify available, effective alternatives.

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
4.0 Pharmaceuticals and Personal Care Products (PPCPs)	4.1 Provide actionable information regarding use and disposal of household products, pharmaceuticals and personal care products	1	SCDHS	USEPA, NYSDEC, SCWA	a. Continue to monitor Contaminants of Emerging Concern (CECs), contaminants on the Contaminant Candidate Lists (CCL), and literature	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Cooperative opportunities, grant availability, other funding options
		1	SCDHS	USEPA, NYSDEC, SCWA	b. Identify safer alternatives to harmful ingredients/additives identified in PPCPs	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Cooperative opportunities, grant availability, other funding options
		2	SCDHS	USEPA, NYSDEC, SCWA, Group for the East End, Estuary Programs	c. Continue to collaborate with others to implement education and outreach program including development and posting of no-flush signs at pharmacies and identifying the locations of take-back programs. The Group for the East End reports that 2,000 lbs. of unused medications were disposed at seven police stations in east end towns during the first year of program implementation; the program was publicized via mailings, press releases, email blasts and radio and newspapers.	Continuous, On schedule	Implementation of the east end program has been provided through Feb 2016. Covanta Energy's RX disposal program is providing free destruction at the East Northport facility. Continue to use existing resources and continue to seek supplemental funding sources, including 1/4% funding for east end towns	Cooperative opportunities, grant availability, other funding options
	4.2 Continue to assess occurrence of PPCPs in groundwater as well as PPCP sources, to support development of informed management decisions	1	SCDHS	SCWA, USGS, NYSDEC	a. Increase PEHL capabilities to include the following analytes: cotinine, diltiazem, hydrochlorothiazide, meprobamate, metropolol, naproxen, 4-nonylphenol, phenobarbital, sulfamethoxazole, tramadol, Tributylphosphate (TBP), Triphenylphospate (TPP), Tri (2-butoxy-ethyl) phosphate (TBEP), Tri (2-chloro-ethyl) phosphate (TCEP), Tri (2-dichlorisopropyl) phosphate (TDPP) and the Ames test.	Short term, Continuous, On schedule	PEHL analytical capabilities have been expanded to include 1,4-dioxane; SCDHS has entered into a cooperative agreement with SCWA who will analyze approximately 50 samples from small public supply and private wells for seven PPCPs that currently cannot be analyzed by SCDHS PEHL	Funding options, cooperative opportunities
		1	SCDHS	SCWA, USGS, NYSDEC	b. Continue to expand analytical capabilities based on information from other investigations, occurrence data, and available information on mobility, persistence and toxicity	Short term, Continuous, On schedule	PEHL analytical capabilities have been expanded to include 1,4-dioxane; SCDHS has entered into a cooperative agreement with SCWA who will analyze approximately 50 samples from small public supply and private wells for seven PPCPs that currently cannot be analyzed by SCDHS PEHL	Funding options, cooperative opportunities
		1	SCDPW, SCDHS	USGS,USEPA	c. Implement PPCP Monitoring Plan to evaluate PPCPs in wastewater and effectiveness of existing treatment modalities	Short term, Continuous, On schedule		Funding
		1	SCDHS	SCWA, USGS, NYSDEC	d. Assess magnitude of 1,4-dioxane sources (e.g., industrial/commercial vs. household) by targeted monitoring downgradient of laundromats and other potential sources	Short term, Not yet scheduled	Use existing resources and continue to seek supplemental funding sources	
		1	SCDHS	NYSDEC	a. Update annual notice that goes out to all New York State registered facilities if and when changes/amendments are made.	Short term, On schedule	Use existing resources and continue to seek supplemental funding sources	Changes in regulations
		2	SCDHS		b. Work with facilities to keep them current and implement any changes/amendments as needed to stay compliant	Short term, On schedule	Use existing resources and continue to seek supplemental funding sources	

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
5.0 Potable Supply	5.1 To the extent that it is practical, extend community supply to all residents.	1	SCDHS	SCWA	a. Prioritize areas where availability of public supply should be provided	Short term, Continuous, On schedule	SCWA, customers and grants	Community support, infrastructure siting/permitting, funding
		1	SCWA	SCDHS	b. Identify supply sources (existing or new wells) as necessary	Short term, Continuous, On schedule	SCWA	Community support, infrastructure siting/permitting, funding
		1	SCWA	SCDHS	c. Design, construct and connect	Short term, Continuous, On schedule	SCWA	Community support, infrastructure siting/permitting, funding
	5.2 Implement conservation plan to reduce domestic and outdoor irrigation use	2	Suffolk County		a. Require rain sensors/moisture sensors in new sprinkler systems	Short term, Not yet scheduled		Enforcement
		2	Suffolk County	Cornell Cooperative Extension	b. Identify daily irrigation needs on website	Short term, Not yet scheduled		
		2	Suffolk County		c. Implement odd/even irrigation program for non-agricultural properties	Short term, Not yet scheduled		Enforcement
		2	Suffolk County water suppliers		d. If other conservation measures are ineffective, then implement conservation measures including conservation pricing/seasonal rate pricing	Short term, Not yet scheduled		
		2	Suffolk County	SCWA and suppliers, Estuary Programs	e. Implement public outreach/education program to encourage use of water conservation plumbing fixtures	Short term, Schedule varies		
	5.3 Provide safe drinking water to all residents	1	Suffolk County water suppliers	SCDHS	a. Incorporate sub-standard supplies into SCWA or other effectively managed municipal water district.	Short term, Continuous; Schedule varies		
		1	SCDHS		b. Increase capability to analyze private well samples	Short term, Continuous, Not yet scheduled		Funding
		1	SCDHS		c. Increase outreach to private well owners	Short term, Continuous, Not yet scheduled		Funding
		2	SCDHS		d. Increase private well income exemption to $50,000/year	Short term, Continuous, Not yet scheduled		Funding
	5.4 Evaluate Lloyd aquifer	3	NYSDEC	SCDHS, USGS,SCWA	e. Investigate potential impacts and safe yield of water supply pumping from the Lloyd aquifer. Identify and quantify conditions under which the commissioner of NYS DEC can grant exemptions to non coastal communities to pump water from the Lloyd aquifer	Medium, Not yet scheduled	No funding in place	Scope, work plan and funding

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.1 Develop a cross departmental leadership team to implement the Reclaim Our Water initiative and manage the County's water from 'cradle to grave.'	1	SCDEDP	SCDHS, SCDPW, SCWA, County Attorney		Completed		
	6.2 Secure the resources and staff necessary to implement the initial phases of the Water Resources Management Plan	1	SCDHS		a. New positions are being filled	Underway, On schedule	Funding from Suffolk County and NYSDEC	
	6.3 Explore the feasibility of operating the existing 193 sewage treatment plants in Suffolk County under the control of the Suffolk County Department of Public Works	1	SCDPW	SCDEDP, SCDHS, NYSDEC	a. Complete sewer consolidation analysis	Short term, Not yet scheduled		
	6.4 Integrate water and wastewater operations	2	SCDEDP	SCDHS, SCDPW, SCWA	a. Assess the feasibility and business case for consolidation	Medium term, Not yet scheduled		
		2	SCDEDP	SCDHS, SCDPW, SCWA	b. Define a future operating model for water and wastewater operations across the County	Medium term, Not yet scheduled		
		2	SCDPW	NYSDEC, Municipalities	c. Evaluate feasibility of including stormwater utility development	Medium term, Not yet scheduled		
	6.5 Facilitate communities to embrace the solutions for improving water quality	1	Suffolk County	SCDEDP, SCDHS, SCDPW, NYSDEC, Estuary Programs, Towns	a. Provide easily accessible information on water quality through online and social media outlets for public knowledge and use	Ongoing, On schedule		
		1	SCDHS	USEPA, Estuary Programs	b. Develop the economic and social value of clean water to our region	Short term, On schedule	Funding secured by EPA for an ecological assessment study and US EPA 3V scoping project which will build social capital among decision makers and stakeholders on water quality issues and more.	
		1	Suffolk County	County, State, Federal and nonprofits	c. Conduct a marketing campaign around the need for upgraded septic systems (2014 Crapshoot Video contest, Teleconference Town Hall with the County Executive)	Ongoing, On schedule	Funding secured	

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.6 Implement a comprehensive integrated data collection, analysis and evaluation program to monitor groundwater, drinking water and surface water, and guide informed protection and management strategies. Reinstate comprehensive groundwater and stream monitoring program and report annually	1	SCDHS	USGS, SCWA, USEPA, NYSDEC, NYSDOH	a. Collaborate to provide sampling and analytical capabilities to assess contamination by Contaminants of Emerging Concern (CEC) and contaminants on the Contaminant Candidate Lists (CCL)	Short term, On schedule	Position funded for dioxane, cooperative effort with SCWA established	Plethora of new analytes, laboratory capacity, funding, cooperator analytical capabilities and funding
		1	SCDHS		b. Enhance SCDHS's capabilities to respond to home owners request for private well testing and increase the ability to perform private well surveys of areas of suspected contamination	Short term, Not yet scheduled		Laboratory capacity, funding
		1	NYSDEC	SCDHS	c. Require that all non-residential private wells report well location, depth, screened interval and pumpage to NYSDEC	Short term, Continuous, Not yet scheduled		Legal authority, cooperation
		1	SCDHS		d. Continue community and non-community well sampling	Short term, Continuous, On schedule		
		1	SCDHS	NYSDEC	e. Pesticide monitoring in target areas	Short term, Continuous, On schedule	NYSDEC grant	Farmer cooperation, analytical capabilities and capacity
		1	SCDHS, SCWA	NYSDEC	f. Salt water intrusion monitoring	Short term, Continuous, On schedule		
		1	SCDHS	NYSDEC	g. Groundwater monitoring in industrial areas based on Reducing Toxics capital program	Short term, Continuous, Schedule under development		
		1	SCDHS	USEPA	h. Beach Monitoring in compliance with BEACH act	Short term, Continuous, On schedule	BEACH Act Grant HSV-2355	
		1	SCDHS	USGS, Estuary Programs, Stony Brook University	i. Implement stream and estuary monitoring programs	Short term, Continuous, On schedule		Analytical capabilities and laboratory capacity
		1	SCDHS	USEPA, NYSDEC, Towns, USGS, Stony Brook University, Estuary Programs	j. Monitor to support TMDL programs	Short term, Continuous, On schedule		
		1	SCDHS	USEPA, NYSDEC, NYSDOH, USGS, SCWA	k. Continue to update data collection and analytical capabilities to support decision making and consideration of emerging issues	Short term, Continuous, On schedule		
		1	SCDHS	NYSDEC, USGS	l. Update water level monitoring program, focus in particular on unsewered near-shore areas to assess impact on on-site wastewater systems	Short term, Continuous, Not yet scheduled		Resources

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.7 Implement and upgrade the Bureau of Public Health Protection and Division of Environmental Quality databases and enhance their capabilities to provide a comprehensive integrated geo-coded data management program for all regulated facilities, public and non-residential private wells (location, pumpage and quality), private well quality, groundwater and surface water quality data, salt water intrusion monitoring data, facility data, inspection records, STP Discharge Monitoring Reports (DMRs) and monitoring data and on-site wastewater management systems' installation, maintenance, inspection and performance	1	SCDHS SCDOIT	SCDPW, SCDEDP	a. Develop scope of work, issue RFP and select data management system	Short term, On schedule with 2015 Capital Program	Capital Project 4081	Funding
		1	SCDHS SCDOIT	SCDPW, SCDEDP	b. Populate database, develop protocols and provide access and training	Short term, On schedule with 2015 Capital Program	Capital Project 4081	Funding
		1	SCDHS SCDOIT	SCDPW, SCDEDP	c. Migrate existing databases to new platform	Medium, On schedule with 2015 Capital Program	Capital Project 4081	Funding
		1	SCDHS SCDOIT	USEPA, NYSDEC, Suffolk County, Estuary Programs	d. Utilize database to access information for management and decisions	Medium, Continuous, On schedule with 2015 Capital Program		Funding
	6.8 Adapt the business processes in the Suffolk County Department of Public Works and Department of Health Services to meet expanded integrated water management responsibility	1	Suffolk County	SCDPW, Performance Management	a. Identify process owners and change agents to prioritize and lead improvement initiatives, create action plans to eliminate problem areas and duplicative work, measure improvements	Ongoing, On schedule		
	6.9 Establish standards for the digital transfer of water quality data parameters between ELAP certified laboratories and NYSDOH, NYSDEC and stakeholders.	2	NYSDOH	SCDHS, NYSDEC, ELAP approved Laboratories	a. Establish Electronic Data Transfer (EDT) standards for water quality parameters	Medium, NYSDEC has standard for non potable water. NYSDOH has no standard.		Funding, Staff
	6.10 Work closely with federal, state and local partners to share readily accessible, actionable information, identify synergies and share resources	1	Suffolk County	USEPA, NYSDOH, NYSDEC, NYSDOS, Towns & Villages, SCWA and other suppliers, stakeholders	a. Produce annual water quality reports on-line including identification of improving trends, areas of concern, new issues	Short term, Continuous, Not yet scheduled		Cooperation and resources
	6.11 Evaluate feasibility of inter-governmental water resource cradle to grave data management plan.	1	Suffolk County	USEPA, USGS, NYSDEC, NYSDOH, SCDHS, SCWA	a. Identify key partners and assess volume of data of interest, data format, plan for periodic EDT updates	Short term, Continuous, Not yet scheduled		Funding, cooperation
		1	Suffolk County	USEPA, USGS, NYSDEC, NYSDOH, SCDHS, SCWA	b. Incorporate key partners' data into County data management plan RFP	Short term, Continuous, Not yet scheduled		Funding, cooperation
		1	Suffolk County	USEPA, USGS, NYSDEC, NYSDOH, SCDHS, SCWA	c. Complete project, mine data from key partners, share access to database with water resource managers/partners	Short term, Continuous, Not yet scheduled		Funding, cooperation
	6.12 Continue to evaluate and address the impacts of composting facilities ,dump sites, micro plastics , sand mines and other emerging contaminants upon water resources	2	SCDHS,CCE, Municipalities	NYSDEC	a. Conduct targeted groundwater monitoring down gradient of composting facilities and work with NYSDEC to define classes of composting and assess appropriate response activities	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Results of groundwater monitoring

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.13 Continue to acquire land and development rights for open space based on water quality criteria	1	SCDEDP	SCDHS	a. Within the context of the SCDEDP's Comprehensive Master List and land acquisition procedures, prioritize parcels within the 50 year contributing area to public supply wells and 25 year contributing area to surface water features for preservation	Continuous, On schedule		Available funding and other priorities
	6.14 Delineation of ground-water source areas and times-of-travel to Long Island streams and estuaries	1	USGS	TNC,SCDHS,NYSDEC	a. Delineate groundwater sources areas and travel times to Long Island streams and estuarine embayments, and (2) produce geospatial layers and metadata that describe these delineations for public dissemination via the Internet.	Short term, Proposed, Not yet scheduled		Funding, cooperation
	6.15 To the extent that it is practical and cost effective incorporate the values and methodologies of EPA's Triple Value decision support tools into the implementation of SCCWRMP	2	SCDHS	SCDEDP	Incorporate the tools of EPA's 3VS into the decision making process of plan implementation	Continuous, Not yet scheduled		Training
	6.16 Optimize compliance with SEQRA regulations. Participate in SEQRA process with towns and other municipalities	2	SCDPW, SCDHS, NYDEC	EPA,NYSDOH, SCWA	Complete Environmental Impact Statement where appropriate.	Medium - On schedule		
	6.17 Coordinate plan implementation with local municipalities. Participate in SEQRA review process and provide data, tools and guidance to municipalities .	2	Towns	SCDHS, SCDPW, SCDEDP, Stakeholders	In implementing plan, county state and municipalities should optimize inter-governmental coordination. This includes participating in SEQRA review, use of GIS coverages (travel times to surface waters and public supply wells), training sessions on wastewater alternatives and programs. SCDHS should continue to use priority sensitive zones (50 yr. to public supply wells 25 yr. to surface water) for programs such as TDR, STP siting, wastewater upgrades and pollution source tracking.	Medium - On schedule		
	6.18 Continuously collect, tabulate and review performance measures of key program elements.	2	Towns	SCDPW, Stakeholders	Annually review key performance indicators and programmatic outcomes. Adaptively manage programs to maximize outputs. At five year intervals reassess programs and goals and key performance indicators	Continuous On schedule		

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
7.0 Coastal Resiliency and Surface Water Quality	7.1 Continue to coordinate regional efforts to address Harmful Algal Blooms by developing and implementing the Harmful Aquatic Blooms Action Plan	1	SCDHS / New York State Sea Grant	SCDHS, NOAA, CCE, PEP	a. Complete HAB Action Plan	Short term, Preliminary Plan Sept. 2015, Final Plan Sept. 2016	SCDHS has developed a work plan and budget for the program.	
	7.2 Coordinate with Federal, State, and local partners to continue to assess the vulnerabilities to sea level rise in Suffolk County and develop action plans that mitigate impacts	1	Suffolk County	NYSDEC, NYSDOS, FEMA, EPA, USACOE, TNC, NY Rising, Estuary Programs, SCSWCD	a. Identify critical areas and review options for sanitary code revisions to address long term needs. Work with local municipalities to help implement Climate Action Plans	Medium term, Underway, On schedule		
	7.3 Implement the Fire Island to Montauk Point project in coordination with the Army Corps of Engineers and appropriate stakeholders	1	US Army Corps of Engineers	Suffolk County, NYSDEC, towns and stakeholders		Short term, Ongoing, On schedule	The Fire Island to Montauk Point (FIMP) project, on the drawing boards since 1964 in various iterations, was allocated $700M by the Superstorm Sandy relief bill. Preliminary projections approximate $450M for road and house elevations, with 7 million cubic yards (cy) of sand borrowing from the Atlantic going to a $207 million, 19 mile-long, 9.5 foot berm to 15 foot dune line interfaced with beach nourishment, plus $60M for green infrastructure projects.	
	7.4 Support the practical implementation of ideas generated by the Rebuild by Design teams	1	New York State			Medium term, Not yet scheduled		
	7.5 Support the implementation and expansion of NY Rising Community Reconstruction Program	1	New York State	Suffolk County		Short term, ongoing, On schedule	Various projects throughout Suffolk County including the "Living" Marsh Grand Canal Levee Improvement	
	7.6 Implement and expand Wetlands Stewardship Strategy efforts throughout Suffolk County	1	SCDEDP	SCDPW, Estuary Programs	a. Implement ongoing and recently funded projects, continue to seek new funding for priority projects identified by stakeholders	Short term, Ongoing	$1,310,000 grant to Suffolk County from the NFWF for Integrated Marsh Management. $525,000 for Smith Point HMGP and $600,000 from NRCS .	
	7.7 Develop drainage strategies in chronically flooded areas through the installation of green infrastructure measures like permeable pavers	1	SCDPW	Estuary Programs, Municipalities, SCSWCD		Short term, Not yet scheduled		Funding
	7.8 Develop a robust stormwater management program in coordination with local municipalities and New York State	1	Suffolk County	NYSDEC, local municipalities, Estuary Programs	a. Assess the effectiveness of current program and funding allocations. Update town codes as necessary.	Short term, Not yet scheduled		
		2	SCDPW	Towns, NYSDEC, SCSWCD	b. Improve coordinated management of streams/sediment removal	Medium Term, Not yet scheduled		
		2	Towns	Suffolk County	c. Continue to support municipal stormwater efforts using Suffolk County Water Quality Protection and Restoration funding	Ongoing	Suffolk County Water Quality Protection and Restoration Program	

Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
7.0 Coastal Resiliency and Surface Water Quality	7.9 Assess the feasibility and effectiveness of hardening coastal infrastructure and the potential to incorporate living shoreline concepts wherever possible and effective.	1	SCDPW, USACE	SC Parks, Estuary Programs NYSDEC, Municipalities	a. Feasibility study completed; identify early implementation tasks and funding sources	Completed		
	7.10 Support the development of an Inter-municipal Agreement among the East End towns and Villages and Suffolk County with the Peconic Estuary Program to implement water quality initiatives	1	PEP	Suffolk County, East End towns	a. Continue to provide funding for the development of clear and measurable outcomes within the Peconic Estuary	Completed	Resolution 440-2014	
	7.11 Examine feasibility of participating in/initiating other inter-municipal agreements (e.g. Northport Harbor, Oyster Bay/Cold Spring Harbor)	2	Suffolk County	Municipalities	a. Prioritize existing funding for joint water quality improvement initiatives	Short Term, PEP IMA Approved by Suffolk County others pending		LISS,SSER, Municipalities
	7.12 Continue to support and coordinate with the Peconic Estuary Program, Long Island Sound Study, and the South Shore Estuary Reserve Program to implement projects	1	Suffolk County	Estuary Programs	a. Provide in-kind staff and financial support to advance the implementation of stakeholder driven initiatives	Short term, Ongoing, On schedule		
	7.13 Optimize the use of data, computer models and TDRs to minimize the siting of wastewater facilities in 25 and 50 year travel time to surface waters and public supply wells.	1	SCDPW, SCDHS, NYDEC, Private industry	SCWA, stakeholders	a. Disseminate water quality, hydrologic data and computer model outputs to optimize siting. Implement SPDES action limits for enhanced performance standards, ensuring nitrogen loading is reduced compared with as-of-right unsewered alternative	On going	Suffolk County Water Quality Protection and Restoration Program	
	7.14 Continue to evaluate and promote development of improved pollution control management measures and structures	2	Towns	Suffolk County	a. Work with towns promote structural and non-structural methods to reduce pollutants	On going		

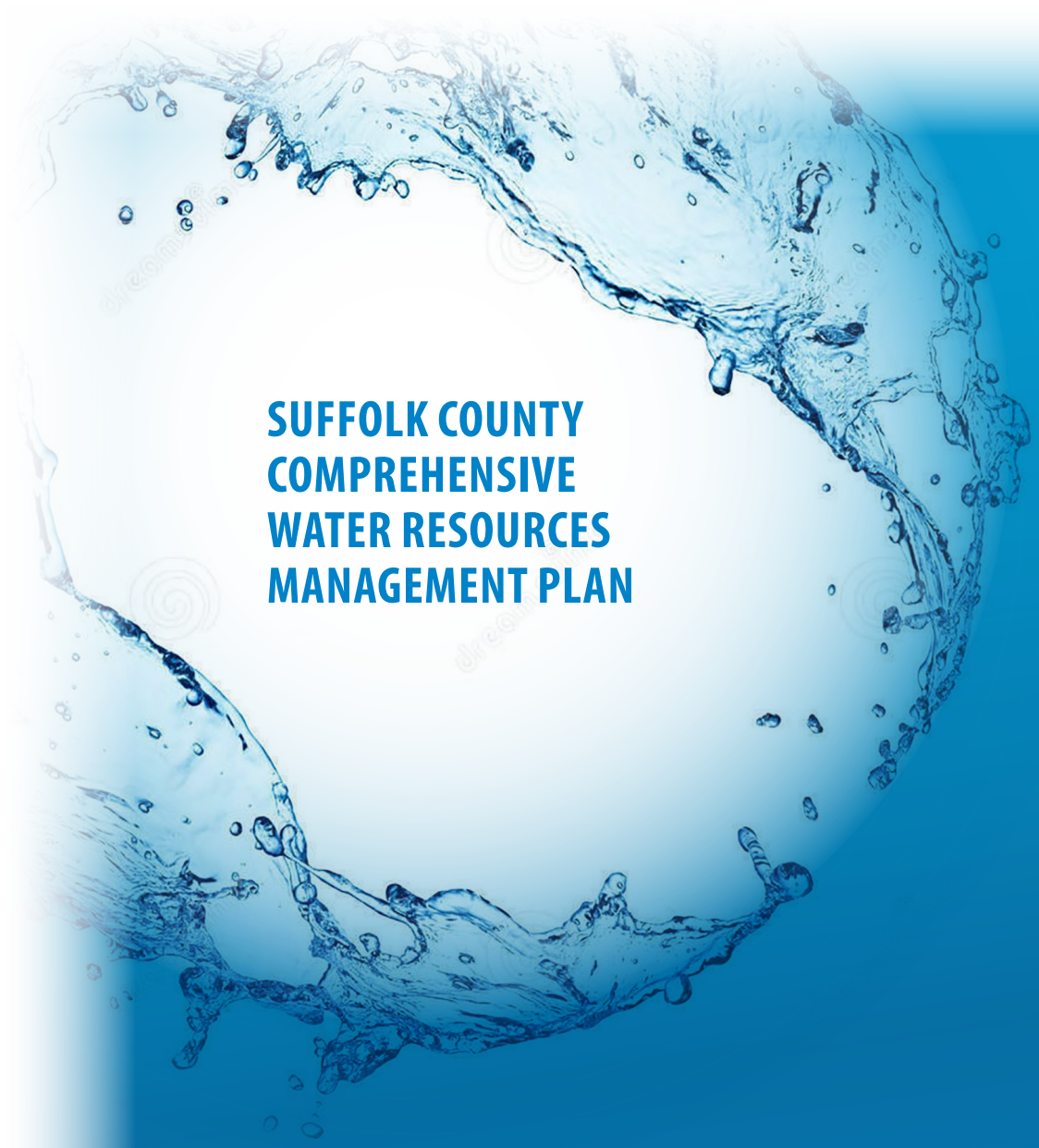
Key:

Priority - 1 highest to 3 lowest

Schedule - short term - < 5 years
5 years < medium > 10 years
Long term > 10 years

LIST OF ACRONYMS

CCE	Cornell Cooperative Extension	NYSDOS	New York State Department of State
CP	Capital Program	NYSEFC	New York State Environmental Facilities Corporation
ECL	Environmental Conservation Law	PEP	Peconic Estuary Program
ELAP	Environmental Laboratory Accreditation Program	RFP	Request for Proposal
ESDC	Empire State Development Corporation	SCDEDP	Suffolk County Department of Economic Development and Planning
FDA	Federal Drug Administration	SCDHS	Suffolk County Department of Health Services
FEMA	Federal Emergency Management Agency	SCDOIT	Suffolk Department of Information Technology
HMGP	Habitat Management Grant Program	SCDPW	Suffolk County Department of Public Works
I/A OWTS	Innovative Alternative Onsite Wastewater Treatment System	SCDPW	Suffolk County Department of Public Works
IMA	Inter-Municipal Agreement	SCLD	Suffolk County Law Department
LCV	League of Conservation Voters	SCWA	Suffolk County Water Authority
LIREDC	Long Island Regional Economic Development Council	SCSWCD	Suffolk County Soil and Water Conservation District
LIRPC	Long Island Regional Planning Commission	SPDES	State Pollutant Discharge Elimination System
LISS	Long Island Sound Study	STP	Sewage Treatment Plant
NFWF	National Fish and Wildlife Federation	SSER	South Shore Estuary Reserve
NOAA	National Oceanic and Atmospheric Administration	TNC	The Nature Conservancy
NRCS	National Resources Conservation Service	USACOE	United States Army Corps of Engineers
NYSDEC	New York State Department of Environmental Conservation	USEPA	United States Environmental Protection Agency
NYSDOH	New York State Department of Health	USGS	United States Geological Survey



SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Section 1
VALUING WATER

Section 1
Valuing Water

The Value Proposition

"Price is what you pay. Value is what you get." – Warren Buffett

"Value is expressed and measured in the eye of the beholder." – IBM Wiki

"From California's historic drought to Toledo's pollution crisis, the country's water challenges have captured the national spotlight." – Brookings

1.1 The Value Proposition

It's Our Planet's Most Valuable Resource
Cities Are Powered by It…People Fight over It…Life Depends on It…

"*Whiskey is for drinking and water is for fighting*." -old saying in the West

William Mulholland, the Robert Moses of Los Angeles' water infrastructure, oversaw construction of the 233-mile Los Angeles Aqueduct that made the L.A. of today possible. Completed less than a year before the Panama Canal, diversion of water from the once fertile Owens Valley into the parched San Fernando Valley ignited the notorious California water wars with farmers dynamiting the aqueduct siphoning their water to L.A., as shown on **Figure 1-1.** "*There it is. Take it*," Mulholland declared upon completion. "*If you don't get the water, you won't need it*."

In the Chinatown film dramatization of events, a former L.A. mayor lays out the case for water infrastructure in front of a map of the PROPOSED ALTO VALLEJO DAM AND RESERVOIR:

"*Gentlemen, today you can walk out that door, turn right, hop on a streetcar and in twenty-five minutes end up smack in the Pacific Ocean. Now you can swim in it, you can fish in it, you can sail in it but you can't drink it, you can't water your lawns with it, you can't irrigate an orange grove with it. Remember we live next door to the ocean but we also live on the edge of the desert. Los Angeles is a desert community. Beneath this building, beneath every street there's a desert. Without water the dust will rise up and cover us as though we'd never existed*!"

SECTION 1 VALUING WATER

Figure 1-1 L.A. Aqueduct Dynamited in Response to Being SOLD Out in the Owens Valley (Source: http://www.moviestillsdb.com/movies/chinatown-i71315/i6a828 http://green.blogs.nytimes.com/2012/04/25/the-water-fight-that-inspired-chinatown/?r=0)

Though both are situated on oceans, Long Island, unlike Los Angeles, is naturally lush, sitting atop a sole source aquifer producing seemingly boundless freshwater. But surface waters surrounding us are impaired and groundwater quality is trending in the wrong direction. We pay a negligible amount for our potable water and the majority of Suffolk County expends nothing to treat it once it is used. Assigning no real value to water, we take it for granted. Much of the rest of world is not so fortunate. What, then, is the **value proposition** of water quality for Long Islanders?

Suffolk Water = 1/6 of a penny per gallon

The Suffolk County Water Authority (SCWA) distributes over 80% of the county's groundwater. SCWA is a public benefit corporation operating pursuant to New York State Public Authorities Law, Article 5, Title 4. SCWA is the largest provider of groundwater in the nation, pumping and delivering approximately 70 billion gallons of potable water each year through nearly 6,000 miles of pipe from 581 active wells and 234 pump stations. In its May 31, 2014 financial report, SCWA showed water service operating revenues of $138.45M and assessed its net capital (water plant) assets at $1,077.32M.

SECTION 1 VALUING WATER

"Nothing is more useful than water, but it will purchase scarce anything"
– Adam Smith, "Wealth of Nations"

In Suffolk County it costs $66.80 to fill this 40,000 gallon pool

Note that, unlike SCWA which levies no fee for wastewater treatment, Fairfax County Water Authority (FCWA) in Virginia charges a multiple of 1.7:1 for 'sewer usage' versus 'water usage.' If a sewerage usage charge were incorporated into SCWA's billing comparable to that in Fairfax, approximately $236M would be generated per annum to address wastewater treatment. As a point of comparative business performance, FCWA more than doubles SCWA's operating income to sales ratio, 0.37:0.15, and the FCWA's debt-to-asset ratio is ⅔ of SCWA at 0.36:0.56 (Water Utility Privatization: A Comparison of Commercially-Owned and Government-Owned Utilities, Maryland Tax Education Foundation, 2008).

SCWA charges $1.67 for 1,000 gallons of potable water or about what one might pay for a pint of Poland Springs. Put another way, bottled water costs 8,000 times as much as SCWA water. It is just about the cheapest water in the nation, one-third the average cost. Unlike the majority of systems that integrate water delivery and treatment, SCWA assigns no charge for wastewater treatment. Residents in the nearly 30% of the County that is sewered pay annually for advanced wastewater treatment; the balance of the County is free of such responsibility. Given the extremely low unit cost for water, water bills go largely unnoticed. As a result, there is, effectively, no cost pressure to conserve and discourage excessive use. Consumers are accustomed to low water rates and frequently protest rate hikes (Apple Valley News 2014).

This graphic, from the SCWA web-site, makes a point of price comparison between water that is "vital to life," and perfume. "Most of us in the U.S. don't even realize how inexpensive the water we get from our tap is." Note that the price of SCWA water is nearly one-third the U.S. average. And SCWA assigns nary a penny to treating the water that is largely contaminated upon delivery and filters untreated back into the aquifer.

Product	Average Price $USD/Gallon
Tap water	$0.0048
Coca-Cola	$3.00
Gasoline	$4.00
Tide laundry detergent	$8.50
Imported beer	$12.00
Evian bottled water	$25.00
Starbucks latte	$22.00
Pepto-Bismol	$65.00
Vicks Formula 44D cough syrup	$100.00
American whiskey	$150.00
Visine eye drops	$750.00
Revlon nail enamel	$1,000.00
Good French wine	$1,000.00
Chanel No. 5 perfume	$45,000.00

Water bills in the U.S. amount to 0.6-0.9% of national household income (Congressional Budget Office, "Future Investment in Drinking Water and Wastewater Infrastructure," Nov, 2002). France is estimated at 2.2%, UK at 2.2% and Hungary at 6.2%. Rate increases for this under-valued commodity nevertheless can be expected to meet resistance, as observed recently in Ireland. A newly imposed charge for water in the Emerald Isle's water-soaked climate has gotten their Irish up, as illustrated by **Figure 1-2.**

Figure 1-2 Government Says It Needs Money for Infrastructure, But Some Citizens Say They Are Willing to Go to Prison for Refusing to Pay

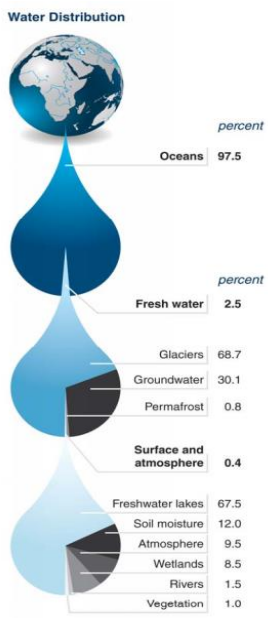
"A household of five will pay €584 ($730). The government notes it was one of the last nations in the western world to bring in water charges, and says it needs the imposition to invest in infrastructure, and promote conservation, the latter because of EU directives on water and the environment (The Guardian, 10/31/14)." From 11/22/14: Irish Prime Minister's party suffers dip in popularity after water charge protests/ Opinion poll shows only 22% would vote for Enda Kenny's centre-right Fine Gael party. **https://www.facebook.com/pages/Protest-against-water-charges-in-the-republic-of-Ireland/213410058694008**.

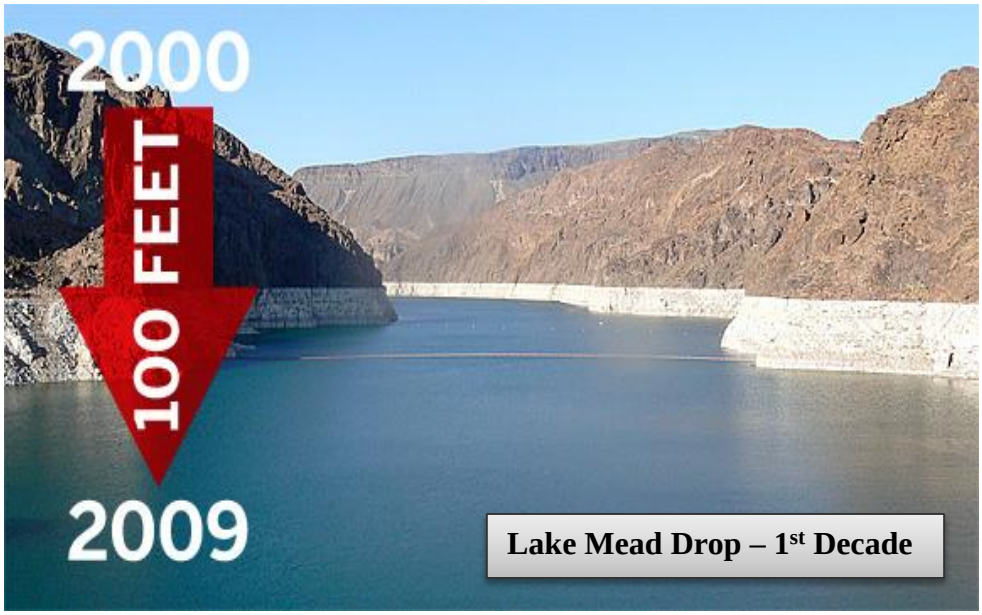
SECTION 1 VALUING WATER

The Irish Times editorialized: "*This claim to EU ownership of a God-given resource…includes the water that falls from the sky, that flows in rivers, springs and underground, water that fills our wells, lines our coasts and stretches out to sea and presumably the water that makes up 60 per cent of our bodies.*"

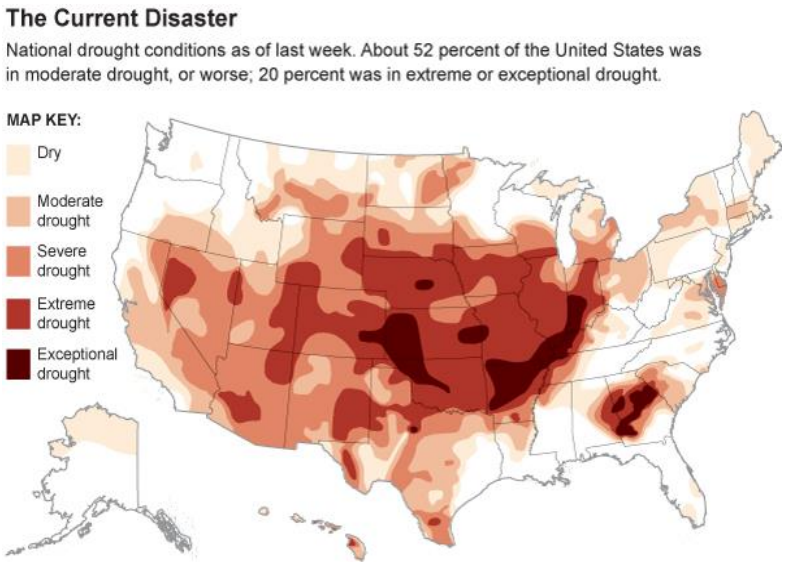
There is a yawning chasm between the demands on water systems and an acceptance of responsibility for meeting those demands. "The price of water going into Americans' homes often does not even cover the cost of delivering it, let alone the depreciation of utilities' infrastructure or their Research & Development (New York Times, 'The Risks of Cheap Water,' 10/14/14)." Absent rate reform, many utilities will remain financially incapable of evaluating, testing, and adopting new technologies. As for willingness to pay (WTP), evidence shows that hypothetical mean WTP exceeds actual mean WTP by an average ratio of 1:4. With WTP and valuation of ecosystems, economists are merely taking stabs to divine some monetary measure of what increased well-being is worth to people (D. MacMillan, "Actual and Hypothetical Willingness to Pay for Environmental Outputs: Why Are They Different? University of Aberdeen, 2004).

With fifteen years of drought across the Southwest, conflict has morphed into crisis with unprecedented declines in reservoir storage and groundwater reserves. "Californians as a whole have failed to conserve water during the worst drought in a generation." (*California Adopts $500 Criminal Penalty for Water Waste,* Sacramento Bee, 7/15/14).





(Source: Global Water Security – Intelligence Community Assessment, February 2012, page 4 http://www.fas.org/irp/nic/water.pdf)



August 21, 2012

1.2 Global Water Security & Scarcity

"Energy Security" fed "Energy Independence" which became a driver for the "drill, baby, drill" promoters (U.S. now neck and neck with Russia and Saudi Arabia as the world's top oil producers) as well as the drive for renewable energy. While climate has been the principal concern fueling renewable alternatives, the U.S military embraced renewables for remote operating locales and theaters of combat, particularly forward operating bases where the logistics of delivering fossil fuels is costly, daunting and produces unacceptable fatalities (http://www.defenseindustrydaily.com/commanders-in-iraq-urgently-request-renewable-power-options-02548/). As oil reserves make realms like Iraq of strategic interest to the U.S. leading to military presence, so too will regional conflicts over water.

As the world's premier power, the U.S. military is obliged to factor issues of climate and overtaxed resources. The following summarizes the assessment that was prepared under the auspices of the Director of the Strategic Futures Group and drafted by the Defense Intelligence Agency (October 2011). A significant

portion of this report focuses on the opportunities, particularly in terms of agricultural water use which constitutes an estimated 70% of the global total. Suffolk County should take particular heed from the standpoint of economic development. The spirit of Long Island's aerospace industry past could mesh with its water resource industry future to evolve into a water management mecca akin to the Netherlands of today. (http://www.dni.gov/files/documents/Special%20Report_ICA%20Global%20Water%20Security.pdf)

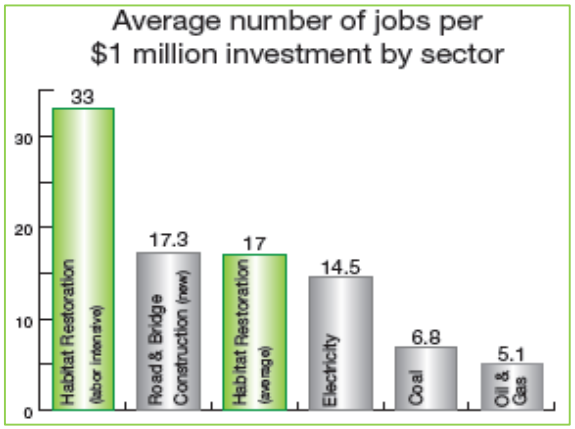
***Bottom Line**:* During the next 10 years, many countries of import to the United States will experience water problems—shortages, poor water quality, or flood. As a result they will risk instability and state failure, increased regional tensions, and distract them from working with the United States on important U.S. policy objectives. Between now and 2040, fresh water availability will not keep up with demand absent more effective management of water resources. Water problems will hinder the ability of key countries to produce food and generate energy, posing a risk to global food markets and hobbling economic growth. The ISIS takeover of the Haditha Dam on the Euphrates, among others, demonstrates both threat and strategic advantage of water assets:

ISIS Push for Iraq's Dams Draws American Airstrikes

CBS/AP September 7, 2014, "U.S. officials have expressed concerns that militants could flood Baghdad and other large swaths of the country if they control the dams. It also would give the group control over electricity, which they could use to strengthen their control over residents. Water is a precious commodity in Iraq, a largely desert country of 32.5 million people. The decline of water levels in the Euphrates over recent years has led to electricity shortages in towns south of Baghdad, where steam-powered generators depend entirely on water levels."

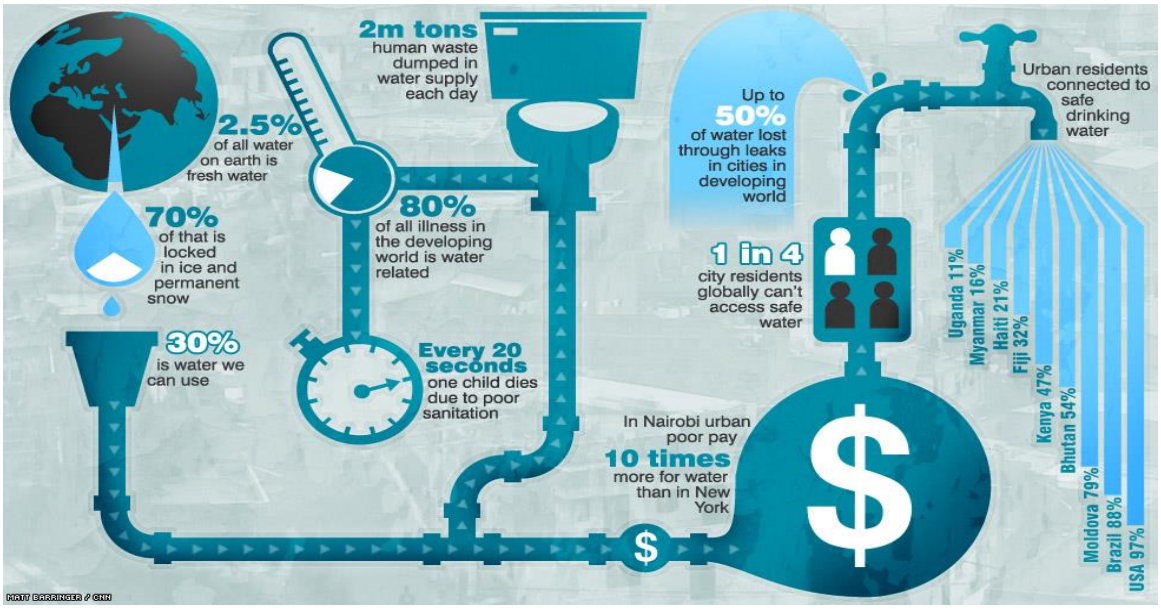
"From now through 2040, improved water management (e.g., pricing, allocations, and "virtual water" trade) and investments in water-related sectors (e.g., agriculture, power, and water treatment) will afford the best solutions for water problems. Because agriculture uses approximately 70 percent of the global fresh water supply, the greatest potential for relief from water scarcity will be through technology that reduces the amount of water needed for agriculture."

Opportunity: States with water problems will require integrated water, land use, and economic data which the U.S. is positioned to provide via satellite, other remote sensing data and hydrological modeling tools. The U.S. will realize increased demand for agricultural exports as water scarcity increases in various regions of the world.



Unlike other economic sectors, restoration jobs can't be outsourced to far-off places. According to the Oregon Ecotrust study, an average of $0.80 of every $1.00 spent on a restoration project stays in the county where the project is located, and $0.90 stays in the state. (file:///F:/Resilience/Restoration%20jobs-NOAA_2012.pdf).

Water technology will evolve to address expected changes in salt-tolerant crops and point-of-use applications for safe



(Source: http://www.cnn.com/SPECIALS/road-to-rio/secret-life-drinking-water/)

consumption of untreated water in areas not served by community supply. Membrane and other nanotechnology applications dominating current desalination and water-purification industries are likely to be the most productive. Desalination, economically feasible for household and industrial water, is not currently feasible for agriculture and faces challenges.

- As desalination processes produce a saline concentrate, the environmental impact of using or disposing this concentrate poses a hurdle.

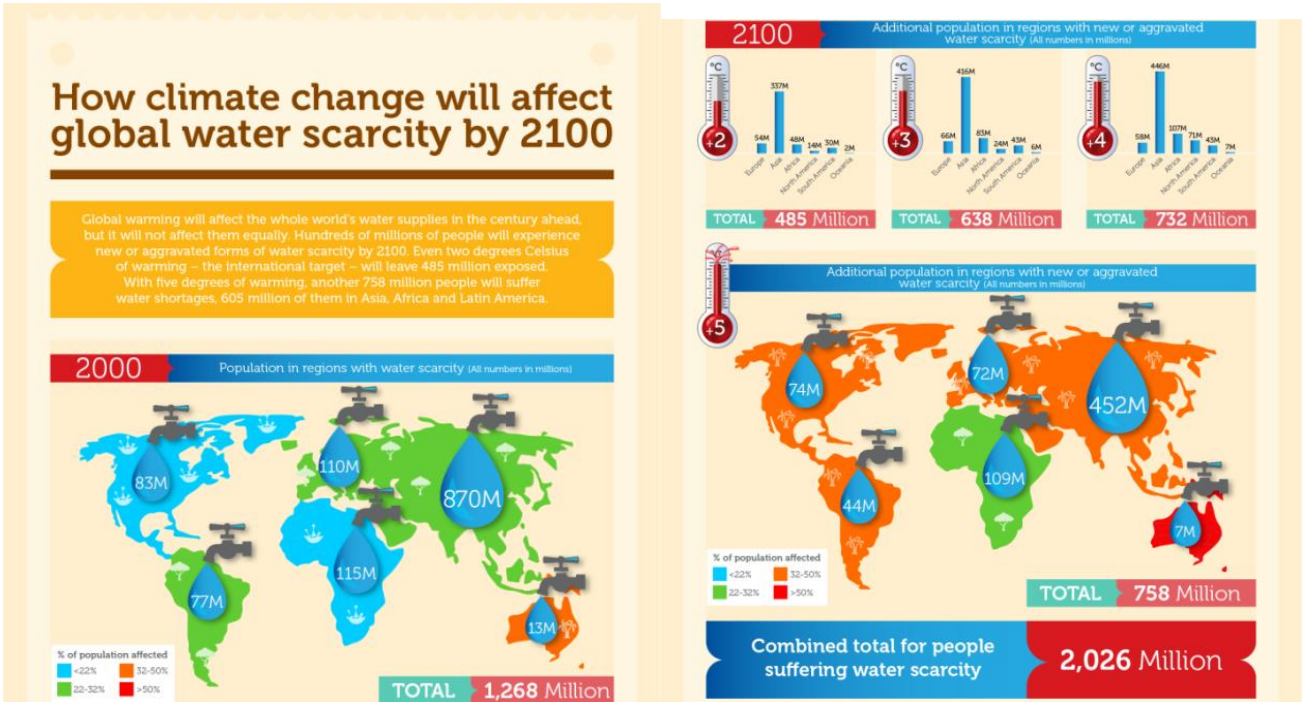
- Given the low price of water charged in most regions of the world, users are less motivated to adopt technologies such as desalination and drip-irrigation systems. For industry and households, water prices in developed countries range from $0.60/cubic meter ($2.27/1000 gallons) to more than $3/cubic meter ($11.36/1000 gallons). Recent data indicate that desalination processes produce water at much higher costs: $0.61/cubic meter for reverse osmosis, and $0.72/cubic meter to $0.89/cubic meter for thermal processes compared to prevailing rate of $0.10/cubic meter ($0.39/gallon)for agriculture use.

- Advances in large-scale drip-irrigation systems are the most likely approach to address water shortages for agriculture.

- During the next three decades, selected crops could be developed that require half the water used by current crops, but drought resistance in crops remains problematic.

- Contamination of coastal aquifers and contraction of freshwater lenses on small islands—due to saltwater intrusion as sea level rises, coupled with contamination by more extensive storm surge incursions is expected. "Reality is already setting in among low-lying island nations, like the Marshall Islands, where rising seas are soaking coastal soil, killing crops and contaminating fresh water supplies. 'The groundwater that supports our food crops is becoming inundated with salt," said Tony A. deBrum, foreign minister of the Marshall Islands. "The green is becoming brown." (New York Times, Optimism Faces Grave Realities at Climate Talks, 11/30/14)"

Limited experiments are being conducted to develop food plants that can tolerate salt or wastewater (see: http://www.desertcorp.com/). The advances in biotechnology may result in new plants or genetically altered strains that can grow in saltwater from the ocean or large saltwater aquifers. Point-of-use water-purification technology relies upon portable, self-contained systems favored by recreational enthusiasts and military personnel, and will be spread in the developing world where drinking water is drawn from untreated sources (e.g., rivers, lakes).



Euractiv.com - Infographic

On average, a child dies from a water-related disease every 15 seconds, according to a 2006 United Nations Human Development Report. Unsafe drinking water and poor sanitation are leading causes of death in the developing world for children under age 5. Close to half of all people living in developing nations are suffering from a health problem related to water and sanitation deficits.

Drawing attention through school communities to the plight of other children via a charitable drive may be a means by which to indirectly uplift appreciation for the Value of Water.

Harnessing water resources was pivotal in the development of the United States. Water infrastructure investments helped overcome regional divisions and brought prosperity. The Pacific Northwest transformed from indigence in the 1930s to one of the most economically successful regions in the world. The change was even more dramatic in the south with the introduction of the Tennessee Valley Authority (TVA). There is contention over water in the West and Southeast, but mechanisms are in place to redress, ostensibly. Globally, the U.S. is a leading exporter of "virtual water" (absorbed in manufacturing or growth). Given the abundance of inexpensive water, that is a distinct strategic advantage for Suffolk County both in terms of export but also from the standpoint of attracting water dependent businesses.

Virtual water: the water used (or consumed) in the development or production of a good or commodity, typically agricultural products. In general, livestock products have a higher virtual water content than crop products. For example, the global average virtual water content of maize, wheat, and rice (husked) is 900, 1,300 and 3,000 cubic meters per ton (m^3/ton) respectively, whereas the virtual water contents of chicken meat, pork, and beef are 3,900, 4,900 and 15,500 m^3/ton respectively. The biomass needed to produce one liter of biofuel (under currently available conversion techniques) consumes between 1,000 and 3,500 liters of water, on a global average. **Figure 1-3** that posts the water consumption of production of a cotton versus polyester shirt at 7:1 is but one so-called 'footprint.' Energy use in millijoules per kilogram (MJ/KG) of fiber organic cotton is 14, for conventional cotton 55, and for polyester 125. KG of CO_2 emissions per ton of spun fiber for crop cultivation is 4.2 and fiber production is 1.7 for a total of 5.9 KG CO_2/ton (Stockholm Environment Institute). Polyester's fiber production spews 9.52 (Dev, Vivek, "Carbon Footprint of Textiles", April 3, 2009, http://www.domain-b.com/environment/20090403_carbon_footprint.html).

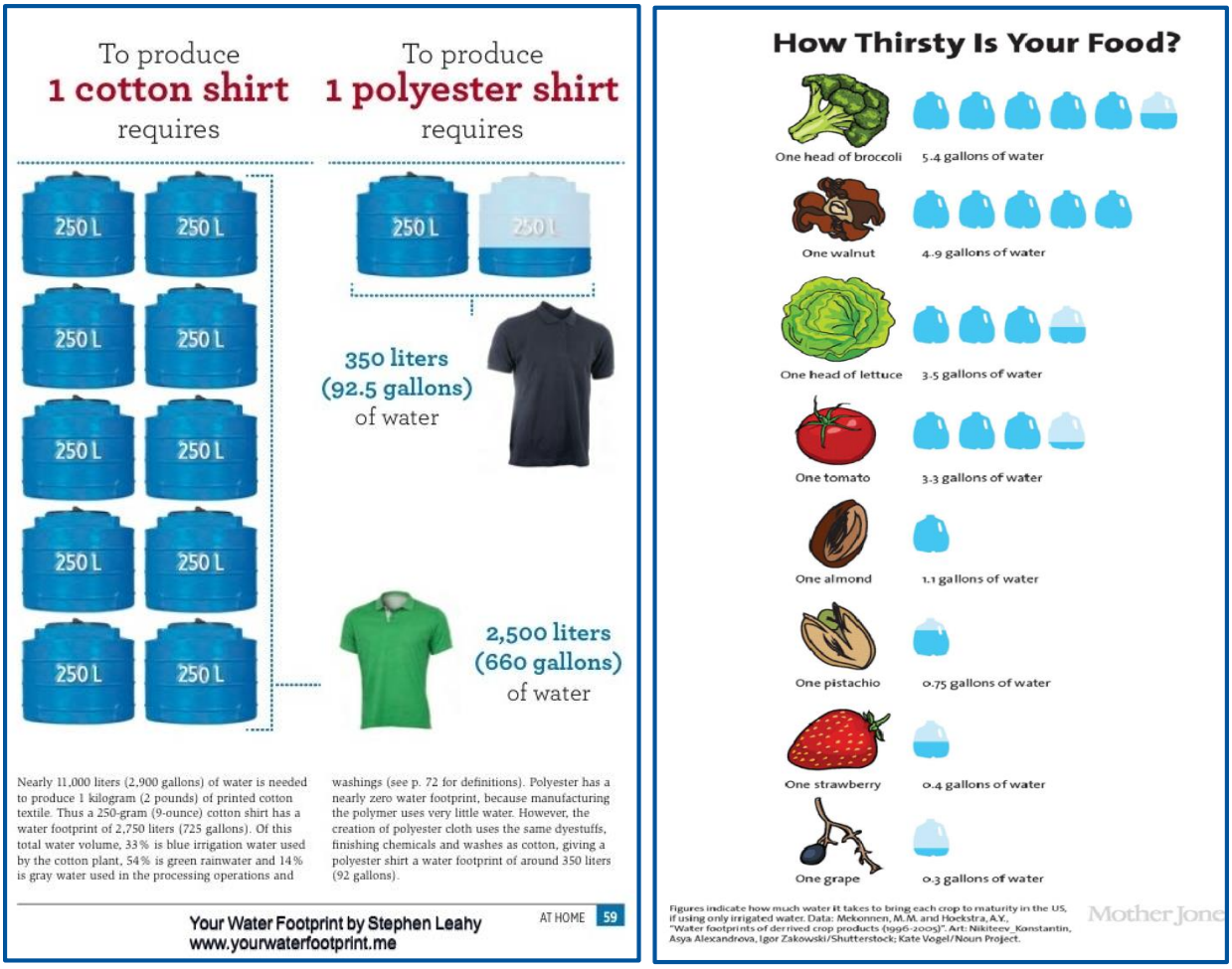


Figure 1-3 Water Required to Produce Clothing and Food

Prediction: Resource valuation, capturing associated cost/benefit 'externalities' will go beyond academic speculation and slowly become more 'internalized' in market pricing.

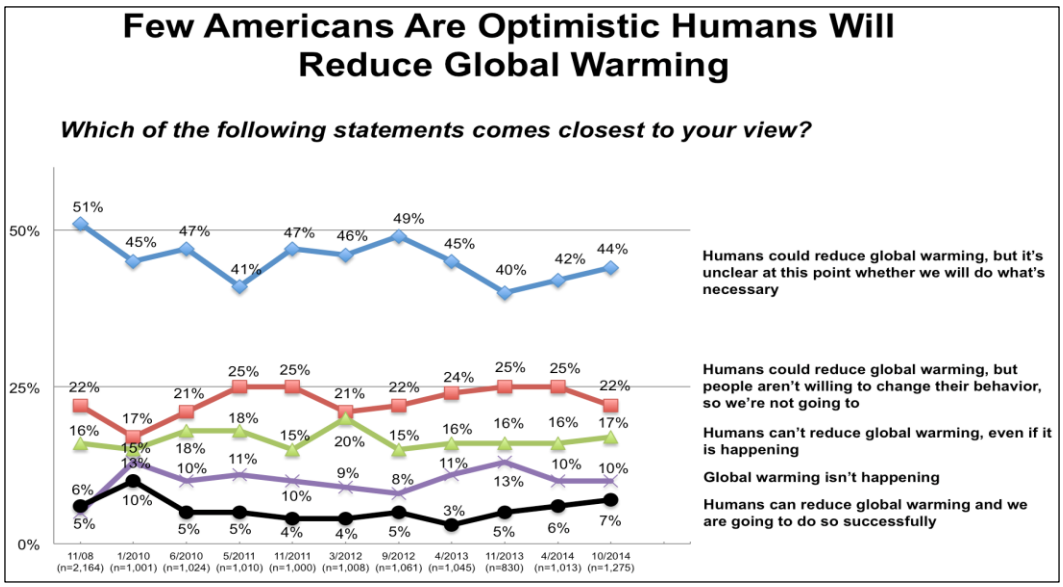
1.3 Public Opinion/Outreach

Public opinion is a moving target; polls are snap shots in time whose queries are often ambiguous. They fail to capture resonant neural images that are more revealing of the brain's limbic-centered decision-making process. In a Gallup snap shot earlier this year, (http://www.gallup.com/poll/168236/americans-show-low-levels-concern-global-warming.aspx) concern for polluted water polled at nearly double the rate of global warming (60% v 34%), showing that people care about their environment not the environment. In talking about concerns and challenges, make it personal. "Reclaim Our Waters" is about "your" well-being.

Major agents of change, such as Henry Ford with automobiles and Steve Jobs with personal computers declared, in no uncertain terms, that they have led the charge in making new markets, absent demand or consumer surveys. "If I had asked people what they wanted," said Ford, "they would have said faster horses." And Jobs said, "People don't know what they want until you show it to them." Market makers are leaders who envision possibilities, marry them to needs and desires and make them accessible. Maslow has said, "If you don't know where you are going any road will take you there." If public opinion is ambiguous, at best, *is it a driver, passenger or going through driver's education*?

Issues of climate change, sea-level rise and coastal resiliency have been largely depoliticized on Long Island. Just as the saying goes, there are no atheists in the foxhole, climate denial is far less prevalent on Long Island than elsewhere. Living on the frontlines of sea-level rise and vulnerability to extreme storm events, concern is bipartisan. To paraphrase Samuel Johnson, there is nothing like a storm the magnitude of Sandy to focus the mind. "As an island that juts out into the Atlantic, we are as vulnerable to climate change as any place in the world.... This is not an academic exercise for Long Island.... This is an existential challenge we are facing." -Steve Bellone https://www.youtube.com/v=erqy9_230Ns&sns=em.

Survey participants are conflicted on environmental issues or, rather, lack clarity on cause, effect and remedy. A Yale poll ("Climate Change in the American Mind," Yale Project on Climate Change Communication, Leiserowitz, A., et al, Oct, 2014) on climate change reveals that only 10% know that well over 90% of climate scientists say that global warming is largely man-made (with fewer than half believing a majority do). Over half of Americans (56%) say they are at least "somewhat worried" about global warming, but only 11% say they are "very worried" about it. About one in five Americans (22%) say they are currently part of – or would "definitely" or "probably" be willing to join – a campaign to convince elected officials to take action to reduce global warming.

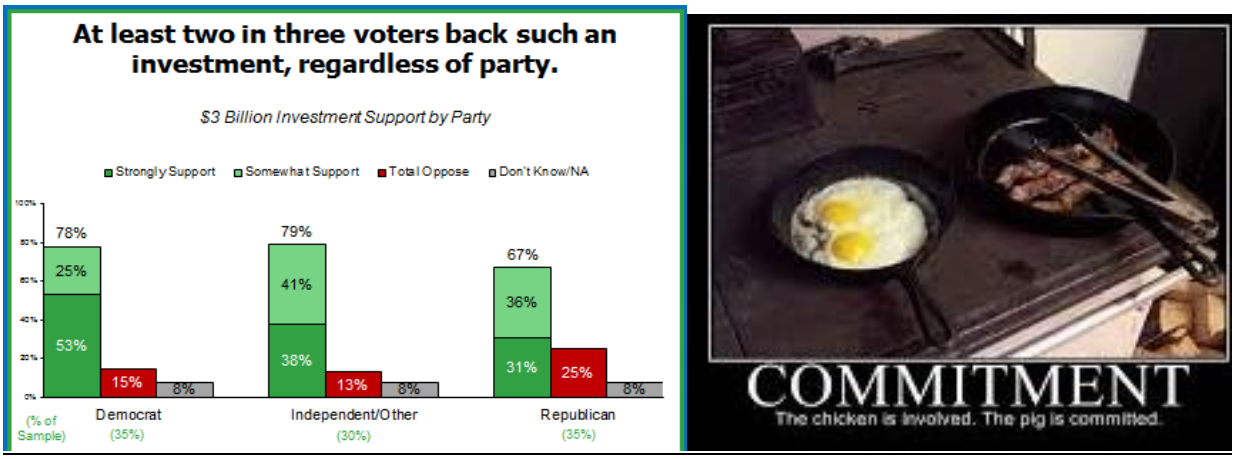


Over the past two decades, the environment has been distinctly politicized. Twenty-five years ago a Republican representative sponsored H.R. 1078 (101st): Global Warming Prevention Act of 1989; today that

scenario would have a snowball's chance on an overheated planet. There are now "two Americas" when it comes to global warming perceptions. America was largely on the same page back in 1992, according to Pew Research, when an overwhelming majority in both parties favored stricter laws and regulation; the gap is now a gaping 39%.

Some have proposed bridging the divide, by reframing the issue as a sociocultural appeal. Welcoming the latest EPA pronouncement on carbon pollution, the CEO of the Evangelical Environmental Network said, "From acid rain to mercury to carbon, the coal utility industry has never acted as a good neighbor and cleaned up their mess on their own. Instead of acting for the benefit of our children's lives, they've internalized their profits while our kids (have) borne the cost in their brains, lungs and lives (Washington Post, 12/2/14)." Here, too, however, the divide has been cleaved to further extremes by fundamentalist heavyweights like Focus on the Family: "one of the greatest threats to society and the church today is the multifaceted environmentalist movement (http://www.resistingthegreendragon.com/)."

Local polling, sponsored by The Nature Conservancy and conducted by FM3 and Public Opinion Strategies, indicate the one consensus issue at the national level – water quality – draws even greater support from Long Islanders augmented by a willingness to actually invest to that end. The big challenge is moving the dial from a pledge to a contribution to total commitment; or, the differing investment made in a bacon & egg breakfast by the diner, chicken and pig.



Yale Project on Climate Change Communication

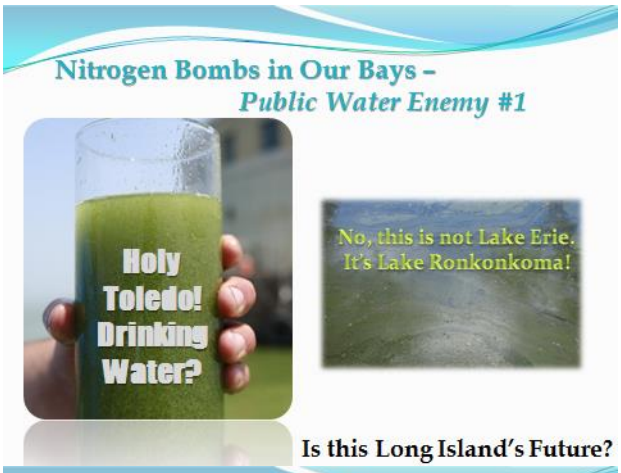
County Executive Bellone launched the **Reclaim Our Waters** initiative at the turn of the year by introducing the revised Executive Summary of the 2015 Suffolk County Comprehensive Water Resources Management Plan. He sounded the alarm over "devastating impacts on our surface water, declines in the quality of our drinking water and enhanced risks for future storms. For the health of our region today and for the sake of future generations, we must reverse these trends." Six weeks later, following his State of the County address, the County Executive hosted a town hall teleconference that drew nearly ten thousand participants, leading to other widely publicized events, identified on **Figure 1-4**.

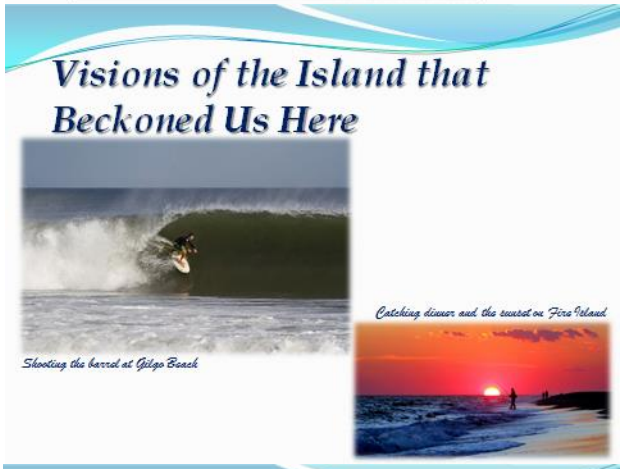
Figure 1-4 Reclaim Our Waters Initiatives Completed in 2014

John Bargh, professor of psychology at Yale, says "We're finding that we have these unconscious behavioral guidance systems that are continually furnishing suggestions through the day about what to do next, and the brain is considering and acting on those, all before conscious awareness (http://www.nytimes.com/2007/07/31/health/psychology/31subl.html?pagewanted=all)." Cognitive scientist Alex Pouget writes in the journal Neuron of the good news: "Once we started looking at the decisions our brains make without our knowledge, we found that they almost always reach the right decision, given the information they had to work on" (http://www.rochester.edu/news/show.php?id=3295).

As a counterpoint, neuroscientists Amos Tversky and Daniel Kahneman were awarded the 2002 Nobel Prize in Economic Sciences for research that posited that people customarily don't make rational decisions ("The Framing of Decisions and the Psychology of Choice," Science, New Series, Vol. 211, No. 4481. Jan. 30, 1981, pp. 453-458). In "Predictably Irrational" and "The Upside of Irrationality." Duke behavioral economist, Dan Ariely, makes lemonade out of this existential lemon, something akin to meditating on paradoxical koans. Dependence on reason must be abandoned in order to force-flash insight: 'what is the sound of one hand clapping?' To paraphrase Dante, 'Abandon all reason, ye who enter here.'

1.4 Messaging: Scare and/or Care



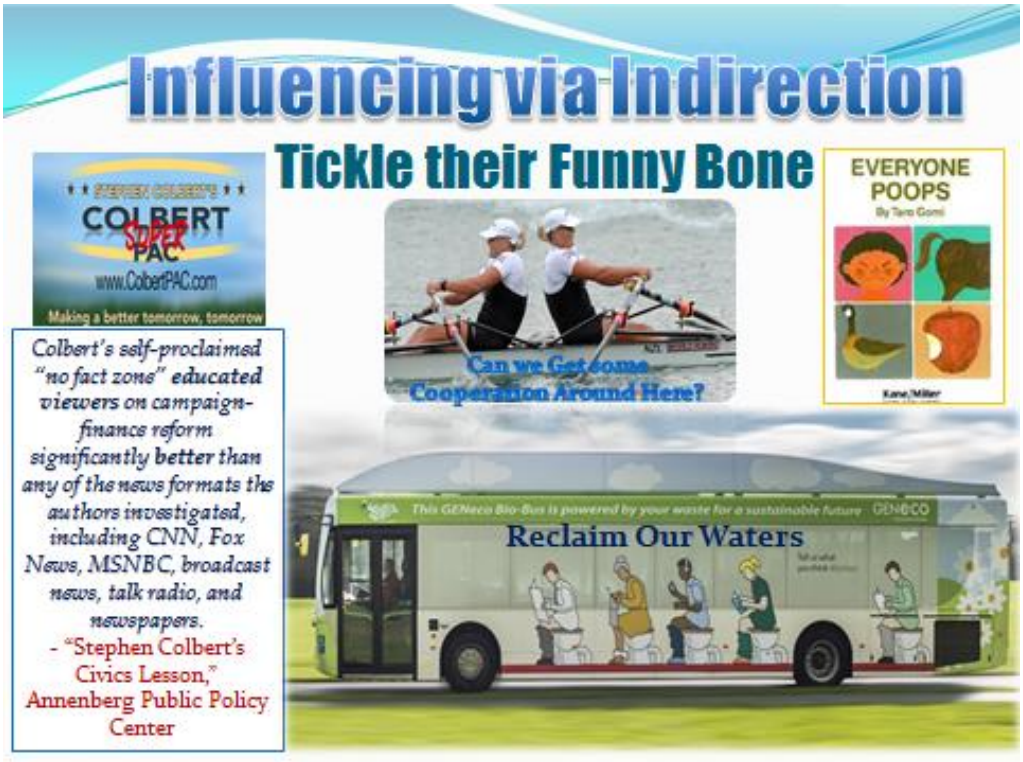


Dubbed the Manipulative Prince, no one has more effectively framed contemporary debate than 'Word Doctor' Frank Luntz, substituting "Death Tax" for the estate tax and "Exploring for Energy" for drilling for oil. With the frame "Climate Change," Luntz bumped "Global Warming" to the back-burner and defined the

debate on his clients' terms. "It's not what you say," Luntz reminds would-be shape-shifters, "it's what people hear." Plus what they pay attention to and sub-cognitive influences they absorb.

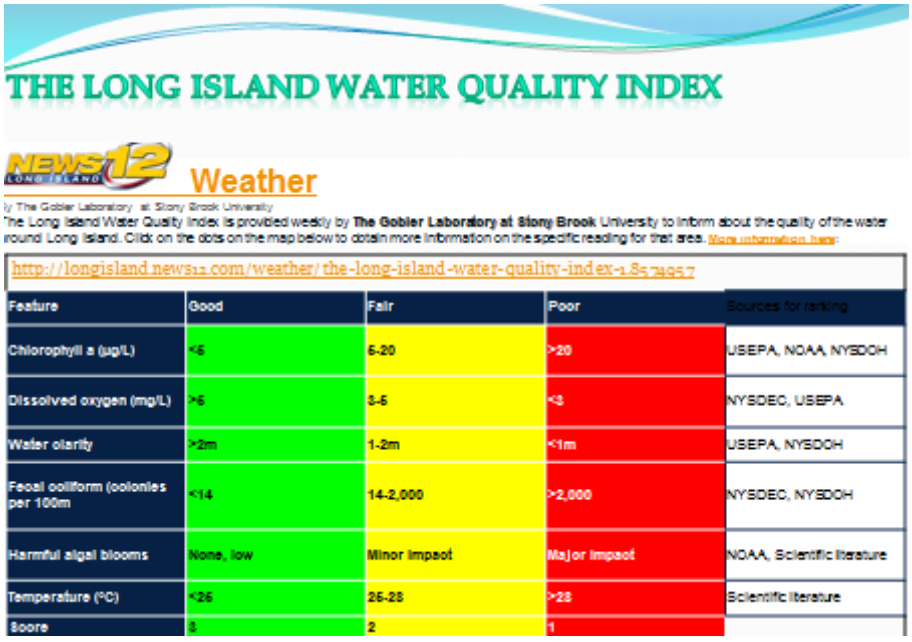
Robert Kenner's 2015 documentary, "Merchants of Doubt," based upon a 2010 book of the same title by historians of science, Naomi Oreskes and Erik M. Conway, makes a primal observation about the so-called climate debate: "Why don't people change their minds when new data comes in about climate? Because it isn't about the data. It's about me being a consistent tribal member and showing my fellow tribal group members that you can count on me."

It's the messenger who gives meaning to the message. More often than not, people hear what they want to hear. "You get at a man through his own religion and not through yours," notes George Bernard Shaw. No one, despite the risks he faced, donned that Shavian clothing more masterfully than Nelson Mandela when he asserted himself as the #1 fan of the Springboks, a symbol of apartheid South Africa (https://www.youtube.com/watch?v=qV5SIFBmfaM).



Home ownership, its rewards and gratifications, has been the leading draw for the half-million+ families living in Suffolk County. Moreover, owning a home in Suffolk is enriched by all variety of natural bounties and recreational options, enhanced by what Nancy Rauch Douzinas describes as Long Island's "legendary range of attractions - a stunning suburban environment in close proximity to the business capital of the world; one of the most storied vacation areas in the world (president of the Rauch Foundation, Huffington

Post, 12/2/14)." For most, their house is their primary asset. Maintenance and enrichment of that asset is welcome; factors devaluing that asset present critical concern to homeowners.



THE LONG ISLAND WATER QUALITY INDEX

NEWS12 LONG ISLAND Weather

by The Gobler Laboratory at Stony Brook University

The Long Island Water Quality Index is provided weekly by **The Gobler Laboratory at Stony Brook University** to inform about the quality of the water around Long Island. Click on the dots on the map below to obtain more information on the specific reading for that area. More information here:

http://longisland.news12.com/weather/the-long-island-water-quality-index-1.8574957

Feature	Good	Fair	Poor	Sources for ranking
Chlorophyll a (µg/L)	<5	5-20	>20	USEPA, NOAA, NYSDOH
Dissolved oxygen (mg/L)	>5	3-5	<3	NYSDEC, USEPA
Water clarity	>2m	1-2m	<1m	USEPA, NYSDOH
Fecal coliform (colonies per 100m	<14	14-2,000	>2,000	NYSDEC, NYSDOH
Harmful algal blooms	None, low	Minor impact	Major impact	NOAA, Scientific literature
Temperature (°C)	<25	25-28	>28	Scientific literature
Score	3	2	1	

The onslaught of Superstorm Sandy exposed various water-borne vulnerabilities. Long Islanders now know, with certainty, that the surrounding waters which are such an attraction can also wreak havoc. In the wake of the storm, a report from New York State's Department of Environmental Conservation (NYSDEC) indicted the nitrogen pollution carried by the untreated wastewater from 74% of Suffolk houses. Nitrogen is deemed the leading culprit in the breakdown of the County's second line of defense – our wetlands. Nitrogen was previously held liable in the decimation of the hugely productive shellfish industry and regular outbreaks of harmful algal blooms. This bleak scenario provides the frame for alarm: **Nitrogen Is Public Water Enemy #1**. We are not discussing the environment; we're talking about **our environment**.

Reclaim Our Waters is the caring counter frame to the nitrogen nemesis.

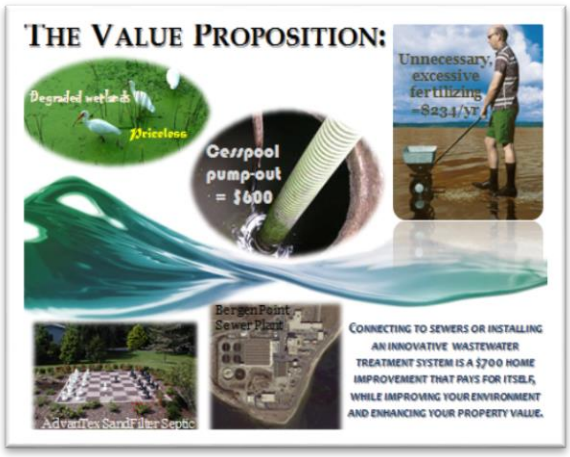
- By reclaiming our waters, we will be restoring the level of water quality that is now but a distant memory for Suffolk residents.
- Cleansing God-given resources that haven't been suitably shepherded will be redemptive.
- Reclamation of our waters asserts pride of joint ownership and the common good from which we all benefit.
- The quality of the drinking water drawn from beneath our feet, the condition of surrounding waters in which we disport, these are vital to our well-being and, yes, the value of our primary asset.

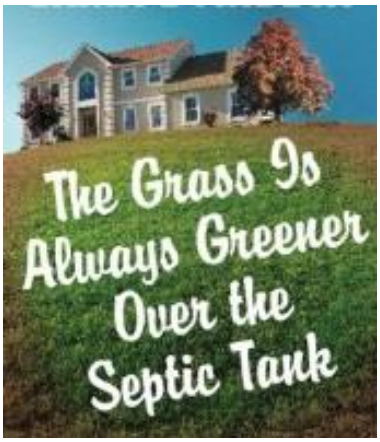
1.5 The *Value* Proposition of Home Improvement

"Connection or social bonding is central to the product's **value proposition**.... When introducing a radically new product, it is necessary to understand how consumers currently frame their experience of the problem addressed by the new offering. That is, no matter how radical a new product is, it will always be perceived initially in terms of some frame of reference. It is essential that this frame be understood (Zaltman, op. cit. http://hbswk.hbs.edu/item/3246.html)."

Market mission: *Projecting and packaging advanced wastewater treatment as a must-have home improvement for 360,000 homeowners, the vast majority of whom already see water quality as their #1 environmental concern - a problem that is now presenting a solution.*

How, then, to make a home-improvement mass market for state-of-the-art wastewater treatment, given its position, hidden beneath that suburban icon – the lush, green lawn? Conceivably that very factor holds a key. Could innovative/alternative septic system come to be considered buried treasure for an ever greener garden?





A leading challenge in the home improvement market is exemplified by the classic marble countertop counter to energy efficiency. Why would a homeowner go with insulation blown into an attic and walls no one sees rather than a kitchen makeover they can show off? This was one of several barriers the Town of Babylon faced when devising the pioneering retrofit program called Long Island Green Homes. Rather than making it a zero-sum, either/or choice between a nifty new kitchen or energy efficiency, Green Homes made it so the homeowner could have both. With the energy efficiency retrofit assigned as a benefit assessment, it paid for itself from utility bill savings, and wasn't financed with conventional debt. The homeowner could do the kitchen or install solar panels, whichever they

preferred.

But where carbon has been 'internalized' as a direct saving to the homeowner on their utility bill, nitrogen cannot be comparably monetized, at present. The existing cost of periodic pump-outs might work for some with high groundwater, but not nearly enough to offset current carrying costs for most. The enhanced property valuation for being connected to sewers or advanced wastewater treatment has yet to be definitively established, so it remains a data point that could clearly be a driver. Integrating the septic drain field in a way that provides natural fertilization could diminish or eliminate the estimated $320/year (www.healthylawns.suffolkcountny.gov) that the average Suffolk homeowner spends to fertilize their lawns.

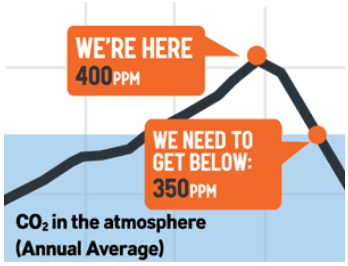
Simultaneous with piloting septic upgrades, Suffolk will set up a responsible management entity (RME) in concert with a county-wide wastewater management district. Then, as with sewers, the obligation can be assessed to the property and charged in reasonable yearly amounts over the system's useful lifetime, defrayed by associated tax advantages. With low-interest financing through the Clean Water State Revolving Loan Fund comparable to Rhode Island's program, the obligation would be on par with what homeowners pay to be connected in the Southwest Sewer District.

The 360,000 cesspools and septics in Suffolk represent an attractive market by itself. But there are also many more septics spread throughout the Northeast, 2.7 million in Florida and 60 million nationwide. In the course of meeting market needs, system performance will likely improve in step with shrinking cost. Early adopters and opportunists with failed systems will lead the market which will evolve at an evolutionary, not revolutionary pace. It took five years for Green Homes to reach a yearly adoption rate of 1% of its eligible housing stock. The Rhode Island program, which is the leader at this point, has not attained that level of uptake. And, as a cash-neutral investment that provided a 12% ROI, Green Homes is certainly more marketable than septic upgrades. But who could have foreseen a couple of decades back when yearly phone bills were in three-figures, that families would be expending four figures for connectivity?

1.6 Confluence of Ecoinfluencers?

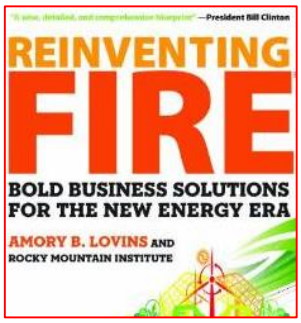
In "Disruptive Ideas: Public Intellectuals and their Arguments for Action on Climate Change," Prof Matthew Nisbet of Northeastern stakes out three different schools of ecoinfluencers who are vying to move the dial on environmental policy. This report identifies them as ecoactivists, ecoreformers, and ecopragmatists. Do these distinct approaches to environmental challenges send mixed messages and muddy the waters?' Or is it all good - different strokes for different folks? Can cross-purposes cross-pollinate? (Nisbet, M.C. (2014). Disruptive Ideas: Public Intellectuals and their Arguments for Action on Climate Change. *Wiley Interdisciplinary Reviews Climate Change).*

1. Ecoactivists, like Bill McKibbens of 350.org with his divestment campaign envision a new consciousness disseminated via grassroots organizing and social protest to dramatically transform society and prevent 'ecocide'. "Capitalism, consumerism has exceeded the carrying capacity of the planet, risking catastrophe, or certain collapse. Call for strong regulation of industry, rationing of energy

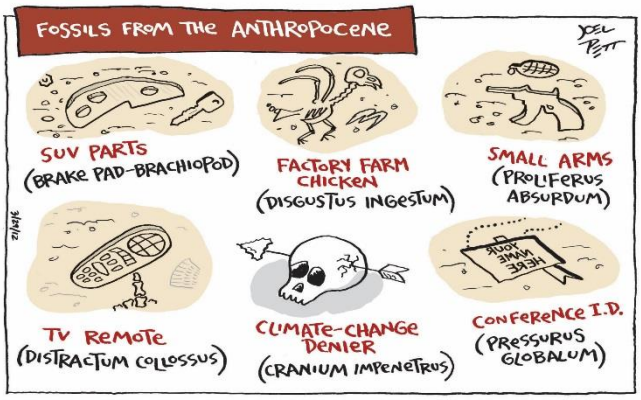


use, localization of economies, food systems, governance." Ecoactivists have taken the baton from neo-Malthusians like Paul Erlich and trace their inspiration back to Thoreau and Emerson. 350.org was founded in 2008 when the concentration of mid-tropospheric carbon dioxide in parts per million (ppm) had already reached 385 on its way to 400 in November, 2014 (J. Hansen, Target atmospheric CO2: Where should humanity aim? Open Atmos. Sci. J. (2008), vol. 2, pp. 217-231). The ecopragmatist warns of 'noble cause corruption.

2. In Natural Capitalism, ecoreformer Amory Lovins sees a "menu of climate-protecting opportunities… so large that over time, they can overtake and even surpass the pace of economic growth." In his scope, Smart Growth conforms within environmental limits driven by the right market-based mechanisms. "Climate change is ultimate market failure, corrected by putting price on carbon and with a new 'mindfulness' overcoming 'deniers.' Put out calls for binding international agreements, national carbon pricing, and government investment in innovation." The model of social change advocated by Smart Growth Reformers tends to be strongly technocratic, reflecting a strong faith in the ability of science, engineering, and economics to identify solutions and persuade others via grassroots mobilization á la civil rights movement.

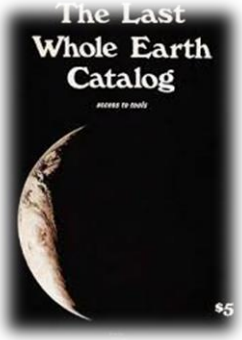


Andrew Revkin, ("The good, the bad, and the anthropocene (age of us)," New York Times, July 7, 2014, http://dotearth.blogs.nytimes.com/2014/07/07/the-good-the-bad-and-the-anthropocene) is an incrementalist who has recognized that, "The primacy of energy access in most of the places in the world trumps long-term concerns about what we are going to do about greenhouse gas concentrations in the atmosphere. When you have endpoints that you don't know how to reach, chanting numbers like [four degrees, or] two degrees, or 350, or 80 by 2050, is less useful than saying, what are the traits in societies and individuals that I can work on that give us the best chance of bending curves in directions that are "good"?… No one had any idea we were going to have a natural gas revolution and, for better or worse, here it is, reshaping global energy policies. So what do you do when you know the things you don't know are going to matter most in coming years?



The impact of human conduct on the Earth and its atmosphere over the previous two centuries is of such magnitude that it has, effectively, carved out an entire geological epoch that has been named the Anthropocene. "The idea of the 'Anthropocene' underscores the point that human activities and their impacts have global significance for the future of all living species -- ours included," says Anik Bhaduri, Executive Officer of the Global Water System Project. "The list of human activities and their impact on the water systems of Planet Earth is long and important. We have altered the Earth's climatology and chemistry, its snow cover, permafrost, sea and glacial ice extent and ocean volume—all fundamental elements of the hydrological cycle. We have accelerated major processes like erosion, applied massive quantities of nitrogen that leaks from soil to ground and surface waters."

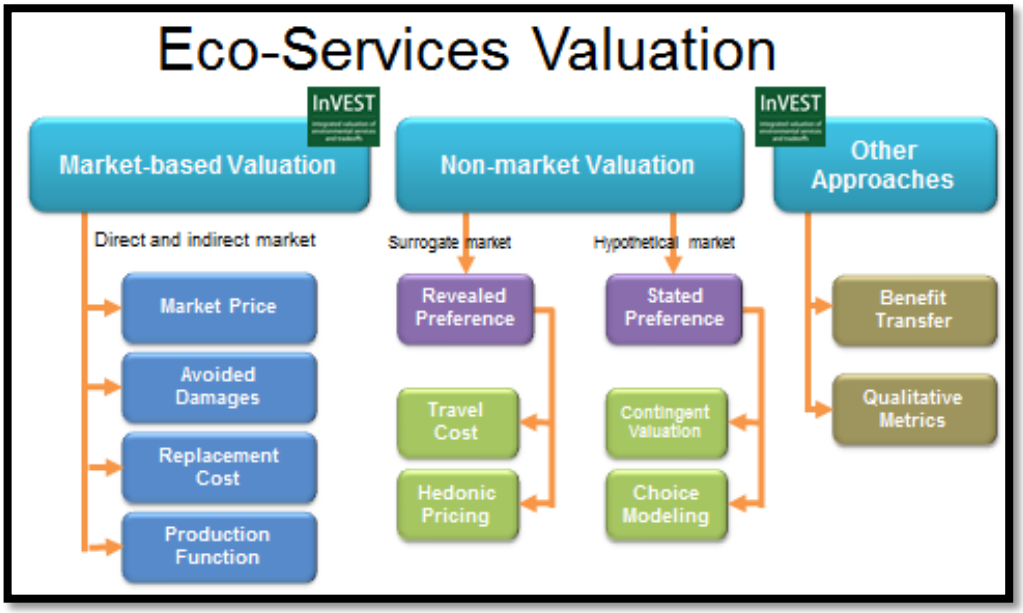
3. In the wake of several international climate summits, ecopragmatists from the Breakthrough Institute critiqued "climate benefits far off in the future — benefits whose attributes, magnitude, timing, and distribution are not knowable with certainty." Their approach "values pluralism over universalism, flexibility over rigidity, and practical results over utopian ideals.... For the United States and other nations to effectively pursue energy innovation, resilience to extreme weather, and pollution reduction, policymakers must make a clean break from the pitched and polarizing climate wars of the last twenty years and embrace a more pluralistic and pragmatic approach. Following Stewart Brand's lead, they embrace the 'positive Anthropocene,' where, in theory we have the capacity to alter course and mitigate impact. Nature's capacity for resilience is heeded and dire warnings are discarded as self-fulfilling prophecies (S. Brand, "Whole Earth Discipline: An Ecopragmatist Manifesto," New York: Viking Adult; 2009). Too much faith is placed in carbon tax; international emissions agreements are not equipped to spur technological innovation which occur in ad hoc fashion as a portfolio of incremental 'clumsy' solutions (Nordhaus T, Shellenberger, et al, "Climate Pragmatism: Innovation, Resilience, and No Regrets. Oakland, CA: The Breakthrough Institute; 2011).



Unsettled Scientists - The problem engendered by so-called ecoinfluencers, as Amitai Etzioni points out, is that they reside in 'communities of assumptions,' and, in effect, preach only to their respective choir of activists, funders, journalists, etc. (A. Etzioni & A. Bowditch, "Public Intellectuals: An Endangered Species?" Rowman & Littlefield, 2006). These competing choirs of fellowships, professorships, research grants, conferences, books, journals, blogs, etc., produce nationwide cognitive dissonance which gets fed into the sausage factory. Prof. Mike Hulme concludes that climate change is, therefore, "a synecdoche (a figurative turn of phrase in which something stands in for something else) for something much more than simply the way humans are changing the weather (M. Hulme, "Exploring Climate Change through Science and in Society," London: Routledge Earthscan; 2013)." Leaving all these competing academic scores unreconciled, a return to valuing home improvements is in order.

1.7 Ecosystem Services Valuation & Externalities

"We need to revise our economic thinking to give full value to our natural resources. This revised economics will stabilize both the theory and the practice of free-market capitalism. It will provide business and public policy with a powerful new tool for economic development, profitability, and the promotion of the public good." -Paul Hawken

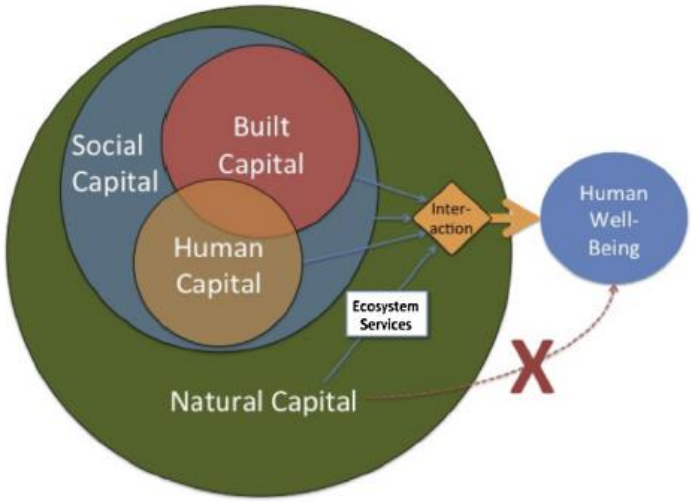


"Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime."
-Maimonides

'**What's in it for you?**' That's the issue that valuation of ecosystem services has been devised to answer, in part. Alternatively referred to as 'natural capital,' it quantifies the benefits to human well-being derived from functioning ecosystems. Leading ecological economist, Prof. Robert Costanza, sums it up: for benefits of 'natural capital' (coined by Costanza in 1992) to accrue, they are generally bundled in a complex mix along with manufactured, human and social capital (R. Costanza, et al, "Valuing ecological systems and services" Biological Reports, 3:14, 2011) Fishing boats manned by experienced fisherman from ports plying waters with thriving aquatic life. "The depletion of the natural capital base has often been counted as profits, because these external costs are miscounted as profits. Are we making bad management decisions because we're not considering all of our capital base?" Costanza asks. In effect, the owner of a patch of redwoods makes money from cutting them down rather than letting them stand, passing along on the substantial external cost of their loss to 6 billion other people. At this point, this academic approach is more aspirational than applicable.

The Millennium Ecosystem Assessment from the U.N. in 2005 characterizes the four **ecosystem services** as follows (http://www.maweb.org/documents/document.429.aspx.pdf):

1. **Provisioning services** that provide food, fiber, forest products, etc.
2. **Regulating services** that proffer the storm protection services of coastal wetlands
3. **Cultural services** offering recreational benefits of natural assets like rowing on a lake.
4. **Supporting services** that maintain habitats for animals while sequestering carbon.



Costanza's estimate for the total global ecosystem services in 2011 is $125 trillion/year (assuming updated unit values and changes to biome areas) and $145 trillion/year (assuming only unit values changed), both in 2007 $US. From this we estimated the loss of eco-services from 1997 to 2011 due to land use change at $4.3–20.2 trillion/year, depending on which unit values are used. (Costanza, 4-1-14). Deforestation and other damage we've inflicted on the natural world has wiped out $23 trillion a year in ecosystem services. To put that loss into perspective, consider that the gross domestic product of the United States is $16.2 trillion.

Purists recoil from reducing the intangibles of the natural world to a cost-benefit analysis and placing price tags on ecosystem services. Nature, by their reckoning is priceless; degrading ecosystems may, in fact, be deemed less valuable and further disregarded. "Mother Earth is the source of life which needs to be protected, not a resource to be exploited and commodified (sic) as 'natural capital,'" decries the Kari Oca 2 Declaration. "The Green Economy is a crime against humanity and the Earth." "Instead of expanding the scope of markets to every domain of nature," states BankTrack, "strengthen the democratic control over the worlds' ecological commons." A Natural Capital spokesperson responds: "We are not talking about 'pricing' nature but 'valuing' it. By valuing it, you are enabling better economic decisions." Add to this mix the salient factor that ecosystems also harbor costly dangers for humans. That makes for a balancing act here on Long Island between marsh management and vector control's preventative role in mosquito control.

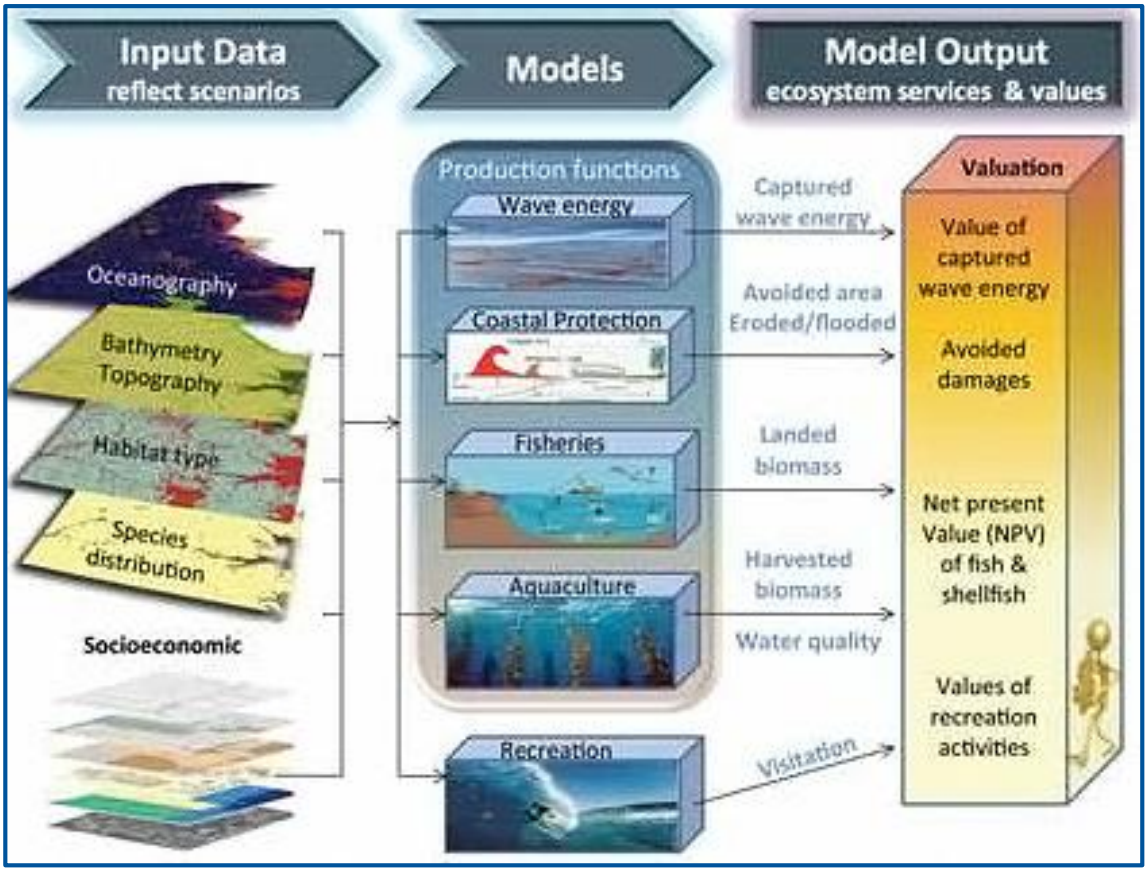
The Natural Capital Project (http://www.naturalcapitalproject.org/) is a collaboration between the Stanford Woods Institute for the Environment and The Nature Conservancy to "develop simple, use-driven approaches to valuing nature: If properly managed, Earth's lands, waters and their biodiversity yield a flow of 'ecosystem services,' including:

- The production of goods such as food and timber,
- Life-support processes such as water purification and coastal protection,
- Life-fulfilling benefits such as beautiful places to recreate, and
- The preservation of options, such as genetic diversity for future use.

Natural Capital offers software models for download. 'Integrated Valuation of Environmental Services and Tradeoffs,' InVEST, defines how ecosystems affect the flows and values of environmental services (http://www.naturalcapitalproject.org/download.html). 'Resource Investment Optimization System, RIOS, provides a standardized, science-based approach to watershed management (http://naturalcapitalproject.org/rios_download.html).

At this stage, the InVEST tool operates at 30,000 feet. Last year a Natural Capital team (K. Arkema, et al, "Coastal habitats shield people and property from sea-level rise and storms," Stanford Woods Institute, 2013) delivered a map of natural habitats indicating where conservation and restoration of reefs and vegetation have the greatest potential to protect coastal communities. "Today 16% of the U.S. coastline comprises `high hazard' areas, harbouring 1.3 million people (an estimate far smaller than others such as CoreLogic's 4.2M houses), 250,000 elderly, 30,000 families below the poverty line and U.S. $300 billion in residential property value." If the extensive coral, mangrove and seagrass ecosystems that line Florida at present persist in the face of development and climate change, the Natural Capital analysis predicts these habitats will reduce exposure of nearly U.S. $4 billion worth of 2010 home property values within 1 km of the coastline by 2100, up from U.S. $0.7 billion at present. Property now protected by coastal habitats is substantial, ranging up to more than U.S. $20 billion in Suffolk and Kings, New York (Natural Project). Valuing ecosystems remains an academic proposition and has far to go before reaching granularity that can be internalized in market price.

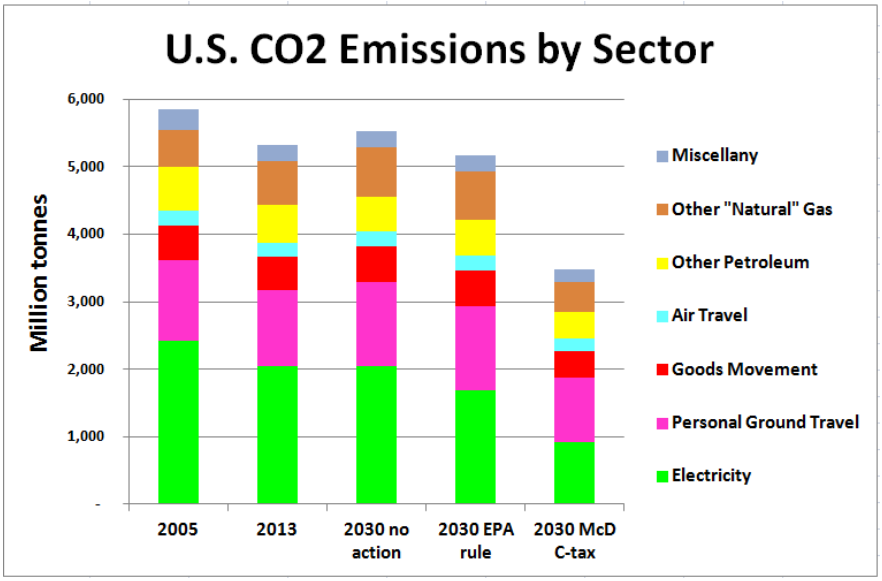
"Valuing Estuarine Resource Services Using Economic and Ecological Models: The Peconic Estuary System (PES) Study," summarized a 1999 evaluation conducted on Long Island by a team from the University of Rhode Island, "Much of what residents and visitors value in the PES—for example, the quality of the area's natural amenities, like open space, attractive views, good beaches, high levels of water quality, and fish and shellfish resources used for recreation—are not bought and sold in markets. The value of these services, therefore, is often omitted in traditional economic impact studies." As beauty is in the eye of the beholder, so too the valuation of that beauty. Fifteen years later, market pricing of ecosystem valuation remains elusive.



An **externality** is a (positive or negative) impact on a third party that is not reflected in market transactions. For example, when a private wetland that provides flood protection for the surrounding area is sold, the price reflects only the value of the acreage to the buyer and seller—not the additional value to nearby homes and businesses. Considerable evaluation has gone into **carbon footprints**, quantifying how much total energy is required for products and activities, in addition to what the impacts may be. The average carbon footprint per person worldwide is 6.3 tons of CO_2 (t/CO_2), while in the U.S. it is 21 t/CO_2. Markets such as the Northeast's Regional Greenhouse Gas Initiative (RGGI), have been trading in carbon credits; the price per ton has dipped as low as $1.86 while this June it spiked as high as $5.02. To coin a phrase in this realm, '**internality**' is where cost and savings are captured in ways that reflect direct consumer value. Energy efficiency measures exemplify the capture of 'internalities' in that the capital cost is offset by savings on energy expenditures, in effect, making it a cash neutral investment (more at http://www.carbontax.org/services/where-carbon-is-taxed/).

As early as the 1920s, British economist Nicolas Pigou advocated for taxes on activities that caused pollution and sickness, in much the same way that state governments now tax tobacco to discourage smoking. Only two examples of Pigouvian taxes, corrective or excise, have been adopted in the U.S. at the Federal level - the gas guzzler excise tax and the excise tax on ozone-depleting chemicals. Operationalizing taxes now runs

head on into undiscerning anti-tax political opposition that precludes consideration, let alone implementation. Cost/benefits, measures of supply and demand atop conflicting regional impacts are murky. Various iterations of what and who is to be taxed how much whirl about what the policy objectives might be. Pigouvian taxes like the carbon tax have had influential proponents such as Harvard's Greg Mankiw, chairman of the Council of Economic Advisers under President George W. Bush, then economic adviser to Mitt Romney. If it happened that the carbon tax came to pass, note the projected impact over the next fifteen years:



Cap & trade (C&T), or cap and dividend, its populist variation, are trading regimens or schemes, as the Europeans call them. C&T is modeled on the successful mitigation of acid rain during the administration of Bush Senior. It is designed to be a market maker for the cost of carbon embodied in power generation and production. The Regional Greenhouse Gas Initiative (RGGI) is a C&T program that joined ten Northeastern states (now minus NJ). Beginning in 2008, carbon credits auctions have financed clean energy programs like Green Jobs/Green NY.

Storm-Prone Property Valuation is considerably closer to the bone than the quicksilver of externalities. That is because actuarial risk assessment provides an 'internality,' real-world data that a homeowner can factor into the household budget. "With the continuing surge of coastal development and about one-half the U.S. population living along coastlines,… it's more important than ever that properties are accurately assessed using tools specifically designed for the insurance industry." -CoreLogic (provider of analytics on more than 135.6 residential million properties) estimates that there are 687,412 homes at risk for potential storm surge damage in the greater New York metropolitan area whose reconstruction value would $251 billion. Nationwide it is estimated that 4.2 million single-family homes valued at over $1.1 trillion are exposed to some level of storm surge. CoreLogic uses GIS data layers and probability models that evaluate and score coastal risk from multiple angles to improve pricing and risk management, using web-based tools such as RiskMeter Online to more effectively assess and distribute coastal risk. Well-designed disaster insurance can play an important role in linking mitigation with financial protection. A statewide insurance

program that incents mitigation measures through the equivalent of a systems benefit charge is an elemental starting point to move the dial on preparedness.

Availability bias: Herein a cautionary tale. There is a documented tendency to ignore rare risks until after a disaster occurs. Low-probability, high-consequence (LP-HC) events, don't, as a rule, catalyze people to make provision. Availability bias, as it is called, is strongly influenced by recent personal experience and can lead to an underestimation of low probability events (e.g., typhoons, floods, or droughts) before they occur, and their overestimation after an extreme event has occurred. The resulting availability bias can explain why individuals first purchase insurance after a disaster has occurred only to cancel several years later. An in-depth analysis of the entire portfolio of the National Flood Insurance Program revealed that the median tenure of flood insurance was between two and four years while the average length of time in a residence was seven years (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2012).

A poll of 1,100 adults living along the Atlantic and Gulf coasts undertaken by Mason-Dixon Polling and Research in May 2006 revealed that 83% of the responders had taken no steps to fortify their home, 68% had no hurricane survival kit, and 60% had no family disaster plan. A survey of nearly 800 residents in coastal counties during Hurricane Irene in 2011 revealed that less than half of storm-shutter owners in the state of New York actually installed them to protect their windows before the hurricane came. Most others did not install them because it would have "taken too long." (E. J. Baker, J. Czajkowski, and R. Meyer, "Modeling the Real-Time Decision to Evacuate from a Hurricane," Wharton Risk Management Center, Philadelphia, PA, 2012).

What **availability bias** underscores more than anything about Americans is that our approach to disaster is reactive rather proactive. Where Americans do post-disaster management reasonably well, the Dutch labor assiduously to avoid disaster. Someone said a clever person solves problems, a wise one avoids them. Consider how proactive the Dutch are, and how to prosper from it.

1.8 Living with Water-Learning & Earning

"The Dutch have in some ways an easy problem to solve. The entire nation is at risk if the western portion floods. So the entire country is united. It's not a question of should we do [flood protection], but how.... In the U.S., because of the way federalism works, it makes it more difficult for the U.S. to have an applied holistic approach." –Dale Morris, American economist with the Dutch government

"*For the Dutch, water management is a growth industry*." (S. Goodyear, "We're In This Together: What the Dutch Know about Flooding That We Don't," The Atlantic CityLab, 1/9/13)

Hansje Brinker tells the tale of a little Dutch boy who finds a hole in a dike and presses his thumb inside to prevent his hometown from flooding.

There is an established connection between managing water resources and mitigating the hazards of water-born storms. Living below sea level, the Dutch have become past masters at coexisting with water, internally and externally, in concert with one another. Their defining experience was the deaths of nearly 2,000 caused by the 1953 North Sea flood, or as the Dutch call it, Watersnoodramp, the "water ordeal disaster." Dutch engineers were retained in the wake of Hurricane Katrina to advise in the reshaping New

Orleans and a Dutchman was appointed post-Superstorm Sandy by the Department of Housing and Urban Development to spearhead the "Rebuild by Design" initiative in the greater New York/New Jersey metropolitan area. Dutch firms pitched projects in the greater metropolitan area, stressing Netherlands' experience with risks posed by coastline and estuaries comparable to New York's.

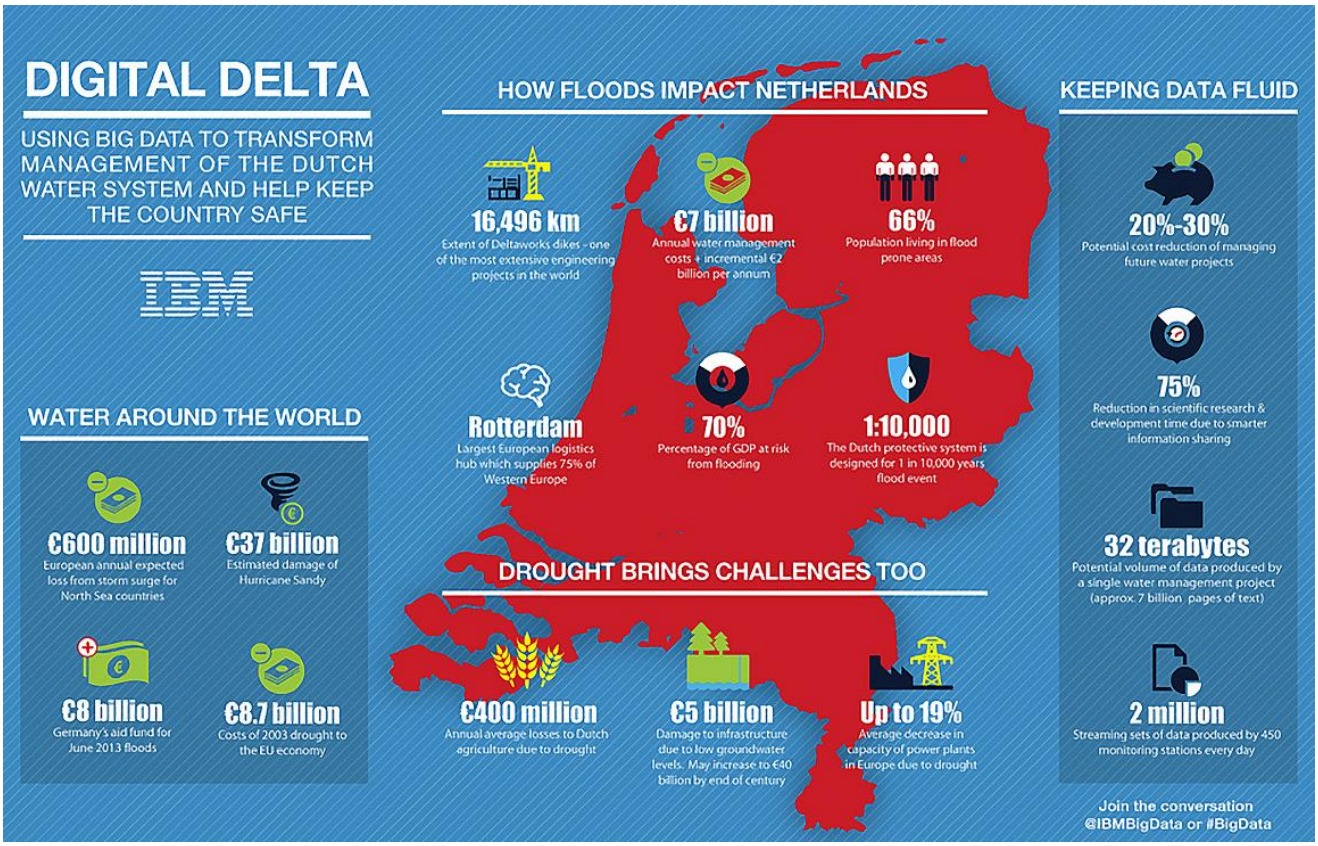
The Maeslantkering, a movable storm surge barrier, both gates the length of the Eiffel Tower, at a cost over $0.5B. Finished in '97, testing aside, it has been used only once - successfully.

The fully integrated management of water resources in contemporary Netherlands is remarkable, but they launched their mission over sixty years ago and have followed through with skill, will, guilders and unity of purpose that may not be replicable in this country, given the temper of the times. The Dutch Association of Regional Water Authorities, known as Waterschappen (water boards in Dutch), elect local bodies that trace their roots to the 13th century and are empowered to levy taxes. The Water Management Center's new central control unit, is stocked with computers flashing real-time data about water levels, wind strength and other potential threats to levees built to hold in check the North Sea, the Rhine River and three other major waterways that flow through the Netherlands.

Dutch thinking had shifted and now puts a priority on methods "to enlarge defenses in a natural way." The state is investing in a plan called Room for Rivers, which aims to ease flooding by giving waterways space to move and even overflow. Last year, the country spent around $100 million to dump 706 million cubic feet of sand off the coast north of Rotterdam to engender promote formation of protective sandbars via a littoral drift driven Sand Engine. In lieu of flood control the new philosophy in the Netherlands is controlled flooding.

Dutch are, by temperament, almost as allergic as Americans to top-down programs that impinge on personal and property rights; but water safety trumps pretty much every other priority in a country where 60% of the nation's gross domestic product is produced below sea level. On the flip-side, Americans expend excessive energy and capital on emergency relief and recovery after the disastrous fact, and not nearly enough on anticipating and mitigating as the Dutch do. It was Einstein who said, "*A clever person solves a*

problem. A wise person avoids it." Post Sandy, in the introductory stage of 'Rebuild By Design, Renée Jones-Bos, the Royal Dutch Ambassador to the United States most effectively delineated what her country had to offer:



"The Netherlands is famous for its flood protection systems which, until recently, 'kept the water out' or 'kept the water contained.' The climate, however, is changing, sea-levels are rising, and the world's deltas are sinking. In the Netherlands, we see these challenges and welcome them, because they present us with **opportunities** too…. Katrina reminded us that living in deltas and in coastal areas can be dangerous. Yet most people of the world choose to live in those areas because they provide unparalleled economic, cultural, recreational opportunities….

"We have an entrepreneurial spirit. We're penny-pinchers. World traders. Calvinist preachers, with at the same time an open-mind. Someone described our collective personality as one of "sober optimism." We find ways "to make lemonade out of lemons," to adapt, and even stand those disasters on their heads. It was this mentality that enabled us to rebuild, and see new opportunities, after every major flood…. Today, the Netherlands is the world's 16th largest economy, the 7th largest trading nation, the 3rd most densely populated country in the world. We derive tremendous opportunity from being the Gateway to Europe. Not bad for a land of swampy marsh, gloomy weather, and stingy preachers!

"And how climate change is nuancing traditional cost-benefit analysis…. Since the early 1990s, the Netherlands has applied cost-benefit analysis to infrastructure and planning decisions. We know that these

analyses are imperfect. And we know with certainty that politicians – even Dutch ones! -- don't always make rational decisions even if they have perfect information!...

"We ask "do the costs of increasing flood safety exceed the benefits of reduced flood damages?" On the cost side of the equation, we look at fixed and variable investment aspects of a project, and operations and maintenance. On the benefit side, we estimate the value of reduced flood damages to roads, buildings, infrastructure. We estimate the economic benefits floods might produce, for instance the additional wages and materials production needed to rebuild after a flood. These types of valuations are traditional, and pretty easy.

"Where it gets tricky, but crucial, is in the assessment of indirect flood damages. Like lower economic activity, business interruption, flood-related environmental damage, pollution. The damage to unique fauna, flora, buildings and cultural assets. Valuing the loss of life is impossible. No international consensus exists on how to precisely quantify these indirect damages. Many assumptions are made. Are assessments imperfect? Yes. But we are trying, because by capturing these values, better investment decisions can be made, better policies designed.

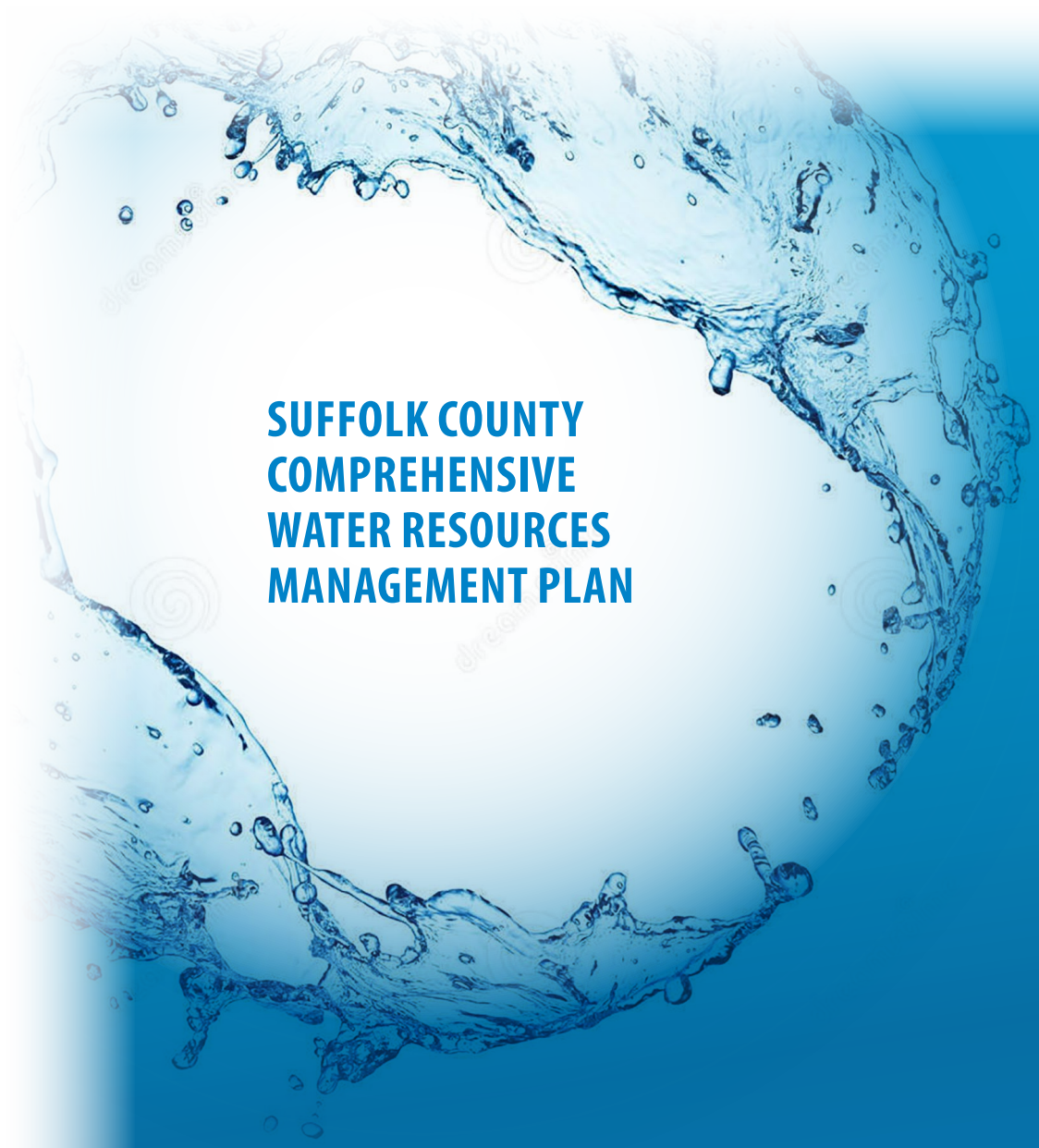
"If you have seen the Dutch landscape, and understand our risks, you might wonder why our dikes are not higher, our rivers not more contained, our buildings not more elevated? The primary reason: cost-benefit analysis says we can't afford it because those very actions might increase the impacts of a catastrophic event. This is a change in mentality, driven by recent events which show us that low probability, high impact disasters are still too common. And another reason? Because we don't want to live in an overly engineered landscape that has lost its aesthetic charm. We like our modern cities, but also our deep green polders, our Amsterdam canals, our low skies and distant horizons.

"That is why a new paradigm — **Living with Water** -- infuses our policy and our public investments today. Of course: we must always be on guard against floods. That cannot and will not change. The new paradigm means, however, that we can't always fight the water. Instead, we need to accommodate water, and give it room. And in the world's 3rd most-densely populated country, giving room to water means taking space from something else. It is a zero sum game. Or is it? Climate change, oddly enough, is reminding us of both the beauty and resiliency of nature, and the benefits of sustainable design. The sober optimist is again making lemonade...."*

"It's the catastrophe for which the Dutch have been planning for fifty years. Or, really, for as long as we've existed. We had cooperative water management before we had a state. The one created the other; either we pulled together as a collective or got swept away as individuals."

- Jim Shepard, "The Netherlands Lives with Water"
"*We must all hang together, or assuredly we shall all hang separately*." - Ben Franklin at the signing of the Declaration of Independence

*http://dutchdialogues.com/about/; http://dc.the-netherlands.org/key-topics/water-management; http://www.dutchwatersector.com/expertise/governance/; http://www.deltawerken.com/23



SUFFOLK COUNTY
COMPREHENSIVE
WATER RESOURCES
MANAGEMENT PLAN

Section 2
WAYS AND MEANS TO ADDRESS WATER QUALITY

Section 2
Ways and Means to Address Water Quality

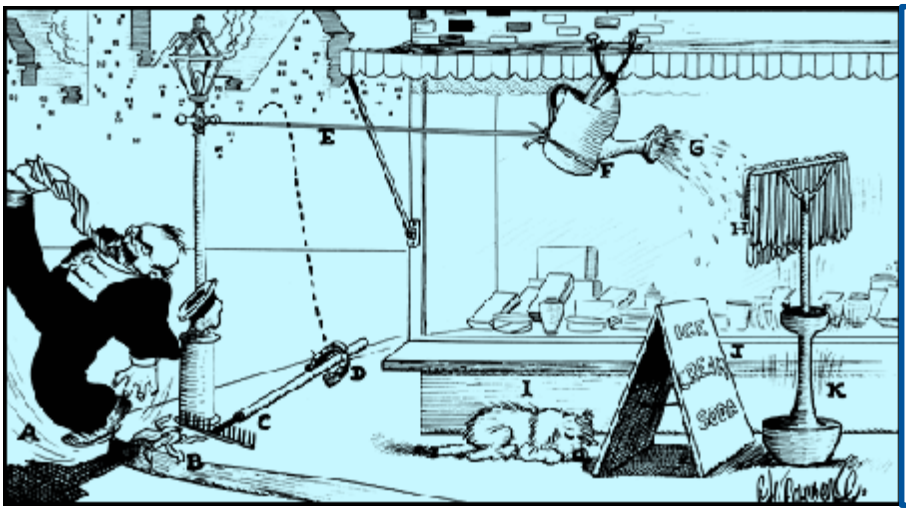
If a benign monarchy were to assume the seat of power in the sovereign County of Suffolk, how might it consider water quality? Upward trends for contaminants in the drinking water drawn from beneath this majestic land are surely cause for concern. More notably, impaired surface waters have been eating away at protective ecosystems setting off alarms in the wake of Superstorm Sandy. The potentate would be relieved that relief has recently come in the form of major new sewer extensions and the launch of an on-site wastewater pilot program. With a taste for cleaner waters, sovereign subjects are showing an appetite for ever more. How to go about funding further improvements short of sowing the seeds of revolt among a populace besieged by the cost of living?

Comprehensively managing water resources holds indisputable benefits for the commonweal. Alas, water operations in the Land of Suffolk are currently Balkanized, absent benefits that accrue to a goodly number of other realms. Without linkage between delivery of water and its treatment once dispelled, there is scant means to check negative impacts. Rock-bottom water rates mean no provision is made beyond maintenance mode. In/out metering along with the leveling of disparate billing in existing sewer districts, would not only be the fair way to go, but augment some of the other ways and means to Reclaim Our Waters.

"People commonly use statistics (economics) like a drunk uses a lamp post; for support rather than illumination."

–Mark Twain

The political/legislative process is often equated to a sausage factory. You don't really want to know what went into a final product; it's tough to swallow and can clog up your system. The bottom line had best be submerged. As Thomas Barthold, currently Chief of Staff for The Joint Committee on Taxation, put it, "*politicians often prefer regulations with obvious benefits and hidden costs over regulations with hidden benefits and obvious costs.*" Or, as Massachusetts Institute of Technology (MIT) economist Martin Gruber put it, *"Lack of transparency is a huge political advantage*." The result, as one analyst observed, is typically a hodgepodge of exacting, opaque regulations, mandates, subsidies, and tax measures that would make Rube Goldberg blush.



Passing man (A) slips on banana peel (B) causing him to fall on rake (C). As handle of rake rises it throws horseshoe (D) onto rope (E) which sags, thereby tilting sprinkling can (F). Water (G) saturates mop (H). Pickle terrier (I) thinks it is raining, gets up to run into house and upsets sign (J) throwing it against non-tipping cigar ash receiver (K) which causes it to swing back and forth and swish the mop against window pane, wiping it clean.

Torn between saving the world and savoring it, E.B. White said, makes it difficult to plan the day. Or, as Dwight D. Eisenhower observed, *"In preparing for battle I have always found that plans are useless, but planning is indispensable."* Planning documents are heavily weighted with "rational choice" modeling. In this model, decision making is guided by probability and utility. Economist Herbert Simon, among others, began noting in the 1950s that this model came up short in predicting how people actually make decisions. Predictions made by the so-called "rational actor" proved to be bounded by the information available, cognitive limits, undifferentiated means and ends, and will o' the wisps of all varieties. How, then, to account for the chain reaction variables resulting from decision-making?

By the 1970s, the answer behind Door #2 was heuristics, hunches based on pre-existing associations, subject to trial and error and/or Monte Carlo simulation. This process can be referred to simply as "back of the envelope calculation," or, with more gravitas, a Fermi estimate. Know that the long and winding road of public policy formulation and implementation is a random walk or a stochastic process, as academics call it. Resilience is the capacity to adjust and bounce back like a well-trained, opportunistic fighter imbued with situational awareness.

Multiple arrow types in the quiver such as adaptive skills, flexibility, anticipation and back-up plans all contribute to outcomes. What follows, then, cannot be a roadmap, but a manual of ways and means, subject to circumstances and determinations of decision-makers enroute.

2. 1 Infrastructure in the Age of Scarcity

"We've run out of money; it's time to start thinking." –physicist Ernest Rutherford

Bill Clinton has said that most Americans start out thinking the federal government couldn't run a two-car funeral. Now they worry that one of the two cars should have been recalled and the other can't go anywhere because Congress is still fighting over whether to fix the road.

"*Our infrastructure is on life support right now*," declares Ray LaHood, former secretary of transportation and currently co-chairman of Building America's Future. One disturbing example is the 70,000 bridges in America -- one out of every nine – that are considered to be structurally deficient. "*I don't want to say they're unsafe*," says LaHood. "*But they're dangerous*." Amtrak president Joe Boardman expressed the crux of the matter: "*It's less a case of wanting to get something done, than coming up with the hundreds of billions of dollars needed to do it*." (http://www.cbsnews.com/news/falling-apart-america-neglected-infrastructure/ -"60 Minutes," Steve Kroft, Nov 23, 2014).

Forty percent of the pipes used in the nation's water distribution systems are forty years old or older, and some key infrastructure is a century old. On average, about 16 percent of the nation's piped water is lost due to leaks and system inefficiencies, wasting about 7 billion gallons of clean and treated water every day (U.S. Environmental Protection Administration [USEPA] 2013; Maxwell 2013).

The share that corporate tax revenues comprise of total federal tax revenues also has collapsed, falling from an average of 28 percent of federal revenues in the 1950s to 7.4 percent in 2003 (J. Friedman, "The Decline of Corporate Income Tax Revenues," Center on Budget and Policy Priorities, 2003). Companies have been called economic traitors for seeking to lower their tax bills by moving overseas. But life insurers are accomplishing the same goal without leaving the country, saving as much as $100 billion in federal taxes, much of it in the last several years. Through complicated accounting maneuvers, the money escapes federal taxation. (M. Walsh, "Life Insurers Use State Laws to Avoid as Much as $100 Billion in U.S. Taxes," NY Times, 12/12/14)

When County Executive Steve Bellone assumed office in 2012, Suffolk was facing a half billion dollar deficit. Two years into his term he announced the County was going to "**Reclaim Our Waters**" by targeting nitrogen loading as "*Public Water Enemy #1*." Heretofore, Suffolk had been in monitoring mode, gauging disturbing upward trends in groundwater contaminants and the wholesale degradation of surface waters. These developments have coincided with a 22% loss of staff in Suffolk's Department of Health Services' Environmental Division since 1998. Despite a drop in testing and inspections, Suffolk still meets state and federal requirements.

"*We're focused on 'how do we solve' the water quality problem*," Newsday quoted the County Executive as saying. "*We've done tons of testing and we know we have water quality issues…. We need to get to actually solving the problems….* (As) *we live in an era of permanent fiscal scarcity*," Bellone said, "*resources are better spent installing sewers and approving advanced septic systems* (Schwartz, D. "Suffolk cutbacks reduce water testing, pollution inspections," Newsday, 9/9/14)."

Over four decades ago, U.S. Surgeon General Jesse Steinfeld was asked what studies supported his contention that second-hand smoke was hazardous to health. Drawing on common sense, he simply deduced that if, as had already been determined, outdoor air pollution was hazardous, it stood to reason that indoor air pollution was as well. Studies finally produced in the '80s affirmed this deduction. For the Surgeon General, it had been a straight forward case of garbage in, garbage out, clean it up now.

Eel grass is akin to the canary in the coal mine of aquatic nitrogen loading. In certain Rhode Island locales that have been installing denitrifying wastewater systems, eel grass, reportedly, hasn't consistently rebounded. Invoking this single variable, some question the efficacy of nitrogen reduction, a conclusion that Surgeon General Steinfeld would, likely reject. There is enough evidence of nitrogen pollution's damaging impact; further granularity to that end is welcome, but will not stall action to check nitrogen loading.

Calling nitrogen pollution "a national and international problem," Governor Andrew Cuomo announced October 29, 2014 that Suffolk County would be receiving close to $400 million to extend sewers to 15,000 homes. The Governor's 2100 Commission stated that, "Our coastlines, one of our most vulnerable assets, are home to a vast majority of the State's population. Because of the significant risk of coastal problems resulting from climate change, this category… focuses specifically on immediate actions to restore and mitigate coastal infrastructure to protect communities, and on strategies for using natural as well as engineered measures to improve resilience."

This initiative was buttressed by a report several months earlier from New York State Department of Environmental Conservation (NYSDEC) that spotlights "*the noxious effect excess nitrogen pollution has on marshland systems that help to protect Long Island against storms like Sandy. Based on this information, it is imperative that efforts to improve coastal storm resiliency include actions to significantly reduce nitrogen pollution*" (NYSDEC, "Nitrogen Pollution and Adverse Impacts on Resilient Tidal Marshlands," http://www.dec.ny.gov/docs/water_pdf/impairmarshland.pdf April 22, 2014). As the first substantial addition to sewer infrastructure in Suffolk in over thirty years, County Executive Bellone declared that these projects will "*dramatically jump start our effort*."

While investment and innovation in the energy sector have soared in recent years, investments in new technology for water markets have stagnated just above zero. In sum, many of the economic mechanisms that are typically used to allocate a scarce resource—such as trading, pricing, and investment in more efficient technology—are absent from our nation's water markets.

2.1.1 Conventional Financing

In 2012, Resolution No. 18-2012: RESOLVED… to *"determine the best and most appropriate structure and method of implementing an **infrastructure bank** in Suffolk County,… as well as the potential benefits and costs associated with the County establishing same."*

With but one variation on the theme, there are no county or municipal versions of infrastructure banks (IB) akin to Federally-sponsored state IBs that address transportation and water systems, such as the New York State Environmental Facilities Corporation (EFC). The Chicago Infrastructure Trust has been the one departure which was, according to Mayor Rahm Emmanuel, going to be the "breakout strategy" for modernizing buildings and bridges without waiting to be sprinkled by Uncle Sugar. In 2012, Mayor Emanuel touted the 1,000 city buildings, $225 million in investment and $20 million in energy savings that was to create 2,000 construction jobs. Two years later all that has materialized is 100 projected jobs linked to a $12.2 million deal, notably less than the $22 million that went into the city's bike-sharing program. "*We built this grand scheme to do these great things and then we do this underwhelming project,*" said one Chicago alderman.

Finding a work-around for the MIA status of Washington is proving a heavy lift.

The infrastructure bank buzz of 2012 spurred a Long Island attorney and trade union member to suggest that, "*by establishing a public-private partnership and creating a local infrastructure bank, the trade unions here could secure work for their members while simultaneously addressing some of Long Island's most pressing needs* (M. Glennon, "Special banks can help LI rebuild," Newsday 3/2/11)." Exploratory exchanges with the County led him to conclude, "*that any workings with Suffolk County on a regional I-Bank is most probably premature at this juncture.*" Note that a mere 1 percent of pension funds worldwide are invested in infrastructure (*Pension Funds Investment in Infrastructure/A Survey*, http://www.oecd.org/sti/futures/infrastructureto2030/48634596.pdf).

The premise that union pension funds could be viably invested in infrastructure has been embraced by Borealis Infrastructure, an arm of Ontario's large municipal workers union, Ontario Municipal Employees Retirement System (OMERS) that makes major international investments. The president of Service Employees International Union (SEIU) 32BJ, with more than 120,000 members in the Northeast, reported that he had been examining possible infrastructure investments for his union's pension fund. An investment in a new Tappan Zee Bridge, for instance, could generate a reasonable return. *"You don't put common good above returns,"* he noted, "*but you can accept a return that's suitable in a basket of different investments. That's the way you have to view infrastructure investments.*" It took eight years to seal the Chicago Skyway deal, and its greatest distinction is that it is the costliest interstate road in the U.S. (Federal Highway Administration). As one analyst observed, "*Many pension funds don't have a clue of the risks involved.*"

A **Public Private Partnership** (P3) is an entity that undertakes the development of all or part of an infrastructure project, which will have a public benefit, pursuant to requirements established in one or more contracts between the entity and a State or an instrumentality of a State. A P3 is an institutional arrangement in which a private entity assumes some level of risk beyond that traditionally associated with supplying its services to a government agency (projects that lend themselves to private operation: roads, rail, and water supply and wastewater treatment). The risk to the private entity of not recouping its investment often is mitigated by advantageous financing available through government sponsorship of the project and through terms that grant the private entity exclusive rights to provide the services in question, i.e. Chicago Skyway (99-year lease/$1.83 billion).

A P3 arrangement differs from conventional public procurement in several respects. In a P3 arrangement, the public and private sectors collaborate to deliver public infrastructure projects – such as roads, railways, airports, hospitals and schools. P3 contracts typically involve not only the delivery of the infrastructure, but also the management of the facility, maintenance and service delivery. Locally, energy-from-waste facilities such as the Covanta plant in West Babylon provide revenues for the private and public partners through power generation and tipping fees.

The Water Resources Reform and Development Act (WRRDA) of 2014 was overwhelmingly approved by Congress in June. At the core of WRRDA is the Water Infrastructure Finance and Innovation Act (WIFIA) which will offer low-interest federal loans and loan guarantees to help finance water projects through public-private partnerships (P3s). A five-year pilot program would authorize the Army Corps of Engineers and the Environmental Protection Agency to provide up to $175 million in direct loans and loan guarantees for the construction of critical water infrastructure projects. WIFIA loans could be used for up to 49 percent of project costs for large projects in excess of $20 million. Municipalities would not be able to use tax-exempt debt to finance the remaining 51 percent of project costs, encouraging the use of private financing. A prime driver of WRRDA is the evaluation of P3s to accelerate a $60 billion backlog of Corps projects for harbor and waterway upgrades, storm/flood mitigation, and restoration of aquatic ecosystem. P3 projects will be evaluated based on economic significance, leverage, use project delivery, and cost-savings.

The program is modeled after the Transportation Infrastructure Finance and Innovation Act (TIFIA) administered by the Federal Highway Administration, which has helped finance many P3 transportation projects nationwide, including the Capital Beltway High Occupancy Toll (HOT) Lanes in northern Virginia, the Port of Miami Tunnel expansion project in Florida. Unlike TIFIA, WIFIA does not allow project sponsors to use tax-exempt debt to cover any portion of the remaining 51 percent (or more) of project costs, including private activity bonds (PABs). Bottom Line: the WIFIA program appears to be a toe in the water. As Brown & Myers, a law firm that plies this sector, concluded, *"Given that the nation's water infrastructure needs are, by most estimates, even larger in total than its transportation needs, this is clearly a "pilot" program—with a very small "p."*

Figure 2-1 summarizes currently identified methods of financing water supply and wastewater infrastructure projects.

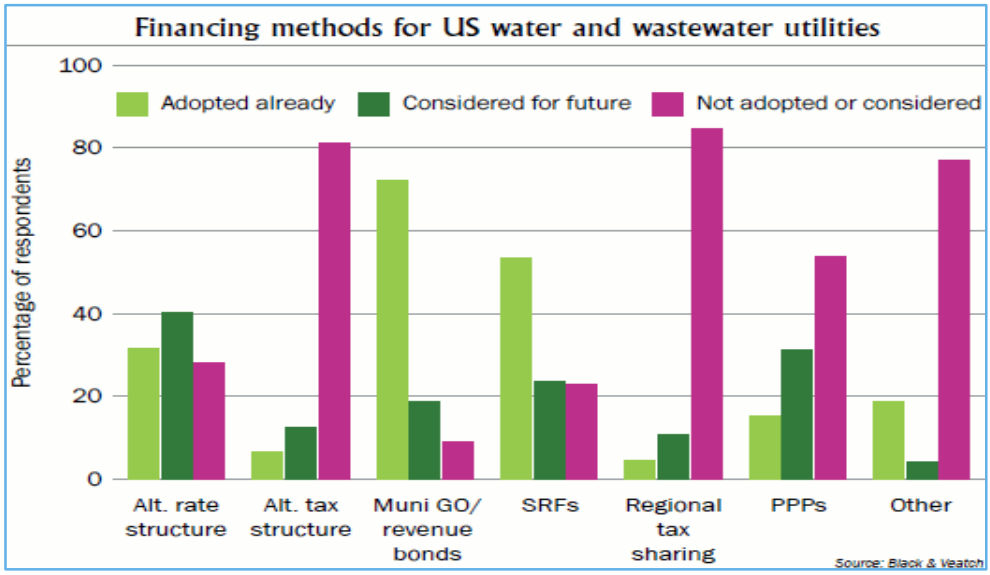
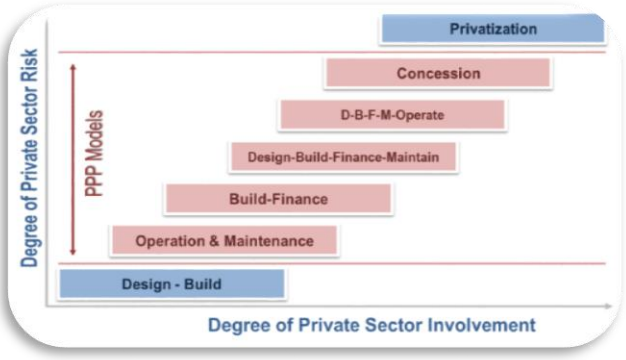


Figure 2-1 Financing Methods for Water and Wastewater Facilities in the United States

The P3 Nassau County signed its sewer system on to in mid-2014 is a 20 year operations and maintenance (O&M) contract, projected to save $158 M largely predicated upon manpower productivity. The size of dedicated workforce will be almost halved, but no current sewer employees will lose their job. Those who don't go with United Water, leave or retire will be given positions elsewhere in the county, and that added cost will, ostensibly, be balanced by cuts in overtime (Y factor). Overall, this deal does not work if Nassau walks away from capital operations. The cost of addressing the considerable capital improvements required by the large Bay Park and Cedar Creek sewage treatment plants (STPs) is the major X factor in this deal. Nassau would pay United Water $57.4 million a year -- adjusted annually for inflation -- to run three sewage treatment plants serving 1.16 million residents.



P3s typically share the following features (*A Guide to Guidance for PPPs*, European Investment Bank, Jan, 2011):

- A long-term P3 contract between a public contracting authority and a private sector P3 company based on the procurement of services, not of assets;
- The transfer of certain project risks to the private sector, primarily in the areas of design, build, operations and finance;
- A focus on the specification of project outputs rather than project inputs, taking account of the whole life cycle implications for the project;
- The application of project finance to underpin the risks transferred to the private sector;
- Payments to the private sector which reflect the services delivered. The P3 company may be paid either by users (toll motorway), by the Authority (availability payments, shadow tolls) or by a combination (low user charges together with operating public subsidies).

Many state and local governments looked at P3s as a way to monetize the market values of infrastructure-like toll roads in order to use the proceeds to alleviate public sector budget deficit. A 2011 report from the New York State Comptroller offers its take in "Controlling Risk without Gimmicks: New York's Infrastructure Crisis and Public-Private Partnerships". This procurement approach has suffered from various setbacks, including a lack of senior funding, bullish economic valuations by bidding consortia and continuing concerns over the protection of the public interest (P3 Development in the US, Brian Chase, Campbell Lutyens, Dec/10). *"I view the fundamentals of the asset class as being the equivalent, or even better, than the fundamentals of the real estate class forty* years ago," Campbell Lutyens' CEO observed. (http://www.prequin.com/docs/quarterly/INF/Infrastructure_Quarterly_-_Q1_2012.pdf)

Special purpose entities (SPE) or vehicles are pass-through frameworks used for structured finance in P3s to capture attributes from the respective sectors such as low-cost capital available to municipalities and tax credits and depreciation that can only be claimed by corporate entities, as shown by **Figure 2-2.** Pass-through structures pass along all of the principal and interest payments of assets to the respective investors.

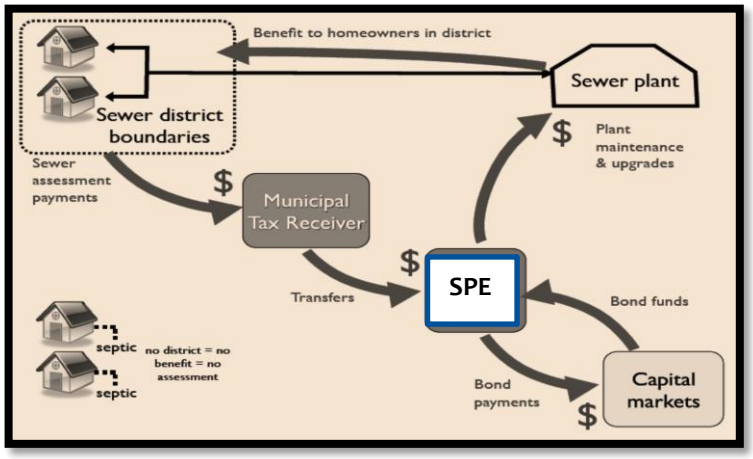


Figure 2-2 Special Purpose Entity

Pass-through structures are therefore generally passive tax vehicles and do not attract tax at the entity level. Pay-through structures allow for reinvestment of cash flows, restructuring of cash flows, and purchase of additional assets.

In 2011, operation and ownership of water and sanitary sewer services in Indianapolis transferred from the city and a public-private partnership to a Public Charitable Trust. In the transition, Citizens Water assumed operations of the water utility from Veolia Water Indianapolis and took assignment of the city's contract with United Water to operate the wastewater system. Most city and Veolia employees who served the water and wastewater systems are now Citizens employees. In the 2010 Memorandum of Understanding (MOU) between the City and Public Charitable Trust, "*Citizens' exemption from federal and state income taxes, its ability to assume or replace and to issue tax-exempt debt and its regulation as a municipal utility without a required return to equity investors will result in substantial long-term benefits to the City and to customers*." Six pages later, the MOU makes the commitment that "*rates shall increase no more than 10.75% annually through 2013*." The results and system characteristics can be summarized as follows:

- City relieved of $1.5B in public debt by Citizens Water's acquisition of the water system for the cost of debt plus $262.6M for the equity in the wastewater system;
- All assets and liabilities assumed, including EPA consent decree for sewer overflow;
- Bond for increase in future increases in payments in lieu of taxes (PILOTs) brought in $425M for infrastructure;
- Transfer expected to keep water and wastewater rates 25 percent lower than projected and save the city $60M/year;
- City will pay Veolia $29M for early termination of contract;
- Water and sewer infrastructures cover approximately 320 square miles;
- The wastewater utility serves 230,000 households in metropolitan Indianapolis;
- Citizens Water is part of 125 year-old trust - Citizens Energy Group; and
- Citizens operates the nation's second largest steam and chilled water distribution system for large commercial customers.

2014 Update on Citizens: *The Indiana state regulator found that "Citizens Water's level of executive compensation was not appropriate for a municipal utility" and limited a requested 14.7% rate increase to 9%.*

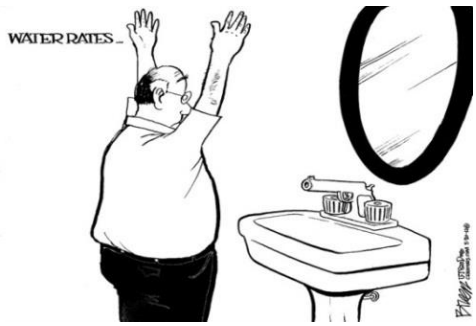
Infrastructure Bank known as a Clean Water State Revolving Fund. EFC has financed a $15 million

sewer extension to the Wyandanch Rising redevelopment and is providing financing for $83 million atop the $300 million coming via Housing and Urban Development's (HUD's) Sandy Recovery funding for major installations on four sub-watersheds feeding the Great South Bay. The EFC role in Suffolk's on-site wastewater management program is considered later in this chapter.

2.1.2 Dedicated Funding Streams

Excise taxes, user fees, systems benefit charges, sin taxes, property transfer taxes, tax credits, permits are all revenue producing mechanisms. User fees, in particular, are considered an equitable and reliable market mechanism. Adam Smith mentions that when infrastructure is privately provided and sustained with user fees, a market test filters out the waste: "*When high roads are made and supported by the commerce that is carried on by means of them, they can be made only where that commerce requires them"* (Smith, Adam. 'Wealth of Nations,' 1776. V.1.III.1). Taxes can be assessed as user fees to fund specific direct expenditure programs. This is sometimes called the benefit principle of taxation; those who benefit should pay the taxes.

As previously stated, current Chief of Staff for the (nonpartisan) Joint Committee on Taxation of U.S. Congress, Thomas Barthold, noted that "*politicians often prefer regulations with obvious benefits and hidden costs over regulations with hidden benefits and obvious costs."* This is one reason why politicians often prefer to hand out permits to firms rather than impose a tax on them, even though the tax is more economically efficient. Free permits create winners of grandfathered firms and losers of the consumer who has to pay more for the same product (Barthold, Thomas A. (1994) "Issues in the Design of Environmental Excise Taxes," The Journal of Economic Perspectives, 8(1): 133-151).



In the aftermath of the Exxon Valdez oil spill, Congress in 1989 imposed an additional **excise tax** on petroleum and petroleum products to fund the Oil Spill Liability Trust Fund. Congress began considering legislation in the 1990s to impose a carbon tax as an approach to dealing with global warming and proposals that would use taxes and/or subsidies to promote recycling. At the same time the EPA (1991) discussed using taxes to deal with the problem of lead leaching into ground water from landfills, the disposal of used automobile tires, the disposal of pesticide containers, and other environmental concerns. President Bill Clinton weighed in with a proposal for a modified BTU (energy) tax. None of these proposals passed muster. Over the course of the '90s and '00s, ozone depleting sulfur dioxide and nitrogen oxide emitting from coal-fired power plants were brought under control in a cap and trade Acid Rain Program, an emissions trading program with similarities to transfer of development rights.

The Maryland Department of Environment (MDE) uses the revenue from the Bay Restoration Fund (BRF) commonly referred to as the "**flush tax**," to fund improvements to wastewater treatment plants owned by utilities throughout the state. The upgrades primarily reduce nitrogen and

phosphorus pollution into the Chesapeake Bay. As of 2012, the BRF Fee was doubled to $60/year charged as a fixed fee generating an estimated $55M/year. Sixty percent of these funds are used for septic system upgrades and the remaining forty percent are used for cover crops. There are 420,000 onsite systems in Maryland. With priority given to failing septic systems in 'Critical Areas' – within 1,000 feet of adjoining waterways – a best available technology (BAT) nitrogen-reducing system, usually a $10,000-to-$12,000 investment, is granted through the program. More recently, '**Rain tax**' legislation would impose a stormwater pollution fee to raise revenue to clean up the Chesapeake Bay (http://mgaleg.maryland.gov/2012rs/bills/hb/hb0987e.pdf).

The State of Massachusetts offers a **tax credit** (General Laws Chapter 62) for forty percent of the repair or replacement of failed cesspools or septic systems up to $6000, spread over 4 years at $1500 per year (few have been extended to date). Despite the State's commitment, not all feedback has been positive. Comments included: "Four years of $1500 deduction. I think the amount was based on some fantasy that the average septic upgrade was about $6,000. In your dreams. Mine cost $30K …. Took 1½ years to get the foolish permit. Because I was too close to a wetlands, and have to pay $425/year for mandatory testing and checking."

The Suffolk County Water Authority (SCWA) charges $1.67/ 1000 gals of water, among the cheapest rates in the country, effectively 1/8000th the amount one pays for a pint of bottled water. The Authority assigns nary a penny to treat the water they deliver that is immediately contaminated upon delivery. Though not certifiably impaired like surrounding waters, groundwater is manifesting disturbing upward trends in nitrogen content and other contaminants. Adding a $0.25 **aquifer protection fee** to every 1,000 gallons would cost the average homeowner a mere $20/year and effectively double the amount the County currently collects for wastewater treatment, as shown on **Figure 2-3.**

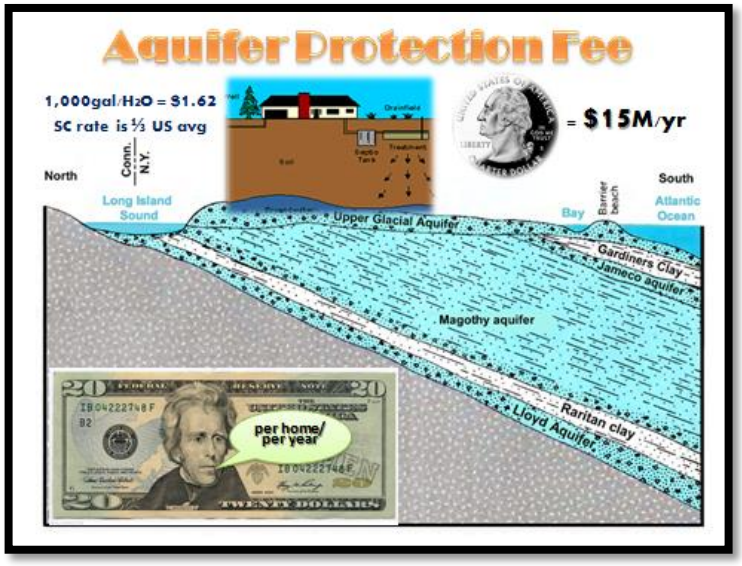


Figure 2-3 Aquifer Protection Fee

The Community Preservation Fund (CPF) was passed into law 16 years ago, bringing in $1 billion over that time (from a 2% **property transfer tax** after first $250,000) for the preservation of open space which has protected 10,000 acres in the five East End Towns. Assemblyman Fred Thiele Jr. (I-Sag Harbor), who sponsored the original CPF legislation 16 years ago, believes that 10 percent of this fund should now be used to Figure improve water quality by providing financing for water treatment systems. The plan would extend the CPF's time frame, from the current 2030 sunset through 2050. Thiele estimates that through 2030, $1.2 billion will be collected for land acquisition and $2.7 billion through 2050.

South Carolina established in 2007 **catastrophe savings accounts** that enabled residents to establish cash reserves for qualified catastrophe expenses. The amount placed in the account reduces the taxpayer's state income tax. A homeowner may deduct contributions to a catastrophe savings account to cover losses to the owner's legal residence against hurricane, rising floodwaters, or other catastrophic windstorm event damages. **Tax incentive** programs such as this one are devised to encourage homeowners to take out a larger deductible on their insurance policy and contribute more to the Catastrophe Savings Account. In the process they pay lower insurance premiums and lower taxes at the same time. The insurer benefits by having lower claims following a disaster. Many homeowners raising their deductible will reduce the insurer's catastrophic exposure. South Carolina also offers tax credits for retrofitting, allowing individuals to take tax credits for costs associated with specific fortification measures and the required materials. (http://www.doi.sc.gov/faqs/CatSavingsAcct.htm.)

Estimated 2007 Insured Value of Coastal[1] Properties by State ($B) State	State Total ($B)	Coastal Counties[2] ($B)	Percent Coastal
Alabama	744.8	92.5	12%
Connecticut	750.4	479.9	64%
Delaware	170.8	60.6	36%
Florida	3,119.6	2,458.6	79%
Georgia	1,573.3	85.6	5%
Louisiana	638.4	224.4	35%
Maine	250.0	146.9	59%
Maryland	1,078.4	14.9	1%
Massachusetts	1,426.4	772.8	54%
Mississippi	394.6	51.8	13%
New Hampshire	237.4	55.7	23%
New Jersey	1875.2	635.5	34%
New York	3,851.1	2,378.9	62%
North Carolina	1,431.8	132.8	9%
Rhode Island	189.3	54.1	29%
South Carolina	698.2	191.9	28%
Texas	3,493.0	895.1	26%
Virginia	1,409.4	158.8	11%
All States Above	23,332.4	8,890.8	38%
Total U.S.	53,495.0	8,890.8	17%

urce: Insurance Information Institute and AIR Worldwide June 11, 2008 release

Mitigation Funding has been extensively evaluated in that most vulnerable of states – Florida - where Voluntary Home Hardening Loans have been considered. While mitigated properties may increase in value due to the added mitigation features, hurricane damage to these properties should be reduced because of the new improvements. The same result should apply to newer houses built to more stringent building codes. Strategic incentive programs consisting of long-term 15 to 30 year loans that can be attached to mortgage or property tax, enabling low-interest loans secured by the improved property, and may be income tax deductible have also been weighed.

2010 Florida Property Assessed Clean Energy (PACE) legislation granted local governments the authority to establish green and/or windstorm hardening districts and to tax citizens that choose to participate in these districts which concur with property and casualty insurers, then assigned to mortgage or property tax (The Florida Catastrophic Storm Risk Management Center, "Home Hardening Incentives Programs," Florida State University (FSU, 6/30/10). Risk Management Solutions has proposed that future mitigation grants be targeted at homes most at risk, with Florida

realizing reductions in statewide 100-year storm loss of as much as $2.75 per $1.00 in mitigation grants, up from the $1.50. Examining 2,100 claims post Hurricane Charley, the Institute for Business and Home Safety (IBHS) determined that homes that meet wind-resistant standards had a claim frequency that was 60 percent less than non-fortified housing stock, claims of $14/square foot for the former, $24/square foot for the latter.

One **model program** identified by the FSU report is the **Babylon, NY Long Island Green Homes Program** operating on the south shore of Long Island. In 2008 the town committed to reducing carbon emissions 12 percent by 2012. To that end, Babylon implemented a self-financing program that draws from a solid waste revolving fund to finance energy retrofits to residential housing stock. The obligation is secured by a benefit assessment and only defaults to the property tax bill in cases of delinquency. The financing rate is 3 % with a maximum loan amount of $15,000.

What considerations would drive insurance uptake in the face of low-probability, high-consequence (LP-HC) events where the logic is not clear cut for those in harm's way (Kunreuther, H & Pauly M, "Behavioral Economics and Insurance: Principles and Solutions," Wharton, 2/14). One vital statistic speaks volumes here in the lead-up to Irene and Sandy – the number of new policies written annually on Long Island by New York Property Insurance Underwriting Association (NYPIUA), the insurer of last resort, has decreased by 23.8 percent over the past three years. NYPIUA only writes 1% of homes in Nassau County and 2.1% in Suffolk County. (http://www.edwardswildman.com/files/upload/2010-09-24_Coastal_Homeowners_Insurance_is_Available.pdf)

Well-designed insurance can play an important role in linking mitigation with financial protection should a disaster occur (H. Kunreuther, et al, "**Making America More Resilient toward Natural Disasters: A Call for Action** " *Environment: Science and Policy for Sustainable Development*, July-August 2013, 15-23). People often use good economic sense in buying insurance. They buy property insurance on their homes. They buy collision insurance on their new cars. They buy life insurance if they have dependents. But they have problems with insurance against extreme events, such as floods and earthquakes, because these events are rarely experienced. Insurance also has the potential to encourage investment in loss reduction measures if homeowners can receive premium reductions based on investment in such measures, reflecting expected reduced claims following a disaster.

Calling attention to the benefits of investing in mitigation measures by focusing on the reduction in losses from specific catastrophic storms such as Sandy or Katrina would attract more uptake than a general message framed in terms of reducing damage from future hurricanes. Even before 9/11, controlled experiments revealed that consumers are willing to pay more for insurance against a plane crash caused by terrorists than for flight insurance due to any cause, a counterintuitive finding since by definition "any cause" includes a terrorist attack.

The New York State Insurance Department (NYSID) considered Proposed Regulation 189 in 2009 that posited property insurance premiums include a charge for potential catastrophe losses, or "catastrophe loads," which would bank a reserve to fund future losses. Wilkie Farr noted concerns about the lack of favorable tax treatment for such a reserve. The Property Casualty Insurers Association of America (PCI), responding to this proposal from the New York Superintendent of Insurance, declared it was *"trying to fix a problem that doesn't exist…. These proposals could create marketplace conditions that negatively affect both the availability and affordability of coastal homeowners insurance for consumers."* The superintendent also directed the Temporary Panel on Homeowners Insurance Coverage to examine the following areas of concern:

- Market assistance programs;
- The catastrophe insurance pool;
- Existing state and local building codes, and retrofitting current structures to mitigate damage from a major weather catastrophe;
- Insurer preparedness for recovery and rebuilding after a catastrophe;
- Public education about storm risks and mitigation techniques; and
- Other coastal homeowners' insurance issues.

Is it realistic to expect the insurance industry to sign off on a mitigation reserve fund drawn from a system benefit charge on risk and casualty insurance? Economist Jonathan Gruber of MIT weighed in on this score in a 2013 exchange at Penn's Leonard Davis Institute: "*Insurance companies are incredibly conservative institutions. They don't try. They just want to be bookies; they want to take their spread off the top. They don't want to innovate; they don't want to do interesting things.*"

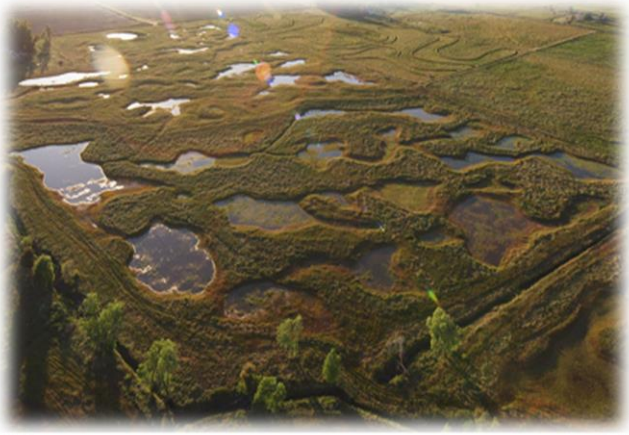
On the other hand, insurance companies doing business in New York might tear a page from the cost-benefit probe of mitigation in Florida which was linked to a proposed catastrophe reserve fund to finance house hardening, i.e. elevation in hazard zones. Could there be something akin to a systems benefit charge assigned to the $32B in New York State property and casualty insurance that could go into a mitigation fund that could fund both house hardening and green and grey mitigation measures to minimize impacts of storm events? This charge would be akin to the set-aside out of the Regional Greenhouse Gas Initiative that incents renewable installations. Current NYSID Superintendent Lawsky, who has demonstrated an appetite for challenging the insurance industry, might see the calculus in this proposition.

2015 saw a spate of proposed usage fees, including one from a MoveNY, headed by a former New York State Traffic Commissioner echoing the 2008 'Ravitch Plan' that proposed tolls for East River bridges that currently cost taxpayers hundreds of millions of dollars in annual maintenance. The City's Citizens Budget Commission proposed volume-based garbage fees (http://www.cbcny.org/sites/default/files/REPORT_SOLIDWASTE_02052015_0.pdf).

2.1.3 Niche Funding

Social Impact Bonds, Green Bonds and other 'pay-for-success' programs are currently being pursued in more than a dozen states across the country, projected to reach $300 million by 2016.

As an iteration of a pay-for-success program, a wetland mitigation bank represents a wetland, stream, or other aquatic resource area that has been restored, enhanced, or preserved which subsequently can be purchased to offset impacts of an unrelated development. In other words, these banks represent a third-party compensatory mitigation credit, in which the responsibility for implementation is assumed by a party other than the permittee. As of August, 2013, there were over 1,800 bank sites loaded into the Regulatory In-lieu fee and Bank Information Tracking System (RIBITS) database.



Wildlands Mitigation Bank, Placer County, CA

Land Banking was launched in 2002 by Genesee County, MI to forestall tax foreclosure and reuse tax-reverted property in the contracting city of Flint and its suburbs. The county has adopted a Brownfield Redevelopment Plan for its entire inventory of tax-foreclosed property controlled by its Land Bank. Utilizing **Tax Increment Financing** (TIF) relies upon taxes on cross- collateralized properties generated by the redevelopment of tax-foreclosed properties to support the bond payments. Genesee assumes the collection of delinquent taxes by borrowing against tax anticipation notes, and, in turn, making local municipalities whole. For properties it can't collect on, the county is able to transfer properties to the Land Bank without bearing the financial and legal burden of owning them. In turn, certain properties lend themselves to 'community gardens' or wastewater treatment clusters.

Pine Barrens Credit Program (transfer development rights) is designed to protect the quality and quantity of surface water and groundwater and the long term integrity of the Pine Barrens ecosystem by promoting sustainable development. "*A Pine Barrens Credit (PBC) Certificate is a document issued on behalf of the Commission which indicates the number of Pine Barrens Credits to which the owner of a particular parcel of land is entitled and which attests to the fact that the development rights of a particular parcel of land in a sending district of the Central Pine Barrens have been severed from the land by the recording of a conservation easement, and that these rights are available for sale or use* (http://www.pb.state.ny.us/chart_pbc_main_page.htm)."

Nutrient Trading Schemes

"The development of simple water trading opportunities, together with basic market institutions like exchanges or water banks, creates the opportunity to deploy more sophisticated market-based

tools that help to manage risk and vulnerability in other market settings…. Insurance companies, farmers, commodities brokers, investment banks, mutual funds, and hedge funds have each developed risk management tools of varying degrees of sophistication to control or hedge against market, weather, and environmental risks. Water markets should borrow some of these risk mitigation strategies. By developing similar tools for water resource management, we can build resiliency into and reduce the vulnerability of our water management institutions and infrastructure" ("Shopping for Water: How the Market Can Mitigate Water Shortages in the American West," Culp, Peter, et al, 2014). Long-standing nutrient control programs for the Chesapeake Bay and Long Island Sound have thus far fallen notably short of their goals. While point source nutrient control technologies have produced reductions, Long Island Sound non-point nitrogen loads have not decreased in 20 years (http://longislandsoundstudy.net/2010/07/estimated-nitrogen-load-all-ct-sources/). *"To date, water quality programs have devoted little attention and resources to exploring and developing technologies and programs to enhancing this nutrient removal pathway."* (Stephenson & Shabman, 'The Use of Nutrient Assimilation Services in Performance-based Water Quality Incentive Programs,' 2013)."

2.2 Wastewater Management District –Extending Septic Upgrades to the Untreated 74%

While Suffolk County at 74 percent may certainly have one of the highest concentrations of cesspool/septics in the country, the EPA estimates that 25 percent of U.S. homes have decentralized systems. Existing onsite systems are over 30 years old on average, and surveys indicate at least 10 percent of these systems back up onto the ground surface or into the home each year. At least 20 percent of the systems are malfunctioning to some degree.

Pursuant to an extended septic tour of the Northeast undertaken by Suffolk in concert with representatives from New York State's EFC, the USEPA, The Nature Conservancy and Peconic Green Growth, the County is piloting a septic upgrade program. This pilot is installing nineteen innovative/advanced (I/A) systems contributed by five manufacturers at homes drawn in a lottery.

By the end of the first year, with systems provisionally approved, the program is projected to expand countywide, with particular focus on critical areas. Five elements must be readied for the launch of an expanded program:

1. Current construction standards for on-site systems must be reformulated to consider the characteristics that distinguish I/A systems, in conjunction with changes to the Sanitary Code.

2. A county-wide wastewater management district must be affirmed and established.

3. The appropriate responsible management entity (RME) must be identified and prepared to function either within or in concert with the Suffolk County Department of Health Services (SCDHS) as regulators and Suffolk County Department of Public Works (SCDPW) as project engineers.

4. Operational staff and funds need to be in place.

5. A financing arrangement with NYSEFC must be formalized to provide low-interest financing.

2.2.1 Current Suffolk County Construction Standards

A variance from the following County standards was required in order to proceed with septic upgrade demonstration pilot:

STANDARDS - APPROVAL OF PLANS AND CONSTRUCTION
SEWAGE DISPOSAL SYSTEMS FOR SINGLE-FAMILY RESIDENCES

5-114 Alternative Systems

A. The treatment systems addressed thus far in these Standards are considered conventional or typical systems and may be used on sites with adequate soil percolation and vertical/horizontal separation distances unless otherwise prohibited. Many sites are not suitable for such systems. The purpose of these Standards is to assure proper treatment of sewage rather than to restrict use of land. In cases where conventional systems are not suitable, alternative designs of sewage disposal systems may be considered by the Department on a limited experimental basis or for replacement systems on difficult sites provided:

1. *The system shall be designed by a licensed professional engineer.*
2. *It is clearly demonstrated that the proposed system is physically equivalent or better than the conventional systems, in respect to storage capacity, leaching area, land area utilization, grading, accessibility, maintainability, reparability, life expectancy, energy usage, effluent quality and reliability.*
3. *An engineering report determines that the proposed design is most suitable for the building site and that the proposed sanitary system will function properly without causing any health hazard and will minimize the impact on the surrounding environment.*
4. *The design professional supervises the installation of the system and certifies that the system was built in accordance with the approved plan and submits as-built plans of the system.*

B. Alternative systems, on an experimental basis, are inappropriate for realty developments or subdivisions and will not be approved for same.

2.2.2 Use of Innovative/Alternative Systems in Massachusetts

Massachusetts Department of Environmental Protection (MassDEP) has set the pace for pilot programs (http://www.mass.gov/eea/agencies/massdep/water/wastewater/massdeps-technology-approval-process-for-ia-systems.html) that are teeing up innovative/alternative (I/A) onsite wastewater treatment systems with an eye to widespread installation:

Stage One: PILOTING

- Technologies can be piloted when available data indicate a technology is likely to perform at least as well as a conventional system. Piloting involves installations on up to 15 sites per technology, with field testing for at least 18 months and full reporting of results. A technology can proceed to the Provisional Use approval stage if 75 percent or more of the pilot systems performed as expected for at least 12 months.

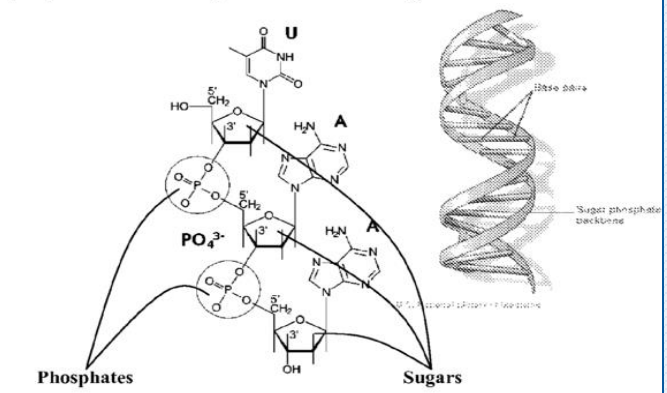
Stage Two: PROVISIONAL USE

- The Provisional Use Approval process evaluates whether an I/A technology can perform at least as well as a conventional system under local field conditions in a less controlled environment than piloting. This stage occurs after a technology has passed the pilot stage or has two or more years of successful general-use performance in one or more other states. At least 50 systems must be installed, and their operation, maintenance, and monitoring is tracked by the manufacturer with reporting to MassDEP for at least three years. Provisional Use is considered successful if 90 percent or more of the installations have, over three years, performed at least as well as a conventional system.

Stage Three: GENERAL USE

- When a technology successfully completes the Provisional Use stage, it is certified for General Use. Certified technologies can be installed at any site where a conventional system can be installed. The system owner is required to complete inspection and testing requirements on a regular schedule as required by the approval. MassDEP uses the data from the Provisional Use Approval process to set discharge standards and other conditions for General Use.

The Hydrogen ions "attack" the negatively charged Phosphate links in the sugar-phosphate backbone (ribbons) in the DNA of the bacterial matter, cleaving the electrically-induced bonds between the sugars and the phosphates and breaking the backbone into fragments.



Once the bonds have been broken, the phosphates and sugars are released into the water and carried on into the holding tank and the Cathode Chamber.

One example of a potential nitrate removal technology is shown here. Aqua Vector conducted a promising pilot application of its technology at the Village of Northport Wastewater Treatment Plant in 2012. The goal of the pilot was to consistently reduce effluent nitrate to less than 3 mg/L. For over two years, a modest flow of effluent from the Northport plant was processed employing Aqua Vector's patented tertiary treatment process. Effluent nitrogen averaged 2.5 mg/L from May to August 2012.

Pat App #: 20130277231 - Electrolytic Apparatus and Method for Treating Water to Remove Nitrates

2.2.3 Wastewater Management District

The following sections from New York State code will be referenced in the development of a countywide wastewater management district. A countywide district is necessitated for operational reasons, in that innovative/advanced septics are akin to mini sewage treatment plants requiring a professional level of maintenance to remain effective. In effect, on-site systems should have oversight comparable to sewage treatment plants and the cost of wastewater treatment should be leveled countywide. From the standpoint of financing, state administrators of the Clean Water State Revolving Fund (CWSRF) have indicated they are predisposed to providing low-interest loans, but only if it is conveyed at the county level. The obligation would then be assigned to the property as it is with sewers, along with all the associated advantages.

2.2.4 Responsible Management Entity (RME)

Responsible Management Entity (RME), as defined by the EPA, is a legal entity responsible for providing management services to ensure that decentralized onsite or clustered wastewater treatment facilities meet established criteria. Management of decentralized systems requires coordination of a cycle of components including public outreach, planning, performance, site evaluation, design, construction, operation and maintenance, residual considerations, training, certification/licensing, inspections/monitoring, corrective actions, accounting/reporting, financial assistance all of which require funding. EPA defines five models with progressively deeper responsibilities:

1. "Homeowner Awareness" model is a starting point for enhancing management programs because it provides communities with a good database of systems owned and operated by individual property owners in environmental areas of low sensitivity. Treatment technologies should be limited to conventional systems requiring little owner attention, with maintenance reminders mailed intermittently by the regulatory authority.

2. "Maintenance Contracts" program addresses more complex designs than conventional systems, including clusters, calling for contracts with qualified technicians to provide proper and timely maintenance.

3. "Operating Permits" applies to treatment systems deemed critical to public health and water quality. Limited-term operating permits are issued, renewable if a system is in compliance with the terms and conditions of the permit. Performance-based designs may be incorporated into programs with management controls at this level.

4. "Responsible Management Entity (RME)/Operation and Maintenance" model specifies program elements and activities where frequent and highly reliable operation and maintenance of decentralized systems is required to ensure water resource protection in sensitive environments. Under this model, the operating permit is issued to an RME instead of the property owner to provide the needed assurance that the appropriate maintenance is performed.

5. "RME Ownership" model specifies that program elements and activities for treatment systems are owned, operated, and maintained by the RME, which removes the property owner from responsibility for the system and diminishes disputes. This program is analogous to central sewerage and provides the greatest assurance of system performance in the most sensitive of environments. Types of RMEs that fall under corporate regulation include special purpose districts, subordinate service districts, non-profit sewer cooperatives, for-profit private utilities, private maintenance contractors, and private homeowners' associations.

The Rhode Island Cesspool {Phase-Out} Act of 2007 (RIGL § 23-19.15) mandates that all cesspools located within 200 feet of the inland edge of the coastal shoreline feature bordering a tidal water area must be abandoned and the home upgraded with a new onsite wastewater

NY CODE – ARTICLE 5-A: COUNTY WATER, SEWER, DRAINAGE AND REFUSE DISTRICTS *The board of supervisors of each county may establish, consolidate, or extend county water quality treatment, sewer, wastewater disposal, drainage or refuse districts …*

2. For the purpose of (a) the conveyance from other municipalities and districts within the county of sewage and treatment and disposal thereof, (b) collection, except as hereinafter provided, or (c) both such conveyance and collection;

3. For the purpose of administration and planning (including educational programs), design, installation, construction, rehabilitation, replacement, operation and maintenance (including pumping and inspections), monitoring, residual treatment and disposal and regulation of private on-site wastewater disposal systems of such district;

7. Except in the county of Suffolk, no county district shall be established hereunder which shall consist wholly of territory within one city, within one village or within that portion of one town outside of a village.

N.Y. CNT. LAW *§252: NY Code – Section 252: Powers of county agency*

2. In the county of Suffolk, the county sewer agency may undertake such other duties, powers and responsibilities as may from time to time be approved or delegated to it by the board of supervisors.

N. Y. CNT. LAW §256: NY Code – Section 256: Establishment of a county district

…Such resolution shall be subject to permissive referendum as hereinafter provided, except in the case of a water quality treatment district and except in the county of Suffolk. In the county of Suffolk, if the owner or owners of all of the land within the proposed district consent in writing to the formation of the proposed district and the board of elections certify that on or after the date of the first publication of the notice of public hearing hereinabove referred to, there is no registered voter within the proposed district, then and in that case the resolution adopted by the board approving the establishment of a district shall not be subject to referendum, permissive, or otherwise.

N.Y. CNT. LAW § 266: NY Code - Section 266: Water rates, water quality treatment, sewage, wastewater disposal and refuse collection charges and revenues

1. Subject to confirmation by the board of supervisors, the administrative head or body: (a) may establish, from time to time, wholesale and retail rate schedules for water sold to, or a scale of charges for the collection, conveyance, treatment and disposal of sewage, wastewater…. Notwithstanding the provisions of sections two hundred seventy, two hundred seventy-one and two hundred seventy-four, revenues derived from water rates, water quality treatment charges, sewer rents and sewage, wastewater and refuse collection charges shall be applied toward the maintenance and operation of the water, water quality treatment, sewer, wastewater.

N.Y. CNT. LAW § 270: NY Code - Section 270: Assessment of the cost

N.Y. CNT. LAW § 277: NY Code - Section 277: Establishment of certain county sewer districts in Suffolk county

NEW YORK STATE TITLE 10, APPENDIX 75-A: WASTEWATER TREATMENT STANDARDS - RESIDENTIAL ONSITE SYSTEMS

Updated NYSDOH regulations (2011) require an owner of an Enhanced Treatment Unit (ETU) be within a jurisdiction served by either a Responsible Management Entity (RME) or the local sanitary code.

treatment system or connected to available municipal sewer lines. The Act also requires cesspools located within 200 feet of public wells or within 200 feet of drinking water reservoirs to be replaced as above.

- All cesspools within the 200 foot zones identified above will have to be inspected by January 1, 2012 or upon notice from the Rhode Island Department of Environmental Management (DEM);
- All cesspools within the 200 foot zones identified above that are found to be failed will need to be replaced within 1 year;
- All cesspools within the 200 foot zones identified above that are found in already sewered areas will need to be hooked up to the sewer by January 1, 2014; and
- All other cesspools within the 200 foot zones identified above will need to be replaced by January 1, 2014.

Rhode Island's efforts at passing a **point-of-sale law** have been unavailing. RIDEM estimates that there are up to 50,000 pre-1968 cesspools; the Cesspool Act will prompt the removal of approximately 5,000 of these. Since 2008, Rhode Island has required installation of nitrogen reducing septics if a property in a critical resource area increases dwelling square footage by 50 percent, or adds two bedrooms or more. The Community Septic System Loan Program was launched by the Rhode Island Clean Water Finance Agency which governs the lending activities of the Rhode Island Water Pollution Control Revolving Fund in accordance with Title VI of the federal Clean Water Act. The Agency vets financial capability for each loan application which is tendered to the homeowner at 2 percent for a term up to ten years.

Cluster systems for four to one hundred homes are halfway between individual onsite systems and municipal sewers. Cluster systems have three basic components: onsite pretreatment and pumping, collection lines, and the community treatment system. These could, quite conceivably, be financed through **wastewater utility districts** in which the obligations are secured by the property via a benefit-assessment. This brings down the interest rates, spreads out costs and assigns any balance to the next property owner should the current one move. The same property-assessed clean energy (PACE) principles that made Long Island Green Homes so successful are at work through this approach and is, in effect, the historical method for assigning sewer costs.

By operationalizing a countywide septic upgrade program, Suffolk will be plying the optimal route of advancing applied technology via market-based solutions. Current innovative/ alternative wastewater technology is a half measure that is more than double the cost of what would be a market maker. The market is the optimal driver of innovation and economies of scale.

Value Proposition for Homeowner:

- Proof of concept – do systems and program delivery work
- Real estate – enhanced appraisal with advanced wastewater treatment

- Reduced costs associated with eliminated pump-outs and reduced fertilizer use
- Valuation of surface water quality for recreation and tourism

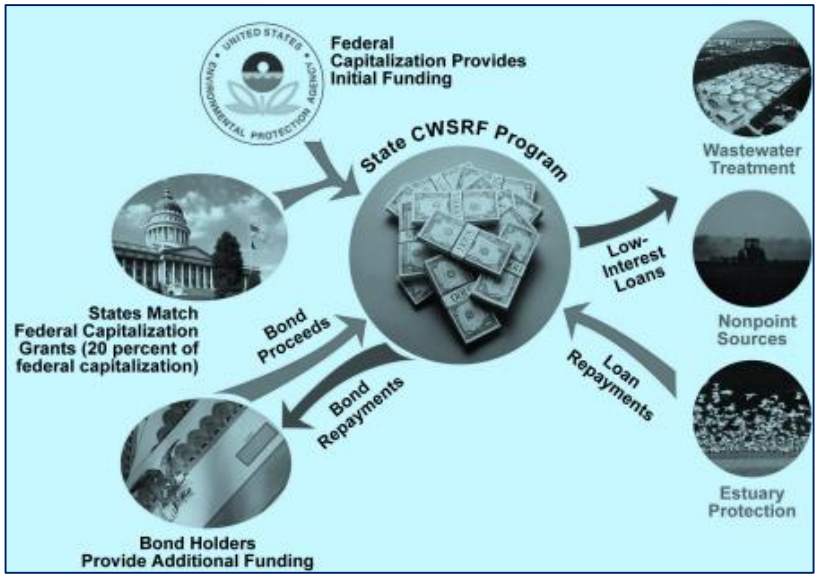
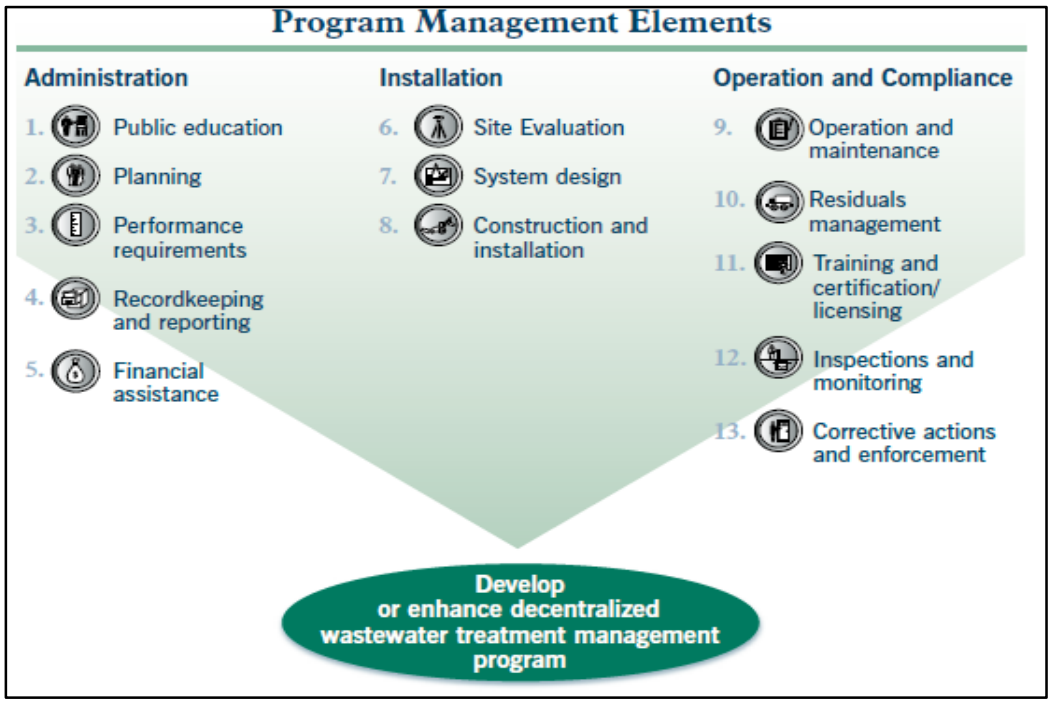


Figure 2-4 Overview of Clean Water State Revolving Funding

Low-interest financing through the CWSRF program has already gotten the green light in Rhode Island from the EPA. It has designated point-of-use treatment devices as "compliance technologies" ("*Guidance for Federal Land Management in the Chesapeake Bay Watershed,*" 5-12-10) as that ensures household charges for such devices would remain at an affordable threshold. This means that the EPA's infrastructure banks, like NYSEFC are prepared to provide millions of dollars in low-interest loans for decentralized/cluster wastewater treatment systems.

Initial funding could come via EFC purchase of a general obligation bond or note of the County or a revenue bond or note of an Industrial Development Authority (IDA), Local Development Corporation (LDC), or other public authority necessary to satisfy EFC's statutory investment and consistent with Issuer's constitutional and other applicable requirements. Debt term would be no greater than a project's useful life with interest no greater than market rates. In consideration, County/issuer will provide standard representations, warranties, covenants, and opinions as to authority to issue debt, operate the program and perform obligations. There would be no transaction costs and standard indemnification of EFC.

Program factors such as septic standards, installation process, O&M and inspection would have to accord with NYSDEC/SCDHS criteria. The County will determine contractor criteria, homeowner eligibility, credit criteria, and loan terms. Homeowner loan credit analysis, origination, collection, monitoring and collections may be subcontracted with consent. EFC would acquire no interest in financed projects but is amenable to acquisition by others.



Once the program is implemented, EFC will consider closing in advance of originations upon request and transfer all bond proceeds at closing. Bond proceeds and repayments to be maintained in a segregated account but may be redeployed into new loans or applied to EFC amortization requirements. Additional funding may be forthcoming dependent upon program pace, and may be converted or refinanced if scale or economics are preferred. EFC would bear none of the risks of homeowner loan defaults.

In terms of program analysis, the County agrees to share records and engage EFC in ways to improve program. The County will participate in publicity and marketing efforts and consult with other interested counties upon reasonable request.

Table 1: Summary of Management Models

TABLE 1: SUMMARY OF MANAGEMENT MODELS

TYPICAL APPLICATIONS	PROGRAM DESCRIPTION	BENEFITS	LIMITATIONS
MODEL 1 - HOMEOWNER AWARENESS MODEL			
• Areas of low environmental sensitivity where sites are suitable for conventional onsite systems.	• Systems properly sited and constructed based on prescribed criteria. • Owners made aware of maintenance needs through reminders. • Inventory of all systems	• Code-compliant system. • Ease of implementation; based on existing, prescriptive system design and site criteria. • Provides an inventory of systems that is useful in system tracking and area-wide planning.	• No compliance/problem identification mechanism. • Sites must meet siting requirements. • Cost to maintain database and owner education program.
MODEL 2 - MAINTENANCE CONTRACT MODEL			
• Areas of low to moderate environmental sensitivity where sites are marginally suitable for conventional onsite systems due to small lots, shallow soils, or low-permeability soils. • Small clustered systems.	• Systems properly sited and constructed. • More complex treatment options, including mechanical components or small clusters of homes. • Requires service contracts to be maintained. • Inventory of all systems. • Service contract tracking system.	• Reduces the risk of treatment system malfunctions. • Protects homeowner investment.	• Difficulty in tracking and enforcing compliance because it must rely on the owner or contractor to report a lapse in a valid contract for services. • No mechanism provided to assess effectiveness of maintenance program.
MODEL 3 - OPERATING PERMIT MODEL			
• Areas of moderate environmental sensitivity such as wellhead or source water protection zones, shellfish growing waters, or bathing/water contact recreation. • Systems treating high-strength wastes or large-capacity systems.	• Establishes system performance and monitoring requirements. • Allows engineered designs but may provide prescriptive designs for specific receiving environments. • Regulatory oversight by issuing renewable operating permits that may be revoked for noncompliance. • Inventory of all systems. • Tracking system for operating permit and compliance monitoring. • Minimum for large-capacity systems.	• Allows systems in more environmentally sensitive areas. • Operating permit requires regular compliance monitoring reports. • Identifies noncompliant systems and initiates corrective actions. • Decreases need for regulation of large systems. • Protects homeowner investment.	• Higher level of expertise and resources for regulatory authority to implement. • Requires permit tracking system. • Regulatory authority needs enforcement powers.
MODEL 4 - RESPONSIBLE MANAGEMENT ENTITY (RME) OPERATION AND MAINTENANCE MODEL			
• Areas of moderate to high environmental sensitivity where reliable and sustainable system operation and maintenance (O&M) is required, e.g., sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, or outstanding value resource waters. • Clustered systems.	• Establishes system performance and monitoring requirements. • Professional O&M services through RME (either public or private). • Provides regulatory oversight by issuing operating or NPDES permits directly to the RME. (System ownership remains with the property owner.) • Inventory of all systems. • Tracking system for operating permit and compliance monitoring.	• O&M responsibility transferred from the system owner to a professional RME that is the holder of the operating permit. • Identifies problems needing attention before failures occur. • Allows use of onsite treatment in more environmentally sensitive areas or for treatment of high-strength wastes. • Can issue one permit for a group of systems. • Protects homeowner investment.	• Enabling legislation may be necessary to allow RME to hold operating permit for an individual system owner. • RME must have owner approval for repairs; may be conflict if performance problems are identified and not corrected. • Need for easement/right of entry. • Need for oversight of RME by regulatory authority.
MODEL 5 - RESPONSIBLE MANAGEMENT ENTITY (RME) OWNERSHIP MODEL			
• Areas of greatest environmental sensitivity where reliable management is required. Includes sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, or outstanding value resource waters. • Preferred management program for clustered systems serving multiple properties under different ownership (e.g., subdivisions).	• Establishes system performance and monitoring requirements. • Professional management of all aspects of decentralized systems through public/private RMEs that own or manage individual systems. • Qualified, trained, owners and licensed professional owners/operators. • Provides regulatory oversight by issuing operating or NPDES permit. • Inventory of all systems. • Tracking system for operating permit and compliance monitoring.	• High level of oversight if system performance problems occur. • Simulates model of central sewerage, reducing the risk of noncompliance. • Allows use of onsite treatment in more environmentally sensitive areas. • Allows effective area-wide planning/watershed management. • Removes potential conflicts between the user and RME. • Greatest protection of environmental resources and owner investment.	• Enabling legislation and/or formation of special district may be required. • May require greater financial investment by RME for installation and/or purchase of existing systems or components. • Need for oversight of RME by regulatory authority. • Private RMEs may limit competition. • Homeowner associations may not have adequate authority.

Table 2-1 Summary of On-site Wastewater Treatment Systems Management Models

Source: EPA: Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems

Program projections on what is, essentially, a large-scale home improvement operation can and should be based on market-based precedents, such as the following:

- From PSEG's web-site: "Since 2000, through LIPA's nationally recognized Solar Pioneer and Solar Entrepreneur Program, rebates of approximately $170,000,000 for the installation of more than 8,000 solar roofs on Long Island have been provided." The 8,000 number includes commercial installs as well as the 32 megawatt (MW) installation at BNL. Residential rebates are now down to $.75/W and with tax credits will now cover up to $5K or 25 percent of the solar system install. That's now all backed by the RGGI (Regional Greenhouse Gas Initiative) administered by New York State Energy Research and Development Authority (NYSERDA).

- Long Island Green Homes is up around 1,400 houses or 2.3 percent of Babylon's housing stock. It reached the 600/year level in year 5 or 1 percent/year (the external force of Federal Housing Finance Agency (FHFA) put the brakes on). Homeowners were not out-of-pocket up front, interest rate 3 percent, utility savings covered the monthly obligation which could be passed along to the next homeowner, and after approximately 10 years the average annual savings to homeowners of $1,340 was in pocket. An attractive home improvement, indeed, particularly considering the enhanced property value of a house that is also healthier and cheaper to operate (http://www.frbsf.org/community-development/publications/community-development-investment-review/2014/march/urban-city-innovative-energy-retrofits-single-family-homes/).

- Rhode Island with approximately 150,000 cesspool/septics has been overseeing 442 installs per year over the previous decade with 581 in 2013 for a total of 5,809. That translates to 2.8 percent market penetration at an annualized clip of 0.21 percent. Maryland, which provides grants from statewide flush tax, is coming in with around the same total.

In the past, SCDPW has commissioned a number of feasibility studies for **extending sewers**. *Project Feasibility for No. 3 Southwest Sewer District Service Area Expansion* was completed in 2012. 29 sub-areas contained within three prioritized tiers were under evaluation, which would add flow of 12 to 15.9 million gallons per day (MGD) from approximately 40,000 new connections and cost nearly $2.1B ($52,500 per connection). "*The overall objective of this study was to delineate and prioritize cost-effective, fundable project areas*." The Southwest Sewer District (SCSD #3 or SWSD) covers 57 square miles with over 950 miles of pipe and 14 pumping stations serving 85,000 parcels (approximately 1/5 of the county). It is connected to the Bergen Point wastewater treatment plant (WWTP) that can treat 30 MGD and is slated to increase that capacity to 40 MGD inclusive of 3.6 MGD of slack. In the *Rocky Point Business District Sewering Feasibility Study* prepared for SCDPW (May, 2010), Cameron Engineering "estimated annual cost for a residential property owner varied from $4,600 to $8,000," exclusive of one-time costs in the thousands.

With the $300M in Sandy Recovery funding plus the $83M EFC low-interest loan, sewering can be extended upwards to 15,000, the most significant since completion of SCSD #3 in the early '80s. IBM's estimated cost to Suffolk for sewering and septic system upgrades is US $8 billion (over 40

years). Conventional funding for these capital programs will be drawn from sewer district capital funds, EFC, ESD, and County general obligation bonds.

2.3 Operational Efficiencies: Synergies of Consolidation

The flip side of SCWA distribution which reaches 85 percent of Suffolk is the hodge-podge of wastewater treatment. There are 28 sewer districts served by 24 county sewage treatment plants (STPs) of various sizes that discharge a total of 31.5 MGD. Fourteen areas are served by a combination of village, town and federal STPs discharging 9.1 MGD. Added to the mix are 157 private STPs with a permitted flow of 8.9 MGD. Approximately 74 percent of Suffolk County's 1.5 million residents have an on-site sanitary wastewater treatment and disposal system. While the density of western Suffolk approximates that of Nassau, the county as a whole is one-third as dense. A rough estimate from SCDPW places the asset value of SCSD #3 and 21 other sewer districts at $1.25B and replacement cost at $5.8B over 20 years (SCDPW Chief Engineer Ben Wright, 11/28/11). If SCDPW operates/oversaw all STPs for network optimization (of 197 public and private STPs, 23 are currently operated by Suffolk County accounting for 90 percent of volume) the following could be realized:

- Consistency of operation;
- Enhanced nitrogen reduction (61 non-SCDPW STPs identified as "high risk" for producing in excess of 10 mg/L N);
- Cost uniformity and price parity countywide and increased revenue, and
- Expanding mission from STPs to include wastewater treatment for the majority of houses that will not be sewered.

With a $25,000 *government efficiency grant*, the County has retained a consultant to assess the synergies of consolidation who has provided an advance assessment:

- Billing methodology, owing to the manner in which Suffolk County acquired its 22 sewer districts over time, has never been integrated. Annual residential bills range widely based on sewer district-specific characteristics (e.g., size, age, etc.) from $63 in Kings Park to $940 in Strathmore-Huntington. While the residents receive similar services, the amount they pay varies greatly from district to district. A portion of one-quarter per cent of the County sales tax supports these circumstances. However, negative net revenues are projected in the future, factoring in capital O&M costs as well as enhanced mitigation. Consolidating districts could convert billing to equitable usage-based fees and enable leveraging sewer system value in extending beyond the approximate 26 percent currently sewered.
- Amalgamating budgets, personnel and tasks and aggregating systems' revenues of all the municipal districts that now operate separately would enhance leverage. The next step

would be to implement the regionalization of wastewater infrastructure services. Uniform automated billing along with economies of purchasing would realize significant savings.

- Operating deficits could be redressed. Currently, each district is autonomous, generating its own revenues and operating expenses. In the majority of districts, operating revenues alone are insufficient to cover operating costs with each of these districts dependent on additional funds from the County to meet their respective sewer budgets. Beyond annual 3 percent adjustments in rates (a requirement for eligibility to receive Assessment Stabilization Reserve Fund (ASRF) funding), increases in sewer fees to control the growth in these operating deficits have been negligible. The exception to this pattern of deficient operating revenues has been SWSD that services large portions of the Town of Babylon and parts of the Town of Islip, operating the largest sewage treatment plant in the County.

- The Assessment Stabilization Reserve Fund generates approximately $16 million in annual tax revenues which, in addition to operating revenues, subsidizes the districts whose revenues (after 3 percent rate increase) fall short of meeting operating expenses. The ASRF is scheduled to expire in 2030. Extending and realigning the ASRF must be a priority.

- Capital Needs of the County sewer system are pronounced. The Proposed 2015 Capital Budget calls for a portion of the $240 million estimate to replace the ocean outfall pipe from the SWSD plant which is close to catastrophic failure (CDM Smith).

- Rate equity is a key factor in that it would level sewer costs and fees, extending parity to both future sewer extensions as well as the vital upgrade of hundreds of thousands of on-site systems. In fact, assuring those with on-site treatment systems that they will be the recipients of service comparable both in terms of performance and price is elemental to widespread acceptance.

- A Base Case Analysis will be prepared by the consultant. This analysis will reflect current revenues and operating expenses by district with normalized growth projections. In addition to projected operating costs, the analysis will incorporate identified capital requirements over a 5 to 10 year period. Revenues will include current and projected sewer fees as well as ASRF funds applied in accordance with statutory requirements.

- A financial analysis will illustrate the impact of a consolidation of sewer districts and will include the following scenarios:

  - More closely aligning sewer fees with the cost of delivering the sewer services;

  - Assume alternative uses for the ASRF beyond currently authorized purpose of subsidizing sewer revenues in districts with insufficient fee income to meet operating costs;

  - Reflects an extension of the ASRF beyond its current expiration date of 2030;

- Illustrates the financial flexibility of consolidation which allows operating revenues to be applied where most needed on a system-wide basis;
- Assumes a level of operating efficiency that current configuration of individual sewer districts impairs;
- Examines the impact of basing some portion of sewer fees on use versus property value.

2.4 Comprehensive Water Resources Management

2.4.1 Integration of Water Supply and Wastewater Management

One of the key recommendations of the IBM Smarter Cities Challenge Report (2014) is that Suffolk County should consolidate water supply and wastewater management, as summarized in **Table 2-2**.

N.Y. PBA. LAW § 1075: NY Code - Section 1075: 3. It is hereby determined and declared that the authority (Suffolk County Water Authority) and the carrying out of its powers, purposes and duties are in all respects for the benefit of the people of the county of Suffolk and the state of New York, for the improvement of their health, welfare and prosperity and that the said purposes are public

Table 2-2 IBM Smarter Cities Challenge Report Recommendation

Recommendation 3: Integrate water and wastewater operations: The County should consolidate its water and wastewater management processes through the integration of the SCWA with the 193 STPs."

Expected Outcomes:
Consolidating water and wastewater operations will provide Suffolk County with the following benefits:

- An integrated view for effective management of the total water cycle
- Tighter orchestration between water management and Department of Health Services regulation
- Network optimization through the elimination of redundant activities and fewer repeat visits to specific sites
- Increased savings and synergies through the integration of key support services, such as sampling, laboratory services, call centers, control centers and management structures
- New revenue opportunities and funding options in addition to water-specific fees
- Uniform pricing for water and wastewater services for a majority of Suffolk County citizens
- Improved management of stormwater runoff.

Costs of inaction:
Continuing to operate water and wastewater operations separately will result in more duplication of services and operations, often within the same facility. In addition, investment decisions about capital construction and refurbishment will not be aligned and may not cover the full water cycle.

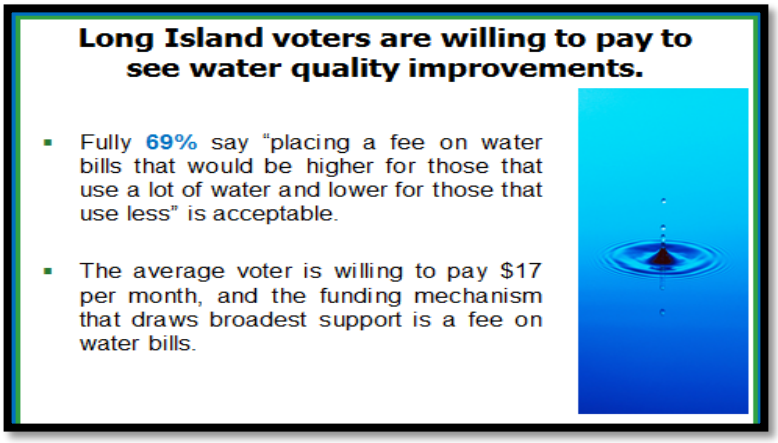
(The IBM Smarter Cities Challenge Report follows this Section.)

purposes and that the authority is and will be performing an essential governmental function in the exercise of the powers conferred upon it by this title.

A scan of water systems in New York State reveals that there are a number of public benefit corporation water authorities comparable to SCWA. There is one in Monroe County (Rochester) and one in Erie County (Buffalo), both of which envelop mid-size cities with installed sewer infrastructure. SCWA has no wastewater treatment charge delineated on its bill nor, by first flush, does Monroe. Erie has an "infrastructure investment charge" which, doubtless goes to the water delivery system. It should be noted that SCWA and these other authorities are pre-historic in that they were established decades before the premise that in-coming water might require treatment as it outflows. So, in Fairfax County (and neighboring counties in Northern Virginia), a sanitary sewer charge appears on the Fairfax Water bill (both departments are under the authority of the county) and is 70% higher than water usage. New York City wastewater charges ($5.88/100 cubic feet – FY 2015) are levied at 159% of water charges ($3.70/100 cubic feet – FY 2015) (http://www.nyc.gov/html/nycwaterboard/pdf/blue_book/bluebook_2015.pdf).

In contrast to Suffolk, Erie and Monroe, *"the New York City Municipal Water Finance Authority ("NYW") is a public benefit corporation created in 1985 pursuant to the New York City Municipal Water Finance Authority Act. NYW's purpose is to finance the capital needs of the water and sewer system of the City of New York (the "System") which is operated by the New York City Department of Environmental Protection. The New York City Water Board sets water and sewer rates for New York City sufficient to pay the costs of operating and financing the System."*

SCWA is the largest provider of groundwater in the nation, pumping approximately 70 billion gallons of potable water each year through nearly 6,000 miles of pipe from 400 active wells in 180 well fields drawn by 231 pump stations. Its May 31, 2014 financial report, SCWA showed water service operating revenues of $138.45M and assessed its net capital (water plant) assets of $1,077.32M.



If a sewerage usage charge were incorporated into SCWA's billing comparable to that in Fairfax, approximately $236M would be generated per annum to address wastewater treatment. As a point of comparative business performance, FCWA more than doubles SCWA's operating income to sales ratio, 0.37:0.15, and the FCWA's debt-to-asset ratio is ⅔ of SCWA at 0.36:0.56 (*Water Utility Privatization: A Comparison of Commercially-Owned and Government-Owned Utilities,* Maryland Tax Education Foundation, 2008).

Note that the principle of linkage, i.e. water *and* wastewater agency, as opposed to separate operations, prevails throughout larger-scale systems across the United States.

- How best to measure outflow than by inflow, attaching related usage and remediation fees?

  - How best to reduce waste than to put pressure on use through market mechanisms?

- To provide the most cost-effective solutions for water quality, the county would need to leverage all its assets. Absent its crown jewel water authority, county infrastructure would be substantially undervalued with significantly less leverage, limiting access to market, while increasing the cost of capital, which requires steady, predictable revenue streams.

  - Private sector models like French-based Veolia and Suez (United Water) are integrated utilities, combining energy, drinking water and waste treatment (resource recovery). Indianapolis' Citizens Energy, constituted as a public charitable trust, reclaimed its water system (Citizens Water) from Veolia in 2011 and off-booked its debt in the process. The principle demonstrated here is the market-based synergy of a unified utility, which is also

manifest in the largest public utility in the country, Los Angeles Department of Water & Power.

It may indeed be the case, as per opinions rendered both by counsel for SCWA and New York State Department of Health (NYSDOH) that, in order for the SCWA to charge an aquifer protection fee, the New York State Legislature would need to amend the New York Public Authorities Law Article 5, Title 4. The SCWA was created under this authority and is statutorily defined under New York Public Authorities Law Article 5, Title 4. Under Section 1078(6) {Powers of the Authority} they have the ability to charge and collect rates as described below:

> "6. To fix, alter, charge and collect rates and other charges for the use of water by the inhabitants of the county or other consumers thereof, at reasonable rates to be determined by the authority for the purpose of providing for the payment of the expenses of the authority, the construction, improvement, repair, maintenance and operation of the water supply and distribution system of the authority, the payment of the principal of and interest on the obligations of the authority, and to fulfill the terms and provisions of any agreements made with the purchasers or holders of any such obligations."

In addition, there are some existing provisions in N.Y. PBA. LAW § 1075: NY Code - Section 1075 beside (3.) cited above that could be liberally interpreted to enable expanded responsibility for a "public benefit corporation":

> "12. To enter into cooperative agreements with other water authorities, municipalities, or utility companies, for the interconnection of facilities, the exchange or inter-change of services and commodities or for any other lawful purposes necessary or desirable to effect the purposes of this title, provided, however, that any such agreement with a municipality located in a county, other than Suffolk county, shall be subject to the approval of the board of supervisors of such county, if any."

There are also "additional powers of the county of Suffolk and towns and villages within Suffolk County:"

> "b. In areas of documented groundwater contamination where potable water may be more economically supplied by a municipal water authority, special district or improvement area established to provide water improvement or by a village, than by the Suffolk County Water Authority, the county board of supervisors and any town board or village board of trustees within Suffolk County may appropriate sums of money to said municipal water authority, special district of improvement area or village, and enter into a contract or contracts, in accordance with this subdivision."

Note the combined authority of Dutchess County, which has the second most septics (52,000) of any New York State county after Suffolk:

> "§ 1123. Dutchess County water and wastewater authority. 1. A public corporation, to be known as the "Dutchess County water and wastewater authority" is hereby created for the

public purpose and charged with the duties and having the powers provided in this title. The authority shall be a body corporate and politic constituting a public benefit corporation and shall be a "public district" for purposes of section eighty-nine-l of the public service law, the objects of which in the judgment of the legislature cannot be attained under general laws.

§ 1124. Powers of the authority. The authority shall have the power:

14. To supply and sell water for domestic, commercial and public purposes at retail to individual consumers within the county or wholesale to municipalities, water districts or district corporations within the county and to collect, treat and discharge sewage produced for such purposes by such generators;".

2.4.2 Case in Point: Seeking Means beyond Grants…

One of ten mega-proposals selected by HUD's '***Rebuild by Design***' (RBD) is Interboro's "Living with the Bay*: A Comprehensive Regional Resiliency Plan for Nassau County's South Shore*." Interboro, which teams a domestic and Dutch contingent, has been granted $125M out of the $930M allocated to RBD via Sandy recovery funding. The 'Green Corridor' component of this Interboro's proposal addresses a stretch of Sunrise Highway from Valley Stream to Freeport, shown in a rendering by **Figure 2-5**. Presently underdeveloped, its post-Sandy desirability lies in the fact that it is high and dry, just beyond the reach of a category 2 surge, a 6-foot sea level rise, and the FEMA flood zone. The corridor is also highly impermeable: its roads and parking lots are a major source of both flooding and polluted stormwater runoff. In addition to transit-oriented, walkable, mixed-use downtowns and relief from river choke-points, the 'Green Corridor' proposes to reuse abandoned water infrastructure under Sunrise Highway for water storage and flow augmentation. This abandoned system, which includes a 72-inch steel force main, a 48-inch cast iron main, a 36-inch cast iron main, and a network of pumping stations, once provided Brooklyn with its drinking water from Long Island's aquifers. The estimate for 'Green Corridor' is $175.4M; the (partial) projected total for 'Living' comes in at $1,874M. With less than 7 percent of the interim estimate in hand, Interboro is clearly obliged to cast about for other funding/financing, three of which they identify:

Figure 2-5 The New Sunrise Corridor as Proposed by the Rebuild by Design/Interboro Team

- Because investments in flood prevention and stormwater retention make the protected land and properties more valuable, Tax Increment Financing (TIF) can stake current investment from the long-term cash flow forthcoming from higher property tax revenues. With other infrastructure work, TIF has been a proven means of using future tax gains to subsidize current upgrades.

- Mitigating measures for at-risk properties reduces storm damage and loss which, in turn, should be reflected in reduced insurance premiums. This provides a premise for applying some measure of insurance receipts to support mitigation. Interboro, however, "encountered a lot of complexities—mainly related to potential free riding—in further structuring this option," How the 'potential' of 'free riding,' i.e. illegal underwriting practice, arises in these kinds of transactions is not explained, though it may be another excuse provided by insurance companies to avoid the linkage of premiums to mitigation.

- Alternatively, it was Interboro's sense that the potential link with a specific tax or fee would experience "less complexity." The government could levy a property-related stormwater tax, or temporary fee or establish a business improvement district thus realizing lower insurance premiums and enhanced property value.

- Interboro proposes use of the 'availability payment' model of Public-Private Partnerships (P3s) for dikes, roads, marshlands, and stormwater systems. Moody's reports (9/8/14) that P3s are trending to the availability model away from the demand-risk model (as exemplified by the bankrupt Indiana toll road). From the standpoint of the private partner that makes sense, as it offloads most of their risk, in that the public partner is contractually bound to provide regular payments as long as the private partner meets performance measures, like construction cost overruns, schedule delays, long-term O&M and lifecycle costs. This past year the Port Authority of NY & NJ closed a $1.5B 'availability payment' model P3 for a new Goethals Bridge and will be contractually obligated to make availability payments over 40 years to compensate the special purpose vehicle (SPV) chosen to design, build, finance, and maintain the new bridge.

- NYS Office of the Comptroller ("Private Financing of Public Infrastructure: Risks and Options for New York State," June, 2013) calls it a new form of "backdoor finance" that "include some sort of payment guarantee to the private partner, so that the public is obliged to pay for years, with no consideration of changing circumstances or ability to pay.... The public may end up paying far more for the facility than it would have using traditional procurement methods." P3s want to have their cake and eat it too.

IMG Rebel, headquartered in the U.S. and the Netherlands served as financial advisor for the Interboro team. They proselytize for P3s which is, for example, how they structured privatization of Milwaukee's sewer utility operations, purportedly reducing costs by 35 percent. Rebel was retained by the Ministry of Infrastructure and Environment of the Netherlands to evaluate the "enormous investment need in water-related climate adaptation projects while funding is lacking." The

European Commission estimates that 80 percent of needed financing will come from private sources. The challenges to this end are formidable with climate adaptation projects:

- Capital-intensive with benefits very long term and dispersed, therefore hard to collect and use to pay back the investment.
- Returns are largely non-guaranteed and non-financial, consisting mainly of avoided costs.
- Offers limited autonomous earning power.

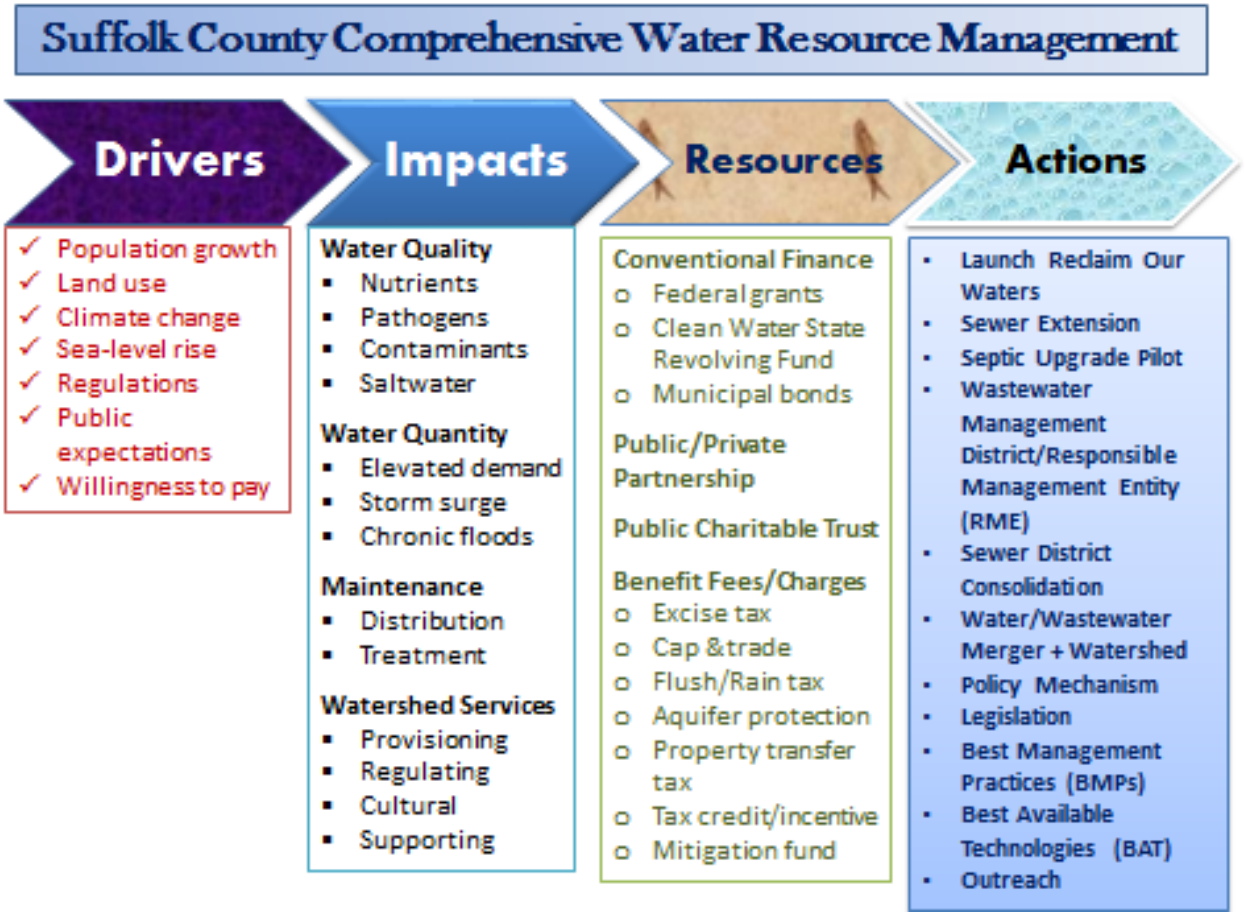
Rebel contends that P3s offer comparative advantage with superior private sector business discipline, productivity and market dynamic while positioning obligation off government books. Here's the catch: "Only a sound funding mechanism will attract private finance." Funding deals with the question who is paying the bill, whereas financing deals with the question how the time gap between the necessary investment and the availability of funding can be closed. Financing is what banks and investors do, funding is what end-users and taxpayers do.

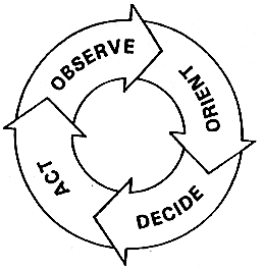
To make the funding component viable on a significant scale, will require engagement of the insurance sector, either through the fiscal instrument of an insurance surtax, or through regulatory instruments. In the latter case, a portion of the investment would be made by insurers adding a surcharge to premiums. Involvement of the insurance sector is contingent on the maturity of the insurance market.

Realization of comprehensive water resource management in Suffolk County cannot be a linear progression. Unlike a straightforward engineering project such as the installation of sewers its development is not subject to a Gantt chart. Contained heretofore, then, is a policy maker's tool chest that can be drawn upon when, where, how and if circumstances reveal themselves and the stars align. Take the following three elemental recommendations from Stanford Woods Institute for the Environment as a jumping off point:

- Pricing policies that would both better align with the full economic cost of supplying water and decouple revenues from the volume of water supplied and to foster more private-sector innovation;
- Regulatory frameworks to create an open and flexible governance environment that is innovation-friendly and encourages valuable new technologies; and
- Financing and funding mechanisms, such as a public benefit charge on water, that can help raise sufficient funds to implement innovative solutions.

("The Path to Water Innovation" (Ajami, Newsha, et al, 2014, p2&6)





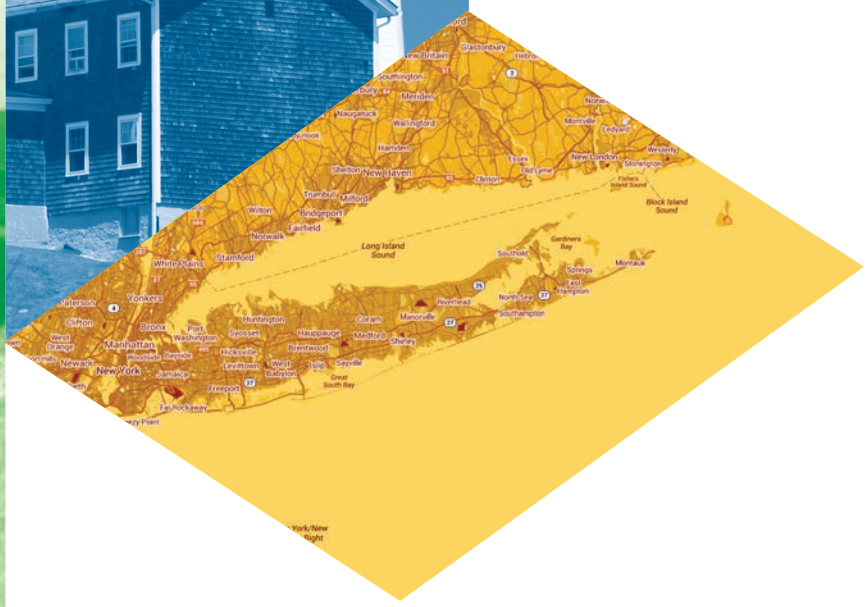
Finally, in matters of public policy application, one is well-served to defer to that profound 21st Century existential observation: *"There are known knowns. There are things we know that we know. There are known unknowns. That is to say, there are things that we now know we don't know. But there are also unknown unknowns. There are things we do not know we don't know."* And "*Stuff happens.*" (D. Logan, "Known knowns, known unknowns, unknown unknowns and the propagation of scientific enquiry," J. Exp. Bot. (2009) 60 (3): 712-714.).

Suffolk County recognizes that Comprehensive Water Resource Management must consider potable water supply, collection and treatment of sanitary wastewater, stormwater management and coastal resiliency. Suffolk County's ***Reclaiming Our Water Initiative*** *will require establishment of an integrated water resource management structure, as well as identification of a source – or more likely, sources -- of funding and financing.*

Suffolk County is currently exploring potential water resource management organizational structures as well as a variety of funding options, including:

- *Benefit Charges*
- *Taxes or Fees*
  - *Property transfer tax*
  - *Aquifer protection fee*
  - *User fees -- Flush Tax/Runoff Tax/Toilet Paper Tax*
  - *Tax credits*
  - *Insurance Surcharges*
  - *Tax increment financing*
- *Conventional Financing*
  - *Infrastructure Bank - Clean Water State Revolving Fund*
  - *Federal Grants*
  - *Municipal Bonds*
- *Public –Private Partnerships (P3)*
- *Increased Rates for Potable Supply (Consistent with Average Market Rate)*

The anticipated investment needed to protect our water resources is significant – but then, so is the value of a clean and healthy water supply, thriving wetlands and ecosystems, our renowned beaches and estuaries and a resilient coastline. Recognizing that sufficient funding to accomplish all of our water quality protection and coastal resiliency goals is not currently available, Suffolk County is committed to identifying and accessing all available funding to implement the programs designed to Reclaim Our Waters, described in the following pages.



Suffolk County, New York, United States
Smarter Cities Challenge report

IBM

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1. Executive summary

Introduction

In 2010, IBM Corporate Citizenship launched the Smarter Cities Challenge® to help 100 cities around the world over three years become smarter through grants of IBM talent. These cities have made great progress on the road to becoming more instrumented, interconnected and intelligent (see www.smartercitieschallenge.org).

Suffolk County, New York, US, was one of 16 cities awarded an IBM Smarter Cities Challenge grant in 2014 as part of ongoing citizenship efforts by IBM to build a Smarter Planet®. In June 2014, a team of six IBM experts spent three weeks in the county working with stakeholders to help solve key challenges as identified by County Executive Steven Bellone.

Nitrogen pollution presents a significant risk to Suffolk County's water quality and is impacting surrounding bays, marshes and rivers. The main source of this nitrogen pollution is domestic properties with on-site treatment systems for waste, such as cesspools and septic systems.

The challenge

The County has noted a decline in the quality of Long Island's surface water as evidenced by brown and red tides, reduced levels of shellfish and marsh pannes. Excessive contaminants in the water bodies, particularly nitrogen, are responsible for this degradation, with 69% of this nitrogen production coming from the septic systems of individual properties. Other sources include agriculture, residential fertilizers and sewage treatment plants.

This contamination can potentially have a significant impact on not only the quality of life for residents and visitors to Suffolk County, but also the economy on the island. This could result in major economic challenges for the County, leading to reduced industry, reduced coastal resiliency, restrictions on development and lower house prices plus a negative impact on tourism. The County has placed a potential value on this of approximately $2.3 billion, with fishing contributing $900 million, use of beaches $670 million and boating $760 million.

The key challenge is to make recommendations that address the County's nitrogen problem and account for the following factors:

- Lack of funding and resources
- Different challenges across the County's various geographies
- Multiple stakeholders with conflicting objectives
- A fragmented structure and management system across the county that limit the County's ability to take action
- Lack of water quality awareness and understanding among citizens and visitors
- Lack of overall information management strategy to support decision making and the long-term management of nitrogen reduction in the county
- Lack of integrated water and wastewater management strategy
- Lengthy timescales for water quality restoration
- Efforts to manage water quality that must be sustained over a long period of time

Findings and recommendations

During its three-week visit, the Smarter Cities Challenge team conducted a series of interviews and workshops with more than 90 stakeholders representing 38 organizations. The team focused on addressing excessive nitrogen loads in the County's water supply. With so many interrelated challenges, this issue could not be solved in isolation. Instead, it required collaboration, coordination and alignment to achieve a sustainable solution.

The people of Suffolk County clearly prioritize the quality of their water and have a passion for addressing and resolving this issue. Residents, businesses and visitors alike value water and the central role it plays in their quality of life on the island, but they need help developing and implementing a plan to improve and protect water quality. For instance, a common misconception is that failing septic systems are the cause of nitrogen pollution when, in fact, on-site septic systems are not designed to remove nitrogen in the first place.

The County and other stakeholders have conducted a significant amount of work to identify the cause of contamination and potential tactics to resolve the problem. However, one of the team's key findings was that this work is not always done in a coordinated manner and at times lacks common objectives or goals. This results in potentially conflicting findings and inadequate management of (or planning for) certain phases of the water cycle. While there is a significant quantity of relevant data across the county, it is distributed across many organizations and is available in various forms. The absence of an overarching strategy for data structure, usage and storage makes it even more difficult for the County to uncover insights and inform actions.

To help Suffolk County achieve a successful platform for integrated water management, the team identified 11 recommendations in four key areas:

1. Blueprint for the future

Suffolk County should establish a long-term Water Resource Plan with a set of target outcomes and a baseline that will inform future decisions on change. This plan should build on existing planning, but the format should become a "living template" that is used regularly within a governance process for water management for the island. The plan should outline the architecture for water management and drive core programs to improve water management and quality. Our recommended initial programs focus on solutions to reduce nitrogen pollution for the properties within Suffolk County currently on cesspools or septic systems, as well as improving the control and management of waste treatment within the existing 193 sewage treatment plants (STPs).

2. Execution

Execution recommendations support the blueprint and focus on establishing a means of sharing and managing data across the entire water cycle, from rivers and streams to water treatment plants and agriculture to aquifers and oceans. This will help ensure that different organizations involved in water management will maintain ownership and security of data and enable sharing of information to support decision making and progress in monitoring water quality. A core principle of integrated water management is to plan and manage water and wastewater in a cohesive manner to ensure the full water cycle is regulated (see Appendix F). The team also recommends a process for compliance management to ensure that processes are followed and improvements are identified on an ongoing basis.

3. Engagement

Water is at the heart of Suffolk County, and its quality directly impacts the lifestyle, health and economy of the County's 1.5 million residents, as well as its five million annual visitors. The Engagement recommendations focus on helping residents and visitors understand the role they play in managing and improving water quality, motivating them to take action.

4. Enablers

Improving the County's water quality and implementing a sustainable solution could take several years. These final recommendations focus on funding the necessary efforts, while ensuring that the processes and organizational structure will be able to meet future needs and continue to support county-wide integrated water management.

Conclusion

Water quality impacts not only the ecological aspects of Suffolk County but also the lifestyle, economy and health of its residents and visitors. Current levels of nitrogen and other pollutants in local bodies of water are the result of water infrastructure and septic systems that evolved over many years with no overall plan. If Suffolk County wants to continue to grow its economy, attract tourists and deliver a high quality of life for its residents, it must tackle water management with common goals, shared information and an integrated approach to managing water and wastewater services.

Highlights

These recommendations will help Suffolk County accomplish the following:

- **Agree on common nitrogen load goals and actions for reduction**
- **Establish a Water Resource Plan that sets out the infrastructure and architecture for robust water and wastewater management**
- **Optimize the water and wastewater management network/ infrastructures with improved operations, capacity and costs and minimize nitrogen output**
- **Increase the number of septic systems with nitrogen removal technology**
- **Share water-related data more easily with key stakeholders through the implementation of a data integration model**
- **Increase civic engagement and active public participation in solving water quality issues**
- **Reduce nitrogen levels in ground and surface waters**

2. Introduction

A. The Smarter Cities Challenge

By 2050, cities will be home to more than two-thirds of the world's population. Cities wield more economic power and have access to more advanced technological capabilities than ever before. However, they are struggling with a wide range of challenges that threaten the sustainability of their core support and governance systems, including transportation, water, energy, communications, healthcare and social services.

Meanwhile, trillions of digital devices, connected through the Internet, are producing tremendous amounts of data. All of this information — from the flow of markets to the pulse of societies — can be turned into knowledge, because we now have the computational power and advanced analytics to make sense of it. With this knowledge, cities could reduce costs, cut waste and improve efficiency, productivity and quality of life for their citizens. In the face of the mammoth challenges of economic crisis and increased demand for services, ample opportunities still exist for the development of innovative solutions.

In November 2008, IBM initiated a discussion on how the planet is becoming "smarter." By this it meant that intelligence is becoming infused into the systems and processes that make the world work — into things no one would recognize as computers: cars, appliances, roadways, power grids, clothes and even natural systems, such as agriculture and waterways. By creating more instrumented, interconnected and intelligent systems, citizens and policymakers can harvest new trends and insights from data, providing the basis for more informed decisions.

A Smarter City uses technology to transform its core systems and optimize finite resources. Since cities grapple on a daily basis with the interaction of water, transportation, energy, public safety and many other systems, IBM is committed to a vision of Smarter Cities® as a vital component of building a Smarter Planet. At the highest levels of maturity, a Smarter City is a knowledge-based system that provides real-time insights to stakeholders and enables decision makers to manage the city's subsystems proactively. Effective information management is at the heart of this capability, and integration and analytics are the key enablers.

Intelligence is being infused into the way the world works.

As IBM aligns its citizenship efforts with the goal of building a Smarter Planet, it realizes that city leaders around the world face increasing economic and societal pressures. Given the growing demand for services, they have to deliver new solutions ever more rapidly.

With this in mind, IBM Corporate Citizenship has launched the Smarter Cities Challenge to help 100 cities around the world over a three-year period become smarter through grants of IBM talent. Suffolk County, New York, was selected through a competitive process and awarded a Smarter Cities Challenge grant in 2014.

During a three-week period in June 2014, a team of six IBM experts worked in Suffolk County to deliver recommendations around key issues for County Executive Steven Bellone.

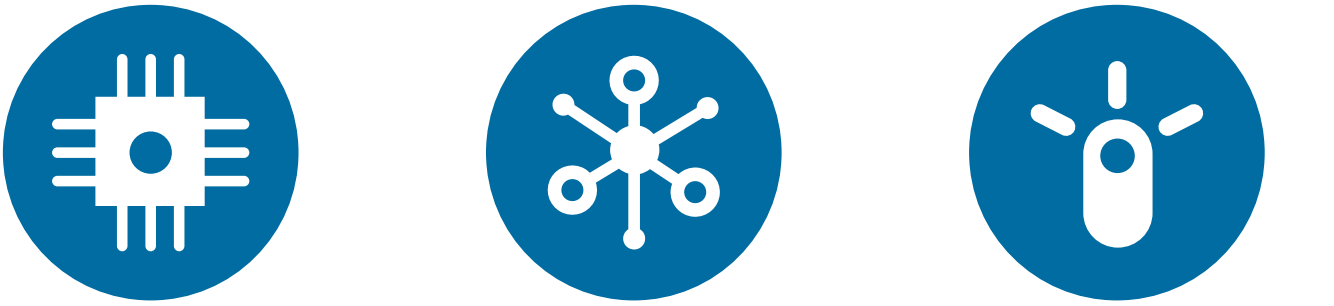

Figure 1: Instrumented, interconnected, intelligent

B. The challenge

The County has recognized a decline in the island's surface water quality, as evidenced by an increase in brown and red tides, reduced levels of shellfish and marsh pannes. The cause of this decline is excessive contaminants in the ground and surface water bodies, particularly nitrogen. The majority (69%) of this nitrogen comes from cesspools and septic systems on individual properties. Other sources include agriculture, lawn fertilizer and outputs from sewage treatment plants.

This contamination may result in economic challenges for the County, including reduced industry, reduced coastal resiliency, restrictions on new development and a negative impact on tourism.

The key challenge is to make recommendations that address the County's nitrogen problem and account for the following factors:

- Lack of funding and resources
- Different challenges across the County's various geographies
- Multiple stakeholders with conflicting objectives
- A fragmented structure and management system across the county that limit the County's ability to take action
- Lack of water quality awareness and understanding among citizens and visitors
- Lack of overall information management strategy to support decision making and the long-term management of nitrogen reduction in the county
- Lack of integrated water and wastewater management strategy
- Lengthy timescales for water quality restoration
- Efforts to manage water quality that must be sustained over a long period of time

3. Findings, context and roadmap of recommendations

A. Findings and context

Based on its three-week visit, the IBM team made the following observations with key supporting points:

- Today's current operating model, which includes multiple organizations, does not address the full water cycle:
  - It lacks long-term network planning and coordinated water and wastewater handling solutions across the entire water cycle, which are necessary to achieve a balanced approach to water quality.
  - There is no regular testing, monitoring or management of septic system maintenance.
  - There is no agreement on required metrics to manage water quality, such as total nitrogen load.
  - There is limited or no coordination across different organizations on similar programs of work.

- Levels of infrastructure monitoring and understanding, particularly for individual households, cannot support or sustain the improvement of water quality:
  - Staff shortages and limited cross-training result in the postponement of preventive maintenance activities to handle emergencies and other reactive work.
  - New technologies and regulations may require additional resources or different skills.
  - Current housing options do not meet the needs of changing demographics and are particularly lacking for young professionals.

- After potential federal and state funding, there is still a US$7 billion gap for wastewater treatment upgrades in Suffolk County (based on Suffolk County Department of Economic Development and Planning cost estimates for septic system upgrades and changes).

- Residents and businesses value water quality but do not understand how they influence it or know what they can do to improve and protect it:
  - Citizens with individual septic solutions generally take action on maintenance only when there is an issue with the septic system.
  - The County lacks a common way to quantify the economic impact that poor water quality has on Suffolk County.
  - Many citizens do not recognize the relationship between their water use and overall water quality; many do not know that their water comes from an aquifer below their homes.

- Lack of coordination across organizations prevents collective and deliberate action:
  - Diffused responsibilities, varying objectives and lack of agreement limit how and when to engage the public.
  - There is no common measure or goal for the amount of nitrogen loading that is acceptable.
  - Interested stakeholders do not meet on a regular basis to discuss water issues.

- Suffolk County recognizes cesspools and septic tanks as the primary contributor of the nitrogen load in the water:
  - There are 360,000 individual properties with an on-site cesspool or septic system.
  - These technologies are not designed to remove nitrogen.

- Current Department of Health Services codes for septic solutions do not address nitrogen reduction needs:
  - Alternative approaches and innovative technologies are not encouraged enough due to a lack of information, resources and incentives, as well as failed previous trials.

- The County lacks an overall data strategy:
  - Relevant data is fragmented and owned by different stakeholders in different formats.
  - There is no single electronic registry or repository that tracks cesspools and septic systems in Suffolk County.

During the three-week visit, the IBM team referenced a number of documents to consolidate its understanding of the issues and support its conclusions. The core documents are identified in Appendix C (see references 4, 8, 9, 18 and 19).

B. Roadmap of recommendations

Based on these findings, the IBM team recommends that Suffolk County develop an Integrated Water Management model. The model should address the granularity and variety of nitrogen sources, the several paths by which nitrogen reaches the water, the limited options of reduction treatment for on-site septic systems and the limited feasibility of new sewers in the county. The County also must consider the multiple interrelated factors that influence water quality in Suffolk County. This comprehensive plan should be resilient enough to absorb and mitigate the impact of factors that are outside the County's control (including federal and state grants, tax revenues, regulations and weather events). The team established multiple action plans to give the County a full scope of considerations it must take into account when approaching nitrogen reduction in water.

The deployment of the Integrated Water Management model is supported by 11 distinct recommendations across four elements: Blueprint for the future, Execution, Engagement and Enablers (see Figure 2).

Blueprint for the future includes three recommendations: the creation of the robust Water Resource Plan, the consolidation of the STP network and the definition of the right technologies for areas where sewers are not a feasible option in the Water Resource Plan.

The Execution of these recommendations covers the full set of available solutions for wastewater disposal. Based on data analytics, the County will be able to identify the most appropriate and cost-effective geographies to serve with new sewers, where to extend existing sewers, which STPs require a capacity increase, locations to install small clusters and which septic/treatment technologies should be installed where sewers are not feasible.

Within this comprehensive model, it is recommended that Suffolk County consolidate existing STPs under the same governance and operations to improve wastewater treatment. The priority is to focus on those plants that have high levels of nitrogen load or are within areas nominated as a priority for sewer construction or extension. Blueprint adoption and implementation is closely connected to the other three elements of the Integrated Water Management model. In fact, the Blueprint can be effective only when it is supported by Execution and Engagement.

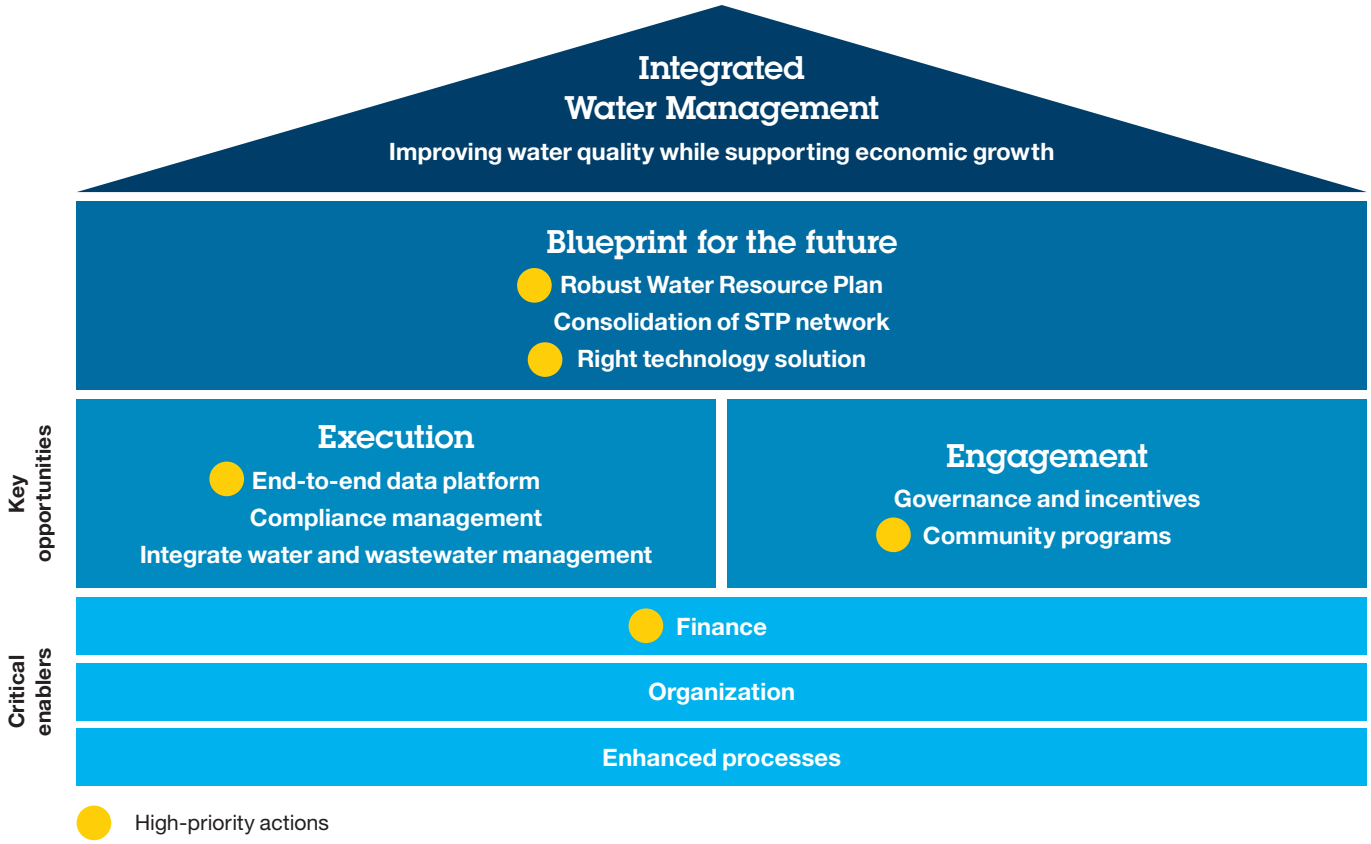

Figure 2: Overview of recommendations, with yellow circles indicating high-priority actions

Critical to the overall success of Integrated Water Management is the implementation of an end-to-end data model, which enforces a common language and is a central source of information for decision makers. The number of stakeholders and the difference in their current data structures is the main inhibitor to data-driven management. The implementation of such a model will provide the data necessary to execute the County's water quality mission and responsibilities in a more effective manner. Compliance management is important for the County to ensure all key processes in the water cycle are monitored, assessed and executed in a way that allows nitrogen reduction goals to be met. Another recommendation is to consolidate water authority and wastewater management activities. There are several examples of improved effectiveness in such a combined operation mode, including the optimization of back-office processes, such as invoicing, procurement and laboratory testing. The consolidation will allow the County to manage the water cycle in an integrated fashion, with potential new opportunities to harmonize water fees and increase revenues for managing wastewater.

In order to achieve the overall plan, the County must address the three key enablers of finance, organization and process. The first enabler of finance is particularly challenging because the funding must be ongoing. Funding all the components, which are much more granular than the 11 recommendations themselves, is a complex puzzle of grants, bonds, fees and savings at several different levels (federal, state, county, municipal and so on). Planning, application, prioritization and monitoring for all must be meticulously controlled. It is recommended that the County appoint a financial team to specifically address the funding of the overall Water Resource Plan execution. This team should have strong leadership, high accountability to the County Executive and a clear understanding of the Water Resource Plan, along with the ability to coordinate funding and expenses.

The organization must be redesigned to support the recommended changes in management oversight of the water cycle. The inclusion of additional STPs, the release of the revised Sanitary Code, the expansion of some responsibilities and the creation of more robust compliance require a more senior and skilled workforce. This may mean an increase of resources and a potential shift in careers generated by new opportunities in the full water cycle.

Finally, it was noted that several processes within County operations should be reviewed for inefficiency or duplication of efforts. The County should consider implementing a continuous improvement process, employing "lean" principles to help improve customer responsiveness and potentially free up valuable resources to be employed in new areas.

Although implementation of most of the recommendations will be led by County staff, a successful outcome requires the participation of the communities, people and organizations of greater Suffolk County. Under the topic of Engagement, two recommendations are made to address this participation. The first is governance and incentives, for which the goal is to define methods to encourage homeowners to become active participants in the Water Resource Plan, primarily by upgrading their on-site septic systems. The definition of appropriate and affordable incentives, supported by financial plans, will increase the success of the County in achieving its upgrade goals.

Remediating all 360,000 individual septic and cesspool installations will require awareness and self-initiation of action from the residents and communities owning these systems. It is recommended that Suffolk County undertake significant engagement activities to encourage residents and visitors to contribute to the solution for excess nitrogen. Engagement programs should offer a broad spectrum of initiatives to increase awareness, achieve an appropriate and distributed level of understanding and obtain adequate commitment. Those initiatives should directly link the value of water quality to daily life. For example, the adoption of such programs as the Blue Flag (see reference 5 in Appendix C) will make the impact of individual behaviors on the surrounding area immediately visible.

Such engagement is vital to this program. In order for the County to achieve its water quality goals, the people must be sufficiently committed to act.

This recommended program is highly ambitious and comprehensive. To build momentum and demonstrate near-term progress, the following high-priority activities must begin as soon as possible:

- Establish common nitrogen load allocation goals
- Create a comprehensive water resource management plan
- Launch a Blue Flag pilot
- Develop an on-site/cluster systems inventory
- Release Sanitary Code updates to support new on-site wastewater management options
- Establish a financing plan to accompany the Water Resource Plan
- Identify priority data sources to integrate into a common water management platform

These actions are reflected in a summary roadmap (see Figure 3). A roadmap of all recommended actions is available in Appendix I.

In order to provide the County with initial guidance for planning purposes, order-of-magnitude cost figures have been estimated for each recommendation. These costs have been estimated in ranges and classified as high (up to $30 million), medium (up to $10 million) and low (up to $1 million). The County has previously estimated total infrastructure costs for septic system upgrades to be approximately $8 billion, which is not included in our cost estimates.

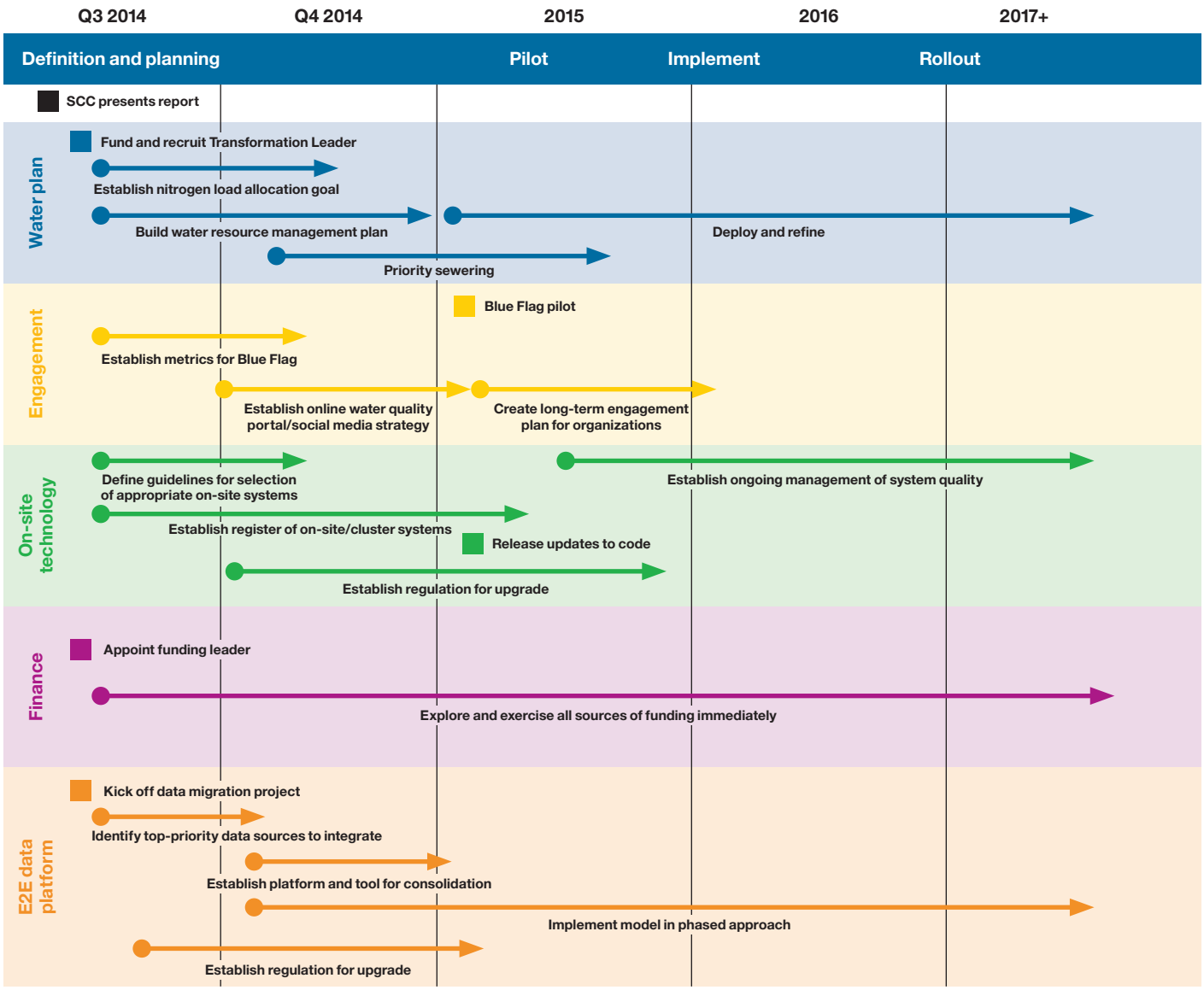

Figure 3: Roadmap of high-priority actions

4. Recommendations

The following paragraphs detail the 11 recommendations for Suffolk County, highlighting the scope, key milestones and stakeholders for each. The recommendations described have been developed based on the information covered within the three week period. The owners identified will need to plan the implementation of these recommendations in the context of the overall priorities and budget for Suffolk County.

Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan

The recognized problem of high nitrogen loads in ground and surface water cannot be addressed in isolation. All contributing elements (households, industry and agriculture) must be considered in an integrated manner (see Figure 4), with the numerous interactions among the components of the water cycle taken into account. Such an integrated approach is not yet implemented in Suffolk County, mainly due to the multiple stakeholders and the variety of needs involved.

There is a need for an integrated water resource management plan supported by clearly identified sponsors and sustained by a related organization. Suffolk County must identify responsibility for water management across the island, and the plan must take into account all contributing or mitigating elements impacting the water resources of Suffolk County. The high diversity of situations in sub-watershed geographies necessitates specific approaches for individual areas, which must be considered in the plan. In addition, the plan should consider future scenarios, such as population growth, water body levels and flows, to help ensure that actions and plans taken today support the long-term outcomes desired for water quality and overall county development.

The proposed Water Resource Plan must serve as a master plan that will help decide the most appropriate scenarios, trigger their translation into action plans and follow up on their impacts. It is important that this plan can be used on a regular basis and is easily maintained to support decision making on water management. In this way, the plan can steer actions and support decisions to help reduce total nitrogen loads on water bodies. Consequently, this will translate into better quality of life and suitable economic development.

The team's proposal is to build the plan incrementally, based on the existing comprehensive plan (see reference 21 in Appendix C), while engaging its use and making outcomes visible at the earliest stage possible. This will help to foster plan acceptance and hasten the development of the surrounding governance structure.

An integrated approach to planning and managing water bodies is being established in many other countries and cities, and this work may help inform Suffolk County during the development of its plan. Examples can be found in Appendix C (see references 20, 23, 25, 26, 29, 30, 33, 34, 35 and 36).

Figure 4: An incremental plan with specific sponsors and immediate outcomes will foster acceptance

Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan

The County should finalize and deploy an integrated Water Resource Plan supported by clearly identified sponsors and sustained by a related project organization.

Scope and expected outcomes

Scope

Develop a master plan for water management that will be used as a framework to support decisions related to agreed-upon outcomes for water quality and related activities.

To achieve desired results, the plan should do the following:

- Provide a vision and overview regarding agreed-upon goals (what the future will look like)
- Offer a common view of the current situation as well as future developments and scenarios
- Contain tools for supporting operational decision making
- Trigger, monitor and integrate specific programs and action plans
- Ensure and streamline related monitoring and communication

Expected outcomes

Developing a master plan for water management and related activities will help to ensure the following outcomes:

- Common goals are defined and an agreed-upon strategy is defined to reach these goals
- All areas of the water cycle are efficiently managed and integrated, including water supply, storm water runoff, wastewater treatment, water production, industrial and agricultural water use and surface and groundwater
- Adequate solutions are developed and implemented that consider local conditions and future development needs

Cost of inaction

The costs of inaction are a lack of plan information, resulting in uncoordinated actions, wasted efforts, duplicated tasks and redundant investments. Key nitrogen reduction goals may be missed without properly synthesizing a full range of actions.

Proposed owner and stakeholders	Suggested resources needed
Owner: Suffolk County Department of Health Services supported by the Department of Economic Development and Planning **Stakeholders:** • All County agencies • Suffolk County Water Authority (SCWA) and other water authorities • STP operations operated both privately and by the County • Towns, villages and hamlets • Nonprofits • Businesses and trade associations • State agencies, such as the New York State Department of Environmental Conservation (NYSDEC) • Federal agencies • Universities	• An external vendor to provide guidance and knowledge transfer to the Suffolk County Department of Economic Development and Planning • Part-time input from other departments and stakeholders during the joint planning phase • A dedicated team to maintain, update, communicate and coordinate efforts according to the plan **Cost estimate:** Medium

Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan (continued)	
Dependencies	**Key milestones, activities and timeframe**
This recommendation requires the consolidation of the STP network (described in Recommendation 2), as well the establishment of a framework to visualize, monitor and manage water quality (see Recommendation 4).	**Short term (up to 6 months):** • Develop initial plan • Establish governance and leadership • Set preliminary goals for nitrogen load allocation • Build resource management plan • Define and launch initial programs **Long term (1 - 5 years):** • Implement program • Launch actions • Measure progress • Manage integrated management resource plan
Priority	
High	

Recommendation 2: Operate the sewage treatment plant network under the control of the Suffolk County Department of Public Works

There are currently 193 sewage treatment plants (STPs) within Suffolk County, of which 23 are operated by the Suffolk County Department of Public Works (SCDPW), including the Bergen Point plant, which accounts for approximately 51% of total STP volume. The STP Report for 2013 (see reference 11 in Appendix C) states that by the end of 2014, all County STPs will be treating for nitrogen reduction. However, 61 plants have been identified as "high risk," a consequence of producing average nitrogen levels in excess of the 10 mg/L target. The recommendation is to include all 193 STPs under the management of SCDPW. This may mean that private operators continue to operate certain STPs under the management of the SCDPW.

Recommendation 2: Operate the STP network under the control of the SCDPW

The County should manage all 193 public and private STPs under the authority of the SCDPW to facilitate the smooth transformation of operations that support a reduction in nitrogen loads. Although the SCDPW will have overall control, there may be instances in which private operators continue execution of operations at the individual plant level.

Operational transfer will be prioritized based upon STP location (proximity to potential areas for new or extended sewers feeding the STP) as well as the plant's history for producing high levels of nitrogen.

Scope and expected outcomes

Scope

To achieve the desired results, the County should take the following actions:

- Transfer operational control of privately run STPs to the SCDPW, covering all 193 plants
- Maintain Suffolk County Department of Health Services (SCDHS) risk-based approach to monitoring STP output

Expected outcomes

Moving STPs under the direction of the SCDPW will help to ensure the benefits listed below:

- Consistent operation, management and monitoring of STPs
- Network optimization and improved overall performance in nitrogen reduction efforts
- Increased revenue and the opportunity to achieve parity on charges for wastewater services across the county
- Waste collection cost uniformity across the county, reducing transport and logistical costs for waste disposal while optimizing waste management capacity
- More focused efforts for addressing areas with high levels of nitrogen

Costs of inaction

The costs of inaction include the continued operation of STPs releasing unacceptable nitrogen levels. Without proper maintenance and oversight, these plants will continue to worsen nitrogen pollution, ultimately undermining economic development and tourism.

Proposed owner and stakeholders	Suggested resources needed
Owner: Head of SCDPW **Stakeholders:** Commissioner of the Department of Health Services, private STP operators, civil services and unions	• Program management and transition planning • Teams to manage new plant operations **Cost estimate:** High
Dependencies	**Key milestones, activities and timeframe**
This recommendation requires the establishment of a Water Resource Plan (see Recommendation 1) and will impact the consolidation of water and wastewater operations (see Recommendation 3). A workforce model and practices also must be designed to meet future needs (see Recommendation 9). Potential solutions for decentralized wastewater treatment (see Recommendation 11) also will influence the consolidation of STP operations.	• Confirm criteria, priority and control of transfer (Month 1) • Develop high-level transition plans aligned to the overall resource plan and place identified resources (Months 2 - 3) • Define STP management and operational approach based on service levels (Months 3 - 9) • Schedule service management meetings with privately run STPs (Months 4 - 12) • Transfer initial tranche of STPs to new network (Months 4 - 24) • Manage ongoing program for STP transfer (Year 2 onward)

Priority

Medium

Recommendation 3: Integrate water and wastewater operations

A number of businesses provide drinking water to Suffolk County, with the Suffolk County Water Authority (SCWA) serving 72 percent of the population (see reference 15 in Appendix C). These water companies operate independently from wastewater services, as well as from one another. Such separation may cause investment decisions to be made in a localized manner without full consideration of overall county needs or the water cycle. In addition, this situation causes a number of support services to be duplicated, including sampling, lab services, customer contact centers and billing.

As part of the Water Resource Plan, bringing water and wastewater services together will allow a more integrated view for management across the county, which may result in a more effective investment portfolio. The combined operations also bring alignment on water consumption and the related level of service requirements for wastewater.

The recommendation is to first assess the feasibility and business case for consolidation, followed by the definition of a future operating model for water and wastewater management across the county. A diagram in Appendix G outlines the core operational and customer cycles for a combined water and wastewater company. Highlighted on the diagram are some best practices that should inform the design and help optimize these services for Suffolk County.

Recommendation 3: Integrate water and wastewater operations

The County should consolidate its water and wastewater management processes through the integration of the SCWA with the 193 STPs currently in operation. This will entail developing a business case and target operating model for the combined water and wastewater services, which may present savings and process improvement opportunities.

This recommendation does not include multiple water providers for approximately 30 percent of the population. Including these companies may be worth considering at a later stage.

Scope and expected outcomes

Scope

To achieve the desired results, the County should do the following:

- Integrate the operations, billing and support services of the SCWA and SCDPW for water and wastewater services
- Integrate the operations and support services of the transferred STPs as they are on-boarded (see Recommendation 2)

Expected outcomes

Consolidating water and wastewater operations will provide Suffolk County with the following benefits:

- An integrated view for effective management of the total water cycle
- Tighter orchestration between water management and Department of Health Services regulation
- Network optimization through the elimination of redundant activities and fewer repeat visits to specific sites
- Increased savings and synergies through the integration of key support services, such as sampling, laboratory services, call centers, control centers and management structures
- New revenue opportunities and funding options in addition to water-specific fees
- Uniform pricing for water and wastewater services for a majority of Suffolk County citizens
- Improved management of storm water runoff

Costs of inaction

Continuing to operate water and wastewater operations separately will result in more duplication of services and operations, often within the same facility. In addition, investment decisions about capital construction and refurbishment will not be aligned and may not cover the full water cycle.

Recommendation 3: Integrate water and wastewater operations (continued)

Proposed owner and stakeholders	Suggested resources needed
Owners: • Commissioner of SCDPW • Commissioner of SCWA **Stakeholders:** Commissioner of the Department of Health Services	Support from transition teams, human resources teams, business representatives and department heads **Cost estimate:** Medium
Dependencies	**Key milestones, activities and timeframe**
Integrating water and wastewater operations depends on the success of the following recommendations: • Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan • Recommendation 9: Develop workforce model and practices to meet future needs Integrating water and wastewater operations will impact the following recommendations: • Recommendation 2: Operate the STP network under the control of the SCDPW • Recommendation 10: Adapt the business processes in the SCDPW and the SCDHS to meet expanded integrated water management responsibilities	• Define business case and identify synergies (2 months) • Determine the target operating model to combine water and wastewater services (4 months) • Establish an implementation plan and budget (3 - 4 weeks) • Agree on working patterns and structures with unions (6 - 9 months) • Transition and consolidation of shared services (6 - 9 months) • Transition and implementation of combined operation (9 months with stabilization of operations for an additional 6 - 12 months)
Priority	
Low	

Recommendation 4: Establish a framework to visualize, monitor and manage water quality

The County currently faces a number of data-related challenges:

- Fragmented data owned by different stakeholders in different formats
- Lack of a unified electronic registry/repository that tracks cesspools and septic systems
- No management or uniform reporting for wastewater disposal companies, such as sludge collectors/haulers
- Data collaboration and data sharing among stakeholders is limited and cumbersome
- Little or no data exchange between the County and towns/villages
- Large amounts of data are paper-based and difficult to collect
- Electronic data may be outdated, inaccurate or missing, including the following examples:
  - Inaccuracies exist in manhole data post-INI-study
  - As-built sewer plans are missing or inaccurate
  - Sewer permits before Merlin 2013 are all on paper
  - No inventories exist for pumping stations that connect to the sewer main
- Freedom of Information Law (FOIL) requests are necessary in some cases to share data among stakeholders
- Household information is limited
- Data is not standardized, and there is no integration layer
- Limited data sharing is currently done via email, PDF, Excel spreadsheets and .csv files
- Data analysis and data reporting are often performed by running custom SQL queries
- Shortage of IT professionals
- IT/software/systems knowledge for certain applications resides with a single person
- Perceived reluctance from some stakeholders to use common systems for particular functions, making data sharing more difficult:
  - GIS systems: Esri vs. MapInfo
  - Operator10 vs. Oper32
  - iFIX used by District 3 vs. Genesis used by the other districts
- Proliferation of data sources created by in-house applications
- Lack of an overall strategic approach to IT
- High reliance on non-production databases, such as MS Access
- Disaster recovery (D/R) approach is based on backups
- No high-availability architecture for IT
- The County's preference is to have open data access for external users
- For some software systems, the County relies on niche software vendors

The team recommends that Suffolk County consolidate its IT into a pool of shared resources that can serve all agencies across the county and create an integrated data platform. This will lead to the rationalization of software licenses, data sources and applications, as well as lead to greater levels of openness, data sharing and collaboration among the different stakeholders. The County is currently using a federated approach to IT that results in a fragmented IT organization in which knowledge sits with individuals instead of in a resource pool of IT specialties, such as GIS, web design and development, data architecting and administration, system administration and many others.

Suffolk County should create a single, non-federated IT organization with computer science professionals to carry out the full software development lifecycle as well as data management for all County agencies. A single integrated data platform will allow the County to easily share its data with other County agencies and external stakeholders, such as towns, research organizations, universities and nonprofits. The data platform can incorporate information owned by other stakeholders, such as zoning data, and it can serve as the repository for data that the County does not currently have but needs, such as a cesspool/septic system registry. Examples of similar data integration platforms are highlighted in Appendix C (see references 1, 2, 27, 28, 31, 32 and 38).

Finally, a disaster recovery program and high-availability architecture are recommended.

Recommendation 4: Establish a framework to visualize, monitor and manage water quality

The County should create a centralized data integration platform to establish a "single source of truth" that is accessible to all stakeholders, promoting collaboration and data sharing.

Scope and expected outcomes

Scope

To achieve desired results, the County should do the following:

- Implement this recommendation in phases
- Start by creating a common information model with a few data sources and add incrementally as the model is enriched
- Create mechanisms (SOA, API management, MDM or data federation) to enable access (interagency and citizen-facing) to the data in the new common information model
- Clean and modify applications that use consolidated data sources per the new common information model
- Migrate existing citizen-facing applications to the newly created data integration platform
- Consolidate the County's currently scattered IT teams into a single IT department that can service all County organizations and departments and act as the owner of the data integration platform
- Digitize existing information and data on key information sets
- Implement a high-availability architecture for the centralized data integration platform
- Define and implement a more robust approach to disaster recovery

Expected outcomes

This recommendation should result in the following outcomes:

- Every stakeholder will have access to current status and insights, enabling them to remain informed and drive decisions and investments that need to be made
- Relevant stakeholders can share water-related information, including the nitrogen loading model, overall water resource management and total maximum daily load (TMDL) across the platform
- Different stakeholders will have information tailored to their requirements to help them take the right actions
- A centralized data integration platform used across the County will make data readily available
- Reduced risk of limiting the management of an application or data set to a single skilled individual
- Reduced risk of data loss
- Operational cost reduction for infrastructure and licenses

Costs of inaction

The result of inaction would be the continued use of fragmented and isolated data owned by different stakeholders across different organizations, making it difficult for anyone to get a single view of the information. In addition, software license cost savings — from multiple GIS systems, databases, operations systems and asset management systems — would not be realized. The County would continue to create one-off applications that require their own databases and fragment the data even more.

Inaction will hinder the modernization of applications and data management systems, compromising County efforts to improve nitrogen pollution levels. The County would continue to use MS Access, a non-production database, and would also continue to store paper-based network and infrastructure information in a single location. Limited disaster recovery planning would continue to present an unacceptable business/operations risk. The County would continue to run the risk of poor availability of IT applications through ongoing use of non-production databases and multiple applications.

Recommendation 4: Establish a framework to visualize, monitor and manage water quality (continued)

Proposed owner and stakeholders	Suggested resources needed
Owner: Deputy County Executive — Operations **Stakeholders:** • All County agencies • SCWA and other water authorities • STP operations — private, County • Towns, villages, hamlets • Nonprofits • Businesses and trade associations • State agencies, such as NYSDEC • Federal government agencies • Universities	• Consolidated IT department • SCDHS • SCDPW • Towns • SCWA • State agencies (such as NYSDEC) • STP operators **Cost estimate:** Medium
Dependencies	**Key milestones, activities and timeframe**
Fulfilling this recommendation is dependent on the County completing the following recommendation: • Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan	**Short term:** • Creation of a unified County IT department (3 months) • Identify initial priority data sources and confirm data ownership and governance (Weeks 2 - 4) • Define information model for pilot sources, for example, select two or three data sources owned by SCDHS to start consolidating a common information model (Weeks 2 - 4) • Implement subset of common information model (Week 5) • Establish a platform and tools to consolidate and share initial models (Weeks 6 - 11) • Enable access to this model subset (Weeks 8 - 10) • Migrate application(s) that use(s) this subset of the model (Weeks 11 - 14) • Identify next set of data sources and models and implement (Weeks 10 - 20) **Long term:** • IT department to chair and continue work to complete the creation of a common information model (all stakeholders involved) (1 year) • Continue work to migrate applications (ongoing) • Enable mobility for applications (ongoing) • Consolidate all distributed County data centers into one, including Hauppauge and Yaphank (1 year) • Develop a resilient D/R strategy (1 year) • Define overall data governance and measurement objectives
Priority	
High	

Recommendation 5: Establish governance to enable the installation of appropriate technology and to motivate responsible behavior

This recommendation addresses three key issues for Suffolk County's governance structure. Local residents in Suffolk County must upgrade their on-site cesspool or septic systems, as these systems do not treat nitrogen, a main pollutant of the water bodies on Long Island. In addition, the majority of residents use their cesspools or septic systems to manage general domestic wastewater, some of which may not be compliant with the Suffolk County Department of Health Services Sanitary Code. Finally, the current Sanitary Code does not encourage or allow residents to upgrade their cesspools or septic systems.

Suffolk County cannot proactively address water quality issues with the current governance structure in place. By permitting new technology, the County will enable local residents to upgrade septic systems to treat nitrogen, helping to improve water quality and quality of life in Suffolk County. Education of the public, proactive and regular septic system checks and quicker permit approval processes will encourage the variety of stakeholders to upgrade their systems.

The governance structure needs to not only allow for new technology but also must establish a system for enforcement and compliance across the county. Currently, Suffolk County does not regularly check or monitor the performance of cesspools and septic systems. Effective public communication, as well as a governed operational regime that includes monitoring and checks, may make residents more likely to maintain their septic systems. The EPA guidelines for management of decentralized septic solutions should be taken into consideration in the definition of this governance structure (see Appendix H).

As Suffolk County combats the harmful effects of nitrogen pollution, an established and enforceable governance structure must begin to manage and monitor pollution reduction progress across the county.

Recommendation 5: Establish governance to enable the installation of appropriate technology and to motivate responsible behavior

Suffolk County should create a governance structure for updated wastewater management systems in individual residences to improve sanitation and minimize nitrate loads in the groundwater. New septic technologies that reduce localized nitrogen levels can help improve water quality, resulting in better quality of life and economic development. The County should encourage citizens to upgrade their septic solution infrastructure.

Scope and expected outcomes

Scope

To achieve desired results, the County should take the following actions:

- Create a governance structure for updating the Suffolk County Department of Health Services Sanitary Code to allow for new and improved technologies
- Launch the pilot program for septic system technology that treats nitrogen and allow homeowners to test new technology
- Communicate alternative system options to citizens and private operators in a timely manner
- Educate citizens about nitrogen in lawn fertilizers and incentivize the use of organic or nitrate-free fertilizer and other acceptable products
- Facilitate removal and upgrade of cesspools across the county through public education and awareness
- Require point-of-sale certifications for residences to upgrade septic solutions and designate homes as "nitrogen free"
- Expedite permit approval process by the Department of Health Services to allow builders, towns, individuals and estate agents to upgrade or install new on-site septic systems that treat nitrogen

Expected outcomes

By following this recommendation, the County should experience the following:

- Decreased number of cesspools in Suffolk County
- Increased number of upgraded septic solutions in Suffolk County that help reduce nitrogen
- Decreased amount and concentration of nitrogen in water bodies in the county
- Expanded public awareness of the impacts of individual septic systems on collective water quality
- Quicker approvals of permits for advanced septic systems or other adapted wastewater treatment technology
- Reduced impact on nitrogen levels from domestic fertilizer
- Septic solutions will no longer be a reason to restrict development of towns and villages in Suffolk County

Recommendation 5: Establish governance to enable the installation of appropriate technology and to motivate responsible behavior (continued)

Scope and expected outcomes (continued)

Costs of inaction

Inaction will perpetuate water contamination from individual septic tanks and cesspools. Residents will remain unaware of the impact of their systems, and County staff will be unable to monitor, evaluate and correct issues with water contamination in an effective and efficient manner. With a lack of maintenance, more septic solutions will begin to fail over time, causing higher operational costs for households and increased health risks from untreated sewage.

Proposed owner and stakeholders	Suggested resources needed
Owner: Commissioner of the Department of Health Services **Stakeholders:** • Department of Economic Development and Planning • Individual residents • Septic system manufacturers • Septic system installers/operators • Towns/communities	• County team to operate transition and manage governance • Communications initiative to raise citizen awareness • County legislature representatives • Owner from Department of Health Services • Representatives from private operators/installers **Cost estimate:** Low
Dependencies	**Key milestones, activities and timeframe**
Establishing a successful governance depends on the following recommendations: • Recommendation 4: Establish a framework to visualize, monitor and manage water quality • Recommendation 10: Adapt the business processes in the SCDPW and the SCDHS to meet expanded integrated water management responsibilities • Recommendation 11: Establish a framework for decentralized wastewater handling solutions	**Short term:** • Complete application for the Sewer Repair Program for pilot septic system upgrades to receive funding (30 days) • Select pilot technology system and initial pilot residents to install new systems (90 days) • Update DHS Sanitary Code to eliminate outdated technologies in Suffolk County (6 months) • Construct a governance structure for monitoring, enforcing and incentivizing citizens to upgrade their wastewater treatment or contribute to county-wide investment (6 months) • Update process for assessment and authorization of new technologies for treatment of nitrogen to include in DHS Sanitary Code (Year 1) • Implement governance structure for monitoring, enforcing and incentivizing citizens to upgrade their wastewater treatment or contribute to county-wide investment (Year 1) **Long term:** • Incentivize citizens to upgrade septic systems with denitrification (Years 1 - 2)
Priority	
Medium	

Recommendation 6: Excite communities to embrace the solutions for improving water quality

Local citizens, governments and organizations understand the fundamental value of water but have yet to create a streamlined and all-encompassing civic engagement strategy to address water quality. Citizens do not yet relate water usage with water and wastewater quality. Suffolk County must engage communities and visitors to embrace local resources for water quality improvements, reaching across diffused interests and uniting them to take action.

To engage citizens, Suffolk County should establish positive reinforcement, such as the global Blue Flag program (see references 3 and 5 in Appendix C), to highlight water quality and safety standards. Beaches and marinas with Blue Flag distinctions have higher attendance and contribute to a thriving tourism industry that benefits local economic development.

Suffolk County also must improve public awareness of water quality, specifically around water usage and its impact on the environment. Social media and online portals provide easy opportunities for citizens, visitors and stakeholders to engage with one another on water quality (see references 1, 2, 6, 7, 10 and 39).

Twitter, Facebook and smartphone apps like Creek Watch and WaterQuality (see Appendix C) provide stakeholders with a place to learn and provide information on water quality. Users can upload photos of issues, check Blue Flag beach conditions and learn about county-wide or local initiatives on water quality. Giving stakeholders the tools to take action is a necessary first step in addressing declining water quality in Suffolk County.

As media platforms spur interest and engagement, Suffolk County must create a cohesive and all-encompassing strategy for public awareness. Continued town hall meetings, as County Executive Steven Bellone has previously held, draw input from stakeholders and provide a structure for engagement. Education and workshops, in which students learn about the water cycle and how to manage wastewater, can engage the community and educate the next generation of water quality stewards in Suffolk County. Focused activities that benefit the local community tend to receive more support, making the towns and villages a pivotal part of the engagement strategy.

Ultimately, citizens' desire to act, in conjunction with a proactive and clear strategy from Suffolk County, can spur collective action in the community and begin to address water quality in a comprehensive way.

Recommendation 6: Excite communities to embrace the solutions for improving water quality

Suffolk County must motivate the various stakeholders and community members to embrace water quality improvements by clearly identifying the importance and benefits these improvements deliver at the local level. The County must explain the value of water across political, social and environmental lines to improve civic engagement and local economic development.

Scope and expected outcomes

Scope

To achieve desired results, the County should perform the following actions:

- Establish positive reinforcement by adopting the Blue Flag approach, or a similar program, to create clean, safe and environmentally friendly beaches and coastal areas as well as make visitors associate closed attractions with poor water quality
- Provide easily accessible information on water quality through online and social media outlets for public knowledge and use
- Engage the public and other stakeholders via social media to help provide information on pollution incidents or risks
- Communicate the economic value of water to the public and translate this understanding into action
- Develop a long-term plan for improved water quality with collective action opportunities for local residents
- Promote civic buy-in from local organizations with regular town hall meetings regarding water quality
- Link sustainable economic development with the inherent value of water to motivate citizens to contribute socially and financially
- Target schools and public buildings to educate children about water usage and pollution as well as the role they play in protecting water quality

Expected outcomes

This recommendation should result in the following outcomes:

- Established water quality and safety standards for beaches with Blue Flag distinctions
- Increased access to information on water quality for residents and visitors
- Improved awareness of beach closures and contaminations
- Shared financial information on the economic impact of clean water throughout Suffolk County, including its effect on sales and tourism and pollution-related expenses
- Cleaner beaches with fewer algae blooms, less prevalent red and brown tides and reduced nitrogen levels
- Increased civic engagement, meetings and volunteer opportunities for citizens to express concerns and share insights related to water quality

Recommendation 6: Excite communities to embrace the solutions for improving water quality (continued)

Scope and expected outcomes (continued)

Costs of inaction

Economic development, specifically development of tourism and water-related industries, will continue to suffer from deteriorating water quality if the County does not act on this recommendation. Citizens will remain unaware of their role as stewards of water quality in Suffolk County and will, therefore, take no action to improve water quality.

Proposed owner and stakeholders	Suggested resources needed
Owner: Suffolk County Department of Economic Development and Planning **Stakeholders:** • Suffolk County Department of Health Services • Long Island Chambers of Commerce • Towns and villages • Long Island Commission for Aquifer Protection • Business owners • Suffolk County Department of Public Works • Nonprofits	• Incremental funding for the establishment and monitoring of the Blue Flag system • Social media expansion • Portal for easy access to information • Town hall meetings with citizen groups for input and feedback • Advocacy and promotion team • Additional resources to monitor and follow new guidelines **Cost estimate:** Low
Dependencies	**Key milestones, activities and timeframe**
Engaging the community in water quality issues hinges on the completion of the following: • Recommendation 4: Establish a framework to visualize, monitor and manage water quality	**Short term:** • Establish metrics, based on Blue Flag criteria, to evaluate safety and environmental quality of beaches and waterways (90 days) • Design and establish a structure for social media use with clear guidelines and goals on how it will help the County manage nitrogen pollution and establish a plan for two-way use of information (4 months) • Publish water quality levels and information online via a portal or social media, as well as on-site with positive reinforcement (6 months) • Establish programs for local school children on water quality education (6 months) • Engage and work with towns regarding application for Blue Flag (6 months) **Long term:** • Update and monitor beach and waterway cleanliness and provide information to the public (Year 1) • Create a long-term engagement plan for organizations to excite individual residents and visitors about water quality protection (Years 1 - 3) • Establish checkpoints and engagement days to reignite dedication to improved water quality (Year 3 and ongoing)

Priority

High

Recommendation 7: Create a structure to drive compliance

With its diverse group of stakeholders and distinct and complicated processes, Suffolk County must ensure citizens and stakeholders comply with the governance established in the Water Resource Plan (see Recommendation 1).

This recommendation defines the appropriate level of control for compliance, showing how and when to keep citizens and organizations accountable. EPA guidelines on the management of decentralized solutions also should be considered (see Appendix H).

Initially, Suffolk County should gather input from key stakeholders involved in protecting water quality. The newly established compliance team should compare stakeholder processes, metrics and milestones to relevant KPIs from the Water Resource Plan.

Suffolk County should define a governance model and approach to manage and adapt the monitoring framework through the different phases of implementation.

Recommendation 7: Create a structure to drive compliance

Suffolk County and vested stakeholders should establish a compliance framework for managing and monitoring key milestones set out in the Water Resource Plan (see Recommendation 1). This includes defining roles and responsibilities to monitor and control key processes and targets to achieve clean water.

Scope and expected outcomes

Scope

To achieve desired results, the County should establish the following roles and responsibilities:

- Suffolk County Department of Health Services
  - Monitor septic system upgrade programs and share progress
  - Perform sample testing, share results in real time and enforce recovery plans when necessary
- Suffolk County Department of Public Works
  - Hold regular governance meetings to discuss STP operations, ensure they meet compliance standards and identify action if needed
  - Monitor operating volumes in STPs and analyze the sample testing of wastewater before and after treatment, driving recovery plans when necessary
  - Monitor source waste location and quality and identify follow-up actions for locations with high levels of nitrogen or septic system failure
- Suffolk County Water Authority
  - Perform sample testing, share results and create timely alerts for critical situations
  - Share records for water sources, locations and volumes
- Towns and villages:
  - Link zoning with the Water Resource Plan and the compliance measures

Expected outcomes

Creating a structure to drive compliance should result in the following:

- Increased stakeholder awareness of issues, such as failing STPs or deficient septic systems
- A cross-functional dashboard with compliance and progress statuses for system upgrades
- A recovery plan for system failures, in place and at the ready
- Adoption of a relevant, recommended EPA management model

Costs of inaction

Without compliance, an established governance structure cannot improve water quality. Lack of monitoring and enforcement prevents Suffolk County from proactively addressing issues with STPs or on-site septic systems, an issue that will continue if the County does not take action.

Recommendation 7: Create a structure to drive compliance (continued)

Proposed owner and stakeholders	Suggested resources needed
Owner: Suffolk County Department of Health Services **Stakeholders:** • Water authorities • Suffolk County Department of Public Works • US Environmental Protection Agency	• New role for ownership of these processes • Data framework • Transition coordination • Assurance role for the County **Cost estimate:** Low
Dependencies	**Key milestones, activities and timeframe**
Establishing a structure to drive compliance depends on the County's ability to fulfill the following recommendations: • Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan • Recommendation 4: Establish a framework to visualize, monitor and manage water quality • Recommendation 5: Establish governance to enable the installation of appropriate technology and to motivate responsible behavior	**Short term:** • Form an interdisciplinary meeting between owner and stakeholders to outline a plan of action and discuss key themes (Week 1 and ongoing) • Confirm initial priority measures for compliance and align with Recommendation 4 focus areas (Weeks 2 - 10) • Develop supporting materials (Weeks 7 - 8) • Execution (Week 13) • Measurement (Week 16 and ongoing) **Long term:** Annually review the critical KPIs, validate compliance processes and modify them as appropriate, based on water quality status, new pollution/water quality factors and improvement of processes
Priority status	
Medium	

Recommendation 8: Continue to develop a funding mechanism

Funding is a pressing issue for the County as it works to solve its nitrogen challenges. We recommend appointing a financial team with strong leadership to generate a funding plan specifically for wastewater management goals.

Suffolk County's Water Resource Plan calls for a multitude of actions that vary in nature and scale, balancing complex needs across the county. Each of these projects, both short- and long-term, will require significant investment. Some recommendations will produce additional revenue, like the consolidation of the STP network. Others, including the Suffolk County Water Authority and wastewater management consolidation and organizational changes, will result in savings. The financial team should coordinate all funding actions, grant applications and bond issuance (see references 16 and 22 in Appendix C). The team must direct resulting revenue and operational savings toward the execution of the Water Resource Plan.

Funding is directly connected to federal, state and county regulations and is not always guaranteed. For this reason, the County should establish a global view of grant applications (to-do, pending, granted, rejected), other funding actions and statuses (such as bonds), new revenue, water fees and expected savings. With this framework in place, the County can plan, prioritize and/or redirect available funding as well as drive the execution of individual projects based on a comprehensive view. Suffolk County may find the Smarter Cities Financing Guide from the Smarter Cities Council useful in identifying various funding options for municipalities (see reference 24 in Appendix C).

Recommendation 8: Continue to develop a funding mechanism

Suffolk County's estimated cost of additional sewers and septic system upgrades is US $8 billion and requires an extensive, long-term approach to finance the entire plan. To get started, the County should construct a complete financial picture of spending along with a timeline and funding options.

Scope and expected outcomes

Scope

To achieve desired results, the County should take the following actions:

- Explore existing and applicable grants at the state and federal level
- Evaluate existing taxes/funding that can be redirected toward water quality issues
- Consider the following options for revenue generation:
  - County loans (including the option to place the repayment responsibility with the homeowners)
  - Adjustments to sales, tourist, property, toll road and vice taxes
  - Wastewater management fee, potentially determined by water consumption for waste services
  - Water consumption—based fee
  - Fees from citizens for their wastewater services managed by the County following the integration of privately operated STPs
  - Leverage efficiencies in the overall water management processes, including testing, invoicing and chemical purchase
- Align the priority and timing of septic system upgrades or sewer extension deployments with the availability of confirmed funding and the priorities defined in the Water Resource Plan
- Define a set of affordable incentives, based on priority, to help ensure earlier upgrades

Expected outcomes

Developing an approach to managing the funding mechanism should result in the following advantages:

- A clear understanding of funding availability within a five-year timeframe, enabling execution and implementation in the very near term
- Generating new revenue sources
- Establishing a regional funding model
- Effective reduction of nitrogen pollution

Costs of inaction

Without a funding mechanism and an approach to managing it, integrated water management efforts will fail and communities will lack the awareness they need to make investments in improving water quality.

Recommendation 8: Continue to develop a funding mechanism (continued)

Proposed owner and stakeholders	Suggested resources needed
Sponsor: The County Executive **Owner:** Finance **Stakeholders:** • County legislators • Federal and state legislators • Suffolk County water authorities and local communities	• Financial leadership • Legislators **Cost estimate:** Medium
Dependencies	**Key milestones, activities and timeframe**
Successful management of the funding mechanism depends upon the County's strong partnership with federal and state governments, as well as the existing management of bonds. The recommendation also depends on the completion of the following recommendations: • Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan • Recommendation 2: Operate the STP network under the control of the SCDPW • Recommendation 11: Establish a framework for decentralized wastewater handling solutions	**Short term:** • Appoint a financial lead • Engage all the stakeholders • Agree on priorities • Implement a funding plan and contingencies to deliver the following: – Proactive application and securing of grants – Development of new revenue sources – Mechanism for progress tracking **Long term:** • Ongoing management and tracking of the funding structure over a multi-year roadmap to monitor the following: – Bond repayments – Distribution of the savings/benefits – Collection of revenue
Priority status	
High	

Recommendation 9: Develop workforce model and practices to meet future needs

Suffolk County must adjust its resource model with the appropriate number and type of resources for present and future needs. Currently, staffing concerns in the Department of Health Services and the Department of Public Works limit Suffolk County's ability to manage water effectively (see reference 14 in Appendix C).

First, open positions and staffing shortages limit the County's proactive maintenance capabilities and effective infrastructure management. Specialized job roles limit flexibility and staff transfers across organizational borders, impacting retention rates.

Finally, an aging workforce and limited new hires with the necessary skills will prevent Suffolk County from effectively planning, managing and monitoring water-related quality improvements.

Suffolk County must establish a succession plan to recruit new employees with the most critical necessary skills.

If Suffolk County allows advanced on-site septic systems (see Recommendation 6) with consolidated governance structures, skill demand in the county will increase significantly.

Ultimately, Suffolk County must build a vigorous and proactive staffing plan to service customers effectively, perform proactive asset maintenance and maintain a workforce with high levels of organizational knowledge.

Recommendation 9: Develop workforce model and practices to meet future needs

The County should update its staffing plan and workforce practices to proactively manage and prepare for changing requirements.

Scope and expected outcomes

Scope

The proposed plans for updating standards, code and management oversight of on-site septic and cluster systems will drive increased workload for the Suffolk County Department of Health Services. The recommendation to consolidate the STP network will potentially drive increased needs for the Suffolk County Department of Public Works. A proactive organizational strategy and staffing plan will help prepare the County to handle the anticipated increase in workload while delivering a higher level of service to constituents.

To achieve desired results, the County requires the following:

- Fast and effective wastewater permit process, especially for new technologies
- Proactive monitoring and maintenance of expanded wastewater network
- Efficient and accurate data gathering, as well as skills to enable data sharing
- Distribution of key skills across several employees, preventing isolated capabilities in the organization, which can be risky
- Career path development to ensure roles within the organization can attract and retain skilled staff

Expected outcomes

With a future-focused workforce model, the County should benefit from the following:

- Improved response times to requests for new on-site permits/variances
- More complete and accurate water quality data
- Reduced overtime costs and optimized labor costs
- Improved workforce retention rates
- Business resilience and continuity for critical skills

Costs of inaction

The result of inaction would be critical skill gaps for operational roles, duplicated waste activities and data management, extended turnaround times for on-site and cluster system permits and potential widespread events due to the lack of critical maintenance and monitoring prioritization.

Recommendation 9: Develop workforce model and practices to meet future needs (continued)

Proposed owner and stakeholders	Suggested resources needed
Owners: • Commissioner of the Department of Public Works • Commissioner of the Department Health Services **Stakeholders:** • Civil service organization • Union representatives • County finance	• Workload planner/staffing leader • Managers of relevant departments • Advocacy by County leadership team • Representation from human resources (HR) **Cost estimate:** High
Dependencies	**Key milestones, activities and timeframe**
Implementing a new workforce model depends on the successful completion of the following recommendations: • Recommendation 2: Operate the STP network under the control of the SCDPW • Recommendation 4: Establish a framework to visualize, monitor and manage water quality • Recommendation 5: Establish governance to enable the installation of appropriate technology and to motivate responsible behavior • Recommendation 11: Establish a framework for decentralized wastewater handling solutions This recommendation will be impacted by the following implementation: • Recommendation 3: Integrate water and wastewater operations	**Short term:** • Identify staffing plan owner and form an interdisciplinary team of owner and stakeholders to outline plan of action (Month 1) • Map workflow processes, determine demand-side and supply-side inputs (such as expected volume of permits, testing, retention levels, expected retirements, skill levels) (Months 2 - 3) • Build gap analysis of skill demand vs. supply (Month 4) • Define and implement communications plan with staff (Month 7 and ongoing) • Develop strategy for supply of needed skills, consider retention strategies and work process redesign (Months 5 - 6) • Develop succession plan for key positions and demand for new roles (Month 6) • Gain financial support for staffing as necessary (Months 6 - 7) • Execute staffing plan (Months 7 - 12) – Deploy training program to keep current staff up-to-date and ready for transitioning into new roles – Work with union representatives to staff new positions – Work with HR to confirm and approve new role descriptions as well as recruitment/deployment plans and processes **Long term:** • Establish regular reassessment (suggest annually) of one- to three-year resource plan (Year 1 and ongoing) • Deploy work process redesign program to reduce process burden and improve responsiveness to customers (Years 1 - 2) • Work with civil service and union representatives to develop apprenticeship programs to meet demand (Ongoing) • Establish strategic relationships with local schools to foster recruitment into the field (Ongoing)
Priority	
Medium	

Recommendation 10: Adapt the business processes in the Suffolk County Department of Public Works and the Suffolk County Department of Health Services to meet expanded integrated water management responsibilities

Consolidation of water cycle management will require continuous process improvement in the Suffolk County Department of Public Works (SCDPW) and the Suffolk County Department of Health Services (SCDHS). Suffolk County has an opportunity to reduce functional duplications between departments and agencies, eliminating unnecessary events, such as multiple visits to a single residence to draw well and pool samples.

Citizens and various stakeholders believe inefficient processes and duplicate responsibilities will continue to slow permit processing times and agency responsiveness. With improved operational efficiencies, Suffolk County departments can absorb the anticipated workload associated with increased management involvement in the overall water cycle.

Recommendation 10: Adapt the business processes in the SCDPW and the SCDHS to meet expanded integrated water management responsibilities

Suffolk County must prepare for increased wastewater treatment volumes by expanding the scope of responsibility and control of the Department of Public Works and Department of Health Services. To do that, the County should improve its operational processes and prepare its organizations and businesses for additional responsibilities using end-to-end management systems.

Scope and expected outcomes

Scope

To achieve desired results, the County requires the following:

- Increased responsiveness to customer needs through waste reduction and cost savings
- Defined goals and metrics across networks and functions
- Expanded access to data, readiness to integrate and effective data use
- Use of economies of scale, such as integrated purchasing, operations, billing and waste disposal

Expected outcomes

Improving processes to help the Department of Public Works and Department of Health Services meet an expanded scope of responsibilities should help the County achieve the following:

- Process alignment with defined outcomes and goals for improved water quality
- Improved service levels with more responsive processes
- Eliminated areas of duplication and wasted effort

Costs of inaction

The County's inaction would result in lost opportunities for cost reduction and efficiency improvements. The County would continue to invest time and money into duplicate efforts and would not be able to measure progress because of continued data fragmentation.

Recommendation 10: Adapt the business processes in the SCDPW and the SCDHS to meet expanded integrated water management responsibilities (continued)

Proposed owner and stakeholders	Suggested resources needed
Owners: • Commissioner of the Department of Public Works • Commissioner of the Department of Health Services **Stakeholders:** • County leadership • Line operators and managers • County finance	• Process optimization program manager • Managers, line leaders and operators • Advocacy by County leadership team **Cost estimate:** Medium
Dependencies	**Key milestones, activities and timeframe**
None	**Short term:** • Identify program owner and form an interdisciplinary team of owners and stakeholders to outline plan of action (Month 1) • Determine client value metrics and common goals (Months 2 - 3) • Identify process owners and change agents to prioritize and lead improvement initiatives (Months 2 - 4) • Conduct value stream mapping workshops and determine areas of duplication and waste (Months 3 - 6) • Create action plans to eliminate pain points and duplicate work (Month 6) • Execute action plans (Months 7 - 12) • Measure improvements (Month 13 and ongoing) **Long term:** Establish regular continuous improvement process discipline (Years 1 - 3)
Priority status	
Medium	

Recommendation 11: Establish a framework for decentralized wastewater handling solutions

The Water Resource Plan will define which areas of the county are sewered. In non-sewered areas, the most appropriate on-site wastewater handling method — decentralized wastewater handling — must be defined separately. In Suffolk County, the on-site legacy methods are cesspools and septic systems connected to leaching pools, which do not remove nitrogen. In addition, these methods are generally poorly maintained and have limited follow-up programs in place.

There are different needs in different areas of the county, so selecting the appropriate technology will be specific to a particular property and location (see references 13 and 17 in Appendix C). Citizens should be able to select their on-site wastewater treatment method from a range of possible solutions (see references 12 and 37 in Appendix C). But even the best on-site solution requires correct operation and maintenance to meet performance requirements for waste treatment and nitrogen reduction.

Therefore, a framework is necessary to monitor and manage compliance to ensure that decentralized wastewater treatment systems are meeting operational requirements. The framework should consider control and certification intervention not only at installation but also at other points in the system's lifecycle, such as transfer of ownership, house development/renovation and upgrade.

This recommendation addresses the needs for the following:

- Improved support for the selection of adequate technology within a broad range of possibilities
- Enhanced follow-up processes to improve existing decentralized wastewater handling facilities throughout the entire lifecycle
- Improved data gathering and performance monitoring of on-site waste disposal facilities
- Increased nitrogen-removing wastewater handling solutions across the county

Recommendation 11: Establish a framework for decentralized wastewater handling solutions

Finalize and implement a framework for the selection, deployment and management of appropriate local wastewater handling solutions for both individual and cluster systems.

Scope and expected outcomes

Scope

To achieve desired results, the County should perform the following actions:

- Provide access to a broader set of adequate technology solutions
- Encourage innovative solutions for wastewater handling
- Set up a framework for the operation and maintenance of decentralized systems
- Set up a framework for the permitting and monitoring of decentralized systems, encouraging an upgrade to nitrogen-removing solutions
- Promote the consideration of cluster systems in situations where it makes sense, considering economies of scale for better operations

Expected outcomes

With a framework for decentralized wastewater handling solutions, the County can expect to experience the following advantages:

- An accessible and available knowledge base for decentralized water treatment possibilities
- Improved solution selection (on-site or cluster) for each property
- A consistent prioritization strategy to determine timing for solution implementation
- An established approach to ensure ongoing management and monitoring of wastewater treatment solutions
- An overall plan that determines what solutions to implement and when, aligning with the overall resource management plan
- Smooth and simple data gathering at all stages of the decentralized system's lifecycle

Costs of inaction

If the County does not establish this framework, it will continue to implement solutions that do not treat nitrogen and will have no visibility of on-site treatment facilities. This will impede the identification and upgrade of poorly operated systems, and the overall nitrogen load will continue to increase.

Recommendation 11: Establish a framework for decentralized wastewater handling solutions (continued)

Proposed owner and stakeholders	Suggested resources needed
Owner: Department of Health Services **Stakeholders:** • Academic institutions (for research/innovation) • Private service companies and treatment facility operators • Towns and villages • Department of Public Works	• Department of Public Works to assess technologies • Universities and wastewater treatment companies to expand innovation and continue research on cluster systems **Cost estimate:** • Develop framework: Medium • Implement infrastructure changes (as estimated by Suffolk County): High
Dependencies	**Key milestones, activities and timeframe**
The successful development and implementation of this framework is contingent on the following recommendations: • Recommendation 1: Finalize and deploy a robust and integrated Water Resource Plan This recommendation will impact the following: • Recommendation 3: Integrate water and wastewater operations • Recommendation 5: Establish governance to enable the installation of appropriate technology and to motivate responsible behavior • Recommendation 6: Excite communities to embrace the solutions for improving water quality • Recommendation 7: Create a structure to drive compliance	**Short term:** • Gather knowledge and provide information regarding on-site and cluster systems (3 - 4 months) • Define guidelines for the selection of appropriate on-site and cluster technology (2 months) • Establish governance and a shareable mechanism: – Establish a register of on-site/cluster systems with self-register capabilities (6 months) – Provide guidelines and training information for private operators (3 - 4 months) – Require certification and inspection for ongoing quality management of on-site solutions (Month 9 and ongoing) • Establish an inspection record information system for on-site and cluster systems (1 month and ongoing) • Establish regulations to ensure the implementation or upgrade of on-site treatment systems during renovation or when property ownership changes (2 months and ongoing) **Long term:** • Establish a “Low-N certified” label for properties that meet nitrogen reduction standards (Year 1 and ongoing) • Define the framework and create a toolkit to help select technology for small cluster/grouping of properties, considering cost-benefit analysis and known environmental impact (6 months, starting Year 2)
Priority status	
High	

5. Conclusion

Water quality in Suffolk County, NY — Long Island's largest county — has a fundamental impact on the quality of life of the County's citizens. Long Island is the second most visited tourist destination in the state of New York, and it relies on water to attract these visitors. Water is critical to local economic development, recreation and industry. As water quality deteriorates and pollution in the local waterways becomes more apparent, Suffolk County has many compelling reasons to address water quality issues immediately. Suffolk County's rich agricultural and seafood history highlights the value of environmental conservation and waterway protection in the region.

Suffolk County faces many challenges that impede water quality improvement:

- A weak economy and limited funding
- A fragmented network of stakeholders
- Outdated standards for septic tank solutions
- Aging infrastructure
- Decentralized land use and zoning
- A geographically diverse land mass with varying challenges
- An outdated governance structure
- Constrained resources for monitoring and permitting
- Numerous data repositories
- A declining population
- High local property taxes
- Concerned residents

As Suffolk County begins to address its water quality challenges, it understands that a comprehensive water resource strategy with actionable and measureable goals, along with support from a diverse group of stakeholders, is the key to success. This report identifies a number of recommendations that together will help Suffolk County transform its water quality now and in the future. The following are key elements that will help the County drive this change:

- An integrated approach to water and wastewater management
- A more proactive and data-driven stakeholder action plan
- A secure funding base
- Engaged communities

The IBM team created an actionable roadmap that enables Suffolk County to take an incremental approach to solving its water quality issues. Each milestone provides necessary actions, key stakeholders and desired outcomes to help Suffolk County become the "gold standard" in managing water contamination from nitrogen pollution. The desire for improvement and change is apparent, as Suffolk County has taken the necessary first step of addressing the importance of water for its community, its economy and its future. Suffolk County, with its passion for change and its commitment to improvement, can position itself as a Smarter County to revitalize its local economy and reclaim its water.

6. Appendix

A. Acknowledgments

Individuals interviewed:

The following is a list of the individuals we met with during our engagement with Suffolk County. We would like to thank them for their contributions and valuable insight.

Name	Title	Organization
Mark Lesko	Executive Director	Accelerate Long Island
Thomas Gallagher	Director of Sales & Operations	Aparo, Sanitary & Environmental Services
David L. Berg	Associate LEED Accredited Professional	Cameron Engineering & Associates, LLP
Mark Wagner, C.E.P.	Partner, LEED Accredited Professional	Cameron Engineering & Associates, LLP
Marianne Garvin	President & CEO	CDC of Long Island
Joel Moser	Adjunct Professor of International & Public Affairs at Columbia University	Columbia University
Lorne Brousseau	GIS & Stormwater Manager, Marine Program	Cornell University, Cooperative Extension of Suffolk County
Frank Castelli	Environmental Projects Coordinator — Water Quality Improvement	Suffolk County Department of Economic Development and Planning
Barry S. Paul	Deputy Commissioner	Department of Health Services
Larry Stipp	Office Systems Analyst III	Department of Health Services, Division of Environmental Quality
Walter J. Hilbert	Chief Principal Public Health Engineer	Department of Health Services, Division of Environmental Quality, Office of Wastewater Management
Kristina Heinemann	Agriculture and Decentralized Wastewater Treatment Coordinator, Watershed Management Branch	US Environmental Protection Agency (EPA), Region II
Robert Riekert	Deputy Director	Huntington
Margo Myles, AICP	Senior Environmental Analyst, Coordinator of Open Space Conservation	Huntington
Jen L. Jordon-Sweet	Research Staff Member, Silicon Technology, Research Division	IBM NSLS 725A/X20, Brookhaven National Laboratory
Damon McMullen	Trustee, Commissioner of Police, Commissioner Wastewater Treatment System	Incorporated Village of Northport
Cara Longworth	Executive Director	Long Island Regional Planning Council
Mitchell H. Pally	CEO	Long Island Builders Institute
Tony Leung	New York State (NYS) Department of Environmental Conservation (DEC)	NYSDEC
Julie Nace	Peconic Estuary Program Coordination NYSDEC, Bureau of Marine Resources	NYSDEC
Glynis M. Berry	Director	Peconic Green Growth
Marshall Brown	Founder	Save the Great South Bay
Alison Branco, Ph.D.	Marine Biologist	Suffolk County Department of Health Services, Office of Ecology Peconic Estuary Program
Joseph M. Fusillo, P.E.	Director of Water Quality and Laboratory Services	Sidney B. Bowne & Son, LLP
Swaroop Puchalapalli, P.E.		Sidney B. Bowne & Son, LLP

Name	Title	Organization
Harold Walker	SBU/CE	Stony Brook University
Christopher Gobler	SBU/SOMAS	Stony Brook University
Larry Swanson	SBU/SOMAS	Stony Brook University
Minghua Zhing	SBU/SOMAS	Stony Brook University
Robert Wilson	SBU/SOMAS	Stony Brook University
David L. Calone	Chairman	Suffolk County Planning Commission
John C. Donovan	Chief Engineer	Suffolk County Department of Public Works, Division of Sanitation Engineering
Steven Bellone	County Executive	Suffolk County
Camilo Salazar, M.S.C.	Environmental Analyst	Suffolk County Department of Economic Development and Planning, Division of Water Quality
Cynthia DiStefano	Director of Classification	Suffolk County Department of Civil Service
Dorian Dale	Director of Sustainability, Chief Recovery Officer	Suffolk County Department of Economic Development and Planning
Sarah Lansdale	AICP, Director of Planning	Suffolk County Department of Economic Development and Planning
Walter Dawydiak, Jr. P.E., J.D.	Director	Suffolk County Department of Health Services, Division of Environmental Quality
Eric Rotondi	Legislative Aide, Office of Presiding Officer DuWayne Gregory	Suffolk County
John M. Kennedy, Jr.	Legislator, District 12	Suffolk County
Jay Schneiderman	Legislator, District 2	Suffolk County
Sarah Anker	Legislator, District 6	Suffolk County
Robert Trotta	Legislator, District 13	Suffolk County
Steve Stern	Legislator, District 16	Suffolk County
William R. Spencer	Legislator, District 18	Suffolk County
Al Krupski	Legislator, District 1	Suffolk County
Robert Calarco	Legislator, District 7	Suffolk County
Kara Hahn	Legislator, District 5	Suffolk County
Monica Martinez	Legislator, District 9	Suffolk County
Ben Wright, P.E.	Principal Engineer	Suffolk County Department of Public Works, Division of Sanitation Engineering
R. Boris Rukovets, P.E.	Public Works Special Project Supervisor	Suffolk County Department of Public Works, Division of Sanitation Engineering
Pamela Donovan	Staff to Sarah Anker, Legislator, District 6	Suffolk County
Dominick Ninivaggi	Superintendent	Suffolk County Department of Public Works
Colleen Capece	Special Projects Coordinator	Suffolk County Office of Budget and Management
Edward Lyons		Suffolk County
Carl Lind	Cartographer	Suffolk County
Kate Oheim	Assistant Cartographer	Suffolk County
Neil Ralph	District 3 Bergen Plant Senior Instrumentation Technician	Suffolk County
Jonathan Schneider	Deputy County Executive	Suffolk County

Name	Title	Organization
Samuel Chu	Chief of Operations and Commissioner of Labor	Suffolk County
Joanne Minieri	Deputy County Executive and Commissioner of Economic Development and Planning	Suffolk County
Vanessa Baird Streeter	Director of Communications	Suffolk County
Connie R. Corso	Budget Director	Suffolk County Executive Office
Robert M. Lipp	Director of Budget Review, Budget Review Office, Suffolk County Legislator	Suffolk County Legislature
Christine M. Lasher	Assistant Laboratory Director	Suffolk County Water Authority
Timothy Kilcommons, P.E.	Chief Engineer, Department of Public Works, Division of Sanitation Engineering	Suffolk County Water Authority
Larry Kulick, C.P.A.	Chief Financial Officer	Suffolk County Water Authority
Jeffry Szabo	Chief Executive Officer	Suffolk County Water Authority
Joseph Pokerny P.E.	Deputy CEO for Operations	Suffolk County Water Authority
Paul Kuzman	Director of Production Control	Suffolk County Water Authority
Karen A. Randazzo	Director of Water Quality and Laboratory Services	Suffolk County Water Authority
Carrie Meek Gallagher	LEED Green Associate, Chief Sustainability Office	Suffolk County Water Authority
Michael G. Mullowney	Systems Analyst	Suffolk County Water Authority
Amy C. Engel	Executive Director	Sustainable Long Island
Stuart R. Lowrie	Conservation Finance & Policy Advisor	The Nature Conservancy
Stephen Lloyd	Conservation Information Manager	The Nature Conservancy
Elizabeth C. Smith	Environmental Economist	The Nature Conservancy
Chris Clapp	Marine Specialist	The Nature Conservancy
Carl LoBue	Scientist	The Nature Conservancy
Andrew Manitt	Research Coordinator	The Sustainability Institute, Molloy College
Tim Carden	Managing Director	The PFM Group
Richard Groh	Chief Environmental Analyst, Dept. of Environmental Control	Town of Babylon
Jeanmarie Buffet	Senior Environmental Analyst	Town of Babylon
Anthony Graves	Principal Environmental Analyst, Division of Environmental Protection	Town of Brookhaven
Edward P. Romaine	Supervisor	Town of Brookhaven
Thomas Talmage, P.E.	Town Engineer	Town of East Hampton
Larry Cantwell	Town Supervisor	Town of East Hampton
Philip C. Ingerman	Director of Intergovernmental Relations, Office of Supervisor Frank P. Petrone	Town of Huntington
Joseph Cline, P.E.	Director, Dept. of Engineering	Town of Huntington
Eric M. Hofmeister	Deputy Supervisor	Town of Islip
Jefferson V. Murphree, AICP	Town Building and Planning Administrator	Town of Riverhead
Stephanie Hurd	Senior Environmental Analyst, Dept. of Environment & Waterways	Town of Smithtown
Allyson Murray	Director	Peconic Green Growth
Kyle Collins	Dept. of Land Management	Town of Southampton

Name	Title	Organization
Jennifer Garvey	Deputy Chief of Staff Officer of the Supervisor	Town of Southampton
Anna Throne-Holst	Supervisor	Town of Southampton
Mark Terry	Principal Planner, LRWP Coordinator	Town of Southold
Michael Collins	Professional Engineer, Office of the Engineer	Town of Southold
Maureen A. Tooke	Decentralized Wastewater Mgmt. Program/SepticSmart	US EPA Office of Wastewater Management — Idaho Operations Office
Kyle Strober	Long Island Regional Director	US Senator Charles Schumer's Office
Debbie Tinnirello	Long Island Regional Director	US Senator Kirsten Gillibrand's Office
Kevin P. Walsh	Managing Director, Long Island Operations	VHB Engineering, Surveying and Landscape Architecture
Tawaun Weber	Assistant Director	Vision Long Island
Elisabeth Muehlemann		Vision Long Island
Conrad Teller	Mayor	Westhampton Beach
Peter Scully	Regional Director	NYS Department of Environmental Conservation
Adrienne Esposito	Executive Director	Citizens Campaign for the Environment
Scott Martella		NYS Office of Governor Andrew Cuomo
Joshua Slaughter	Legislative Aide	representing Kate Browning, Legislator
Ann Golob	Long Island Index Project	Rauch Foundation
Steven Romalewski	Director	CUNY Mapping Service, Center for Urban Research

Organizations represented:

We spoke with individuals who represented the following organizations and stakeholders in Suffolk County and its surrounding areas. Each contributor was extremely knowledgeable, passionate and engaged in the water quality issues of Suffolk County, NY.

Accelerate Long Island	Brookhaven National Laboratory	Save the Great South Bay
Aparg, Sanitary and Environmental Services	Incorporated Village of Northport	SCDHS — Office of Ecology Peconic Estuary Program Suffolk County
Cameron Engineering and Associates, LLP	Long Island Regional Planning Council	Sidney B. Bowne and Son, LLP
CDC of Long Island	Long Island Builders Institute	Suffolk County
Columbia University	Sustainable Long Island	Town of Brookhavenw
Come!! University, Cooperative Extension of Suffolk County	The Nature Conservancy	Town of East Hampton
Suffolk County Department of Environment and Energy	The Sustainability Institute, Molloy College	Town of Huntington
Suffolk County Department of Public Works	Town of Babylon	Town of Islip
Suffolk County Executive Office	VHB Engineering, Surveying and Landscape Architecture	Town of Riverhead
Suffolk County Legislature	Vision Long Island	Town of Smithtown
Suffolk County Water Authority	Westhampton Beach	Town of Southampton
Environmental Protection Agency (EPA) Region II	Peconic Green Growth	Town of Southold
Suffolk County Department of Health Services	New York State Department of Environmental Conservation	Stony Brook University
Public Financial Management, Inc.		

B. Team biographies

Jan Bowen
Executive Partner and Water Industry Leader
IBM UK (Bristol)

Bowen has more than 20 years of experience working within supply chain management and operations, focusing on realizing performance improvement across both geographic and organizational boundaries. She has worked in a variety of industries spanning automotive, aerospace and defense, chemicals and petroleum and more recently utilities. Her leadership has driven significant improvement-focused projects that address not only the change in business process and organization but also the associated enabling technologies. Bowen's experience within the utilities industry has involved the design and implementation of work and asset management solutions for water and wastewater companies. She recently led a project in which IBM helped establish a new national water utility in the Republic of Ireland.

Kelly Clifton
Strategy and Analytics Consultant
IBM North America (Charlotte)

Clifton's work focuses on business strategy and transformation services for external clients. She has acted as a consultant for large industrial clients and has extensive experience with innovative business opportunities within IBM, such as cloud, mobile, social and analytics. She assists with business development opportunities and research for the Smarter Cities Center of Excellence and IBM Smarter Water. Clifton has worked in local government reorganization and urban planning in the Commonwealth of Virginia. While in graduate school, she consulted for a multinational company in North Carolina, providing effective social media strategies to improve business-to-business marketing. Clifton holds a BA from the University of Virginia in government and history and an MA in management from Wake Forest University.

Antonio Nasuto
Director of Operations and Sales Transformation for Central and Eastern Europe
IBM (Prague)

Nasuto has more than 25 years of IBM experience, and most recently he led the integration of Sales Management Support into the global CRM model. Previously, he held several management roles in Sales and Business Operations, leading Global Technology Services CoE, Europe Sales Reporting CoE and Sales Management Support CoE in Bratislava. Nasuto has successfully managed global teams' transformation, integration and sales support. Prior to his international assignment, Nasuto specialized in services and was responsible for such clients as Exxon, Generali, Telecomitalia and many more.

Vincent Mottier
Application Innovation Services Managing Consultant
IBM (Zurich)

Currently, Mottier's work focuses on Smarter Water™, enterprise asset management and business process analysis and design projects for transportation and water/wastewater utilities companies. He has 12 years of experience in the IT and telecommunications industries — with positions that span market research, product management and corporate strategy — combined with more than eight years working for renowned water research institutions on topics like wastewater treatment, runoff water handling and information management and data modeling for urban water management. Mottier holds a PhD and a Master's degree in environmental engineering from the Swiss Federal Institute of Technology, as well as an MS in hydrology from the University of Montpellier, France.

Allison McFadden
Director of Integrated Supply Chain, Business Integration and Transformation
IBM North America (Raleigh)

McFadden has 15 years of experience in supply chain management, operations and business process transformation, during which she has focused on global and cross-functional team leadership. She has led large-scale projects for multiple product lines within IBM, including the launch of IBM systems software manufacturing in Dublin, Ireland. After this successful launch, McFadden served as the senior leader of the Dublin Software Center where she was responsible for the manufacturing and fulfillment of all IBM software products for the European and Growth Market regions. She has also led significant transformation projects for the IBM hardware division, the most recent of which was recognized as a finalist for both the Institute of Supply Chain Management and Supply Chain Council awards for excellence in supply chain. Her current responsibilities include developing strategic direction for the IBM Integrated Supply Chain and partnering with business services to provide supply chain talent and assets to clients. She holds a BS in industrial engineering from Purdue University and an MBA from Duke University.

Cesar Saavedra
Worldwide Software Systems and Data Management Consultant
IBM North America (Orlando)

Saavedra has 24 years of IT experience, focusing primarily on architecting, implementing, testing, integrating and maintaining software and data systems. He holds BS and MS degrees in computer science from the University of Kansas, as well as an MBA from the University of Florida. Saavedra has experience in a variety of industries and sectors, including airlines, city and federal government, energy, telecommunications, retail, logistics, semiconductor manufacturing and many others. Currently, he is part of the IBM Worldwide WebSphere Competitive Team and works with sales teams around the world advising on IBM competitors in a variety of areas, including integration, BPM, SOA, API management, databases and the Internet of Things. Before joining IBM, Saavedra worked at Oracle, TIBCO, Lucent Technologies and AT&T Bell Laboratories. He is TOGAF certified.

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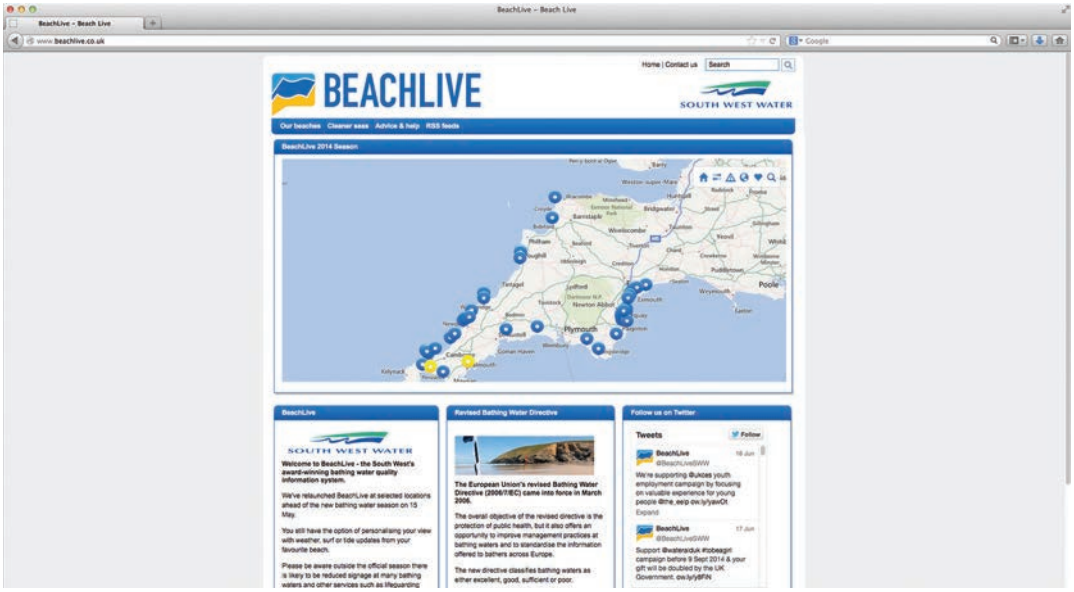

Figure 5: A BeachLive view gives the public access to information about water quality at public beaches and other factors that may affect beach use

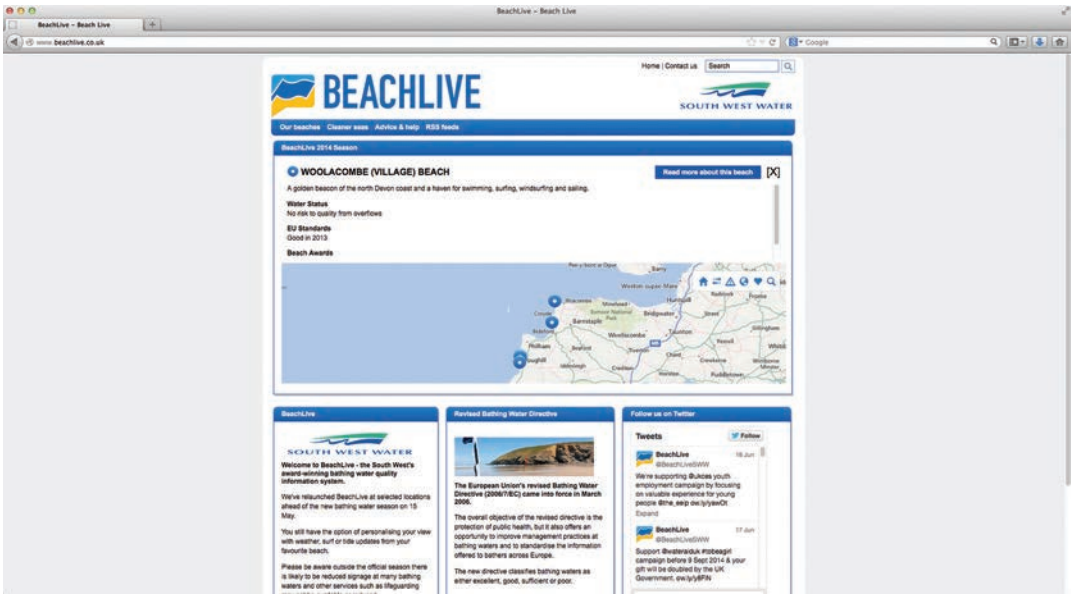

Figure 6: A detailed BeachLive view about a particular beach's status

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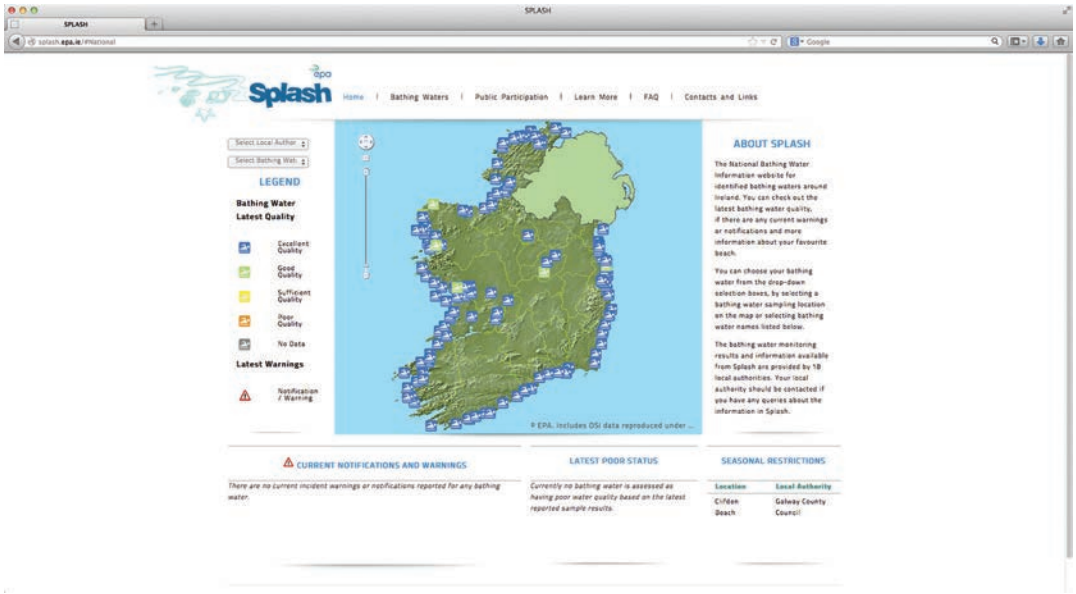

Figure 7: A view of Splash, a site where the public can learn about the quality of water at public beaches in the Republic of Ireland

Figure 8: Splash view displaying details about a particular beach

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12 "Voluntary National Guidelines for Management of On-site and Clustered (Decentralized) Wastewater Treatment Systems." Office of Water, Office of Research and Development, US Environmental Protection Agency. March 2003. http://water.epa.gov/scitech/wastetech/upload/septic_guidelines.pdf

13 "Standards: Approval Of Plans And Construction — Sewage Disposal Systems For Single-Family Residences." Suffolk County Department of Health Services, Division of Environmental Quality. November 13, 1995. www.suffolkcountyny.gov/Portals/0/Documents%20and%20Forms/Health%20Services/Wastewater%20Management/Residential%20Standards.pdf

14 "Office of Wastewater Management Organizational Chart and Manpower Estimates for 2014 and 2016." Suffolk County Department of Health Services, Division of Environmental Quality.

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17 "Request for Expressed Interest in: A Demonstration of Innovative Alternative On-site Wastewater Treatment Systems in Suffolk County." Issued April 14 2014. www.suffolkcountyny.gov/Portals/0/planning/general/RFEI-WQ-I-AWSS.pdf

Submissions reviewed the following companies:
- AK Industries and AK/HA Mfg. LLC
- Orenco Systems
- Biogard Inc.
- Busse, Green Technologies Inc.
- Norweco

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The water agencies in France are public institutions of the Ministry for Sustainable Development. Their primary objective is to help reduce pollution and protect water resources and aquatic environments. The six water agencies employ some 1,800 employees who are organized around the catchment management of river basin districts. They fulfill their duties within the framework of multi-year action programs.

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The Digital Delta project brings together the Dutch Ministry of Water, the Delfland local water authorities, the University of Delft, IBM and other organizations. The project focuses on the provisioning of unlimited and readily accessible water and climate services. One of the key objectives is to integrate and open up water-related data from more than 100 ongoing projects, making it available to organizations, scientists and businesses involved in water management.

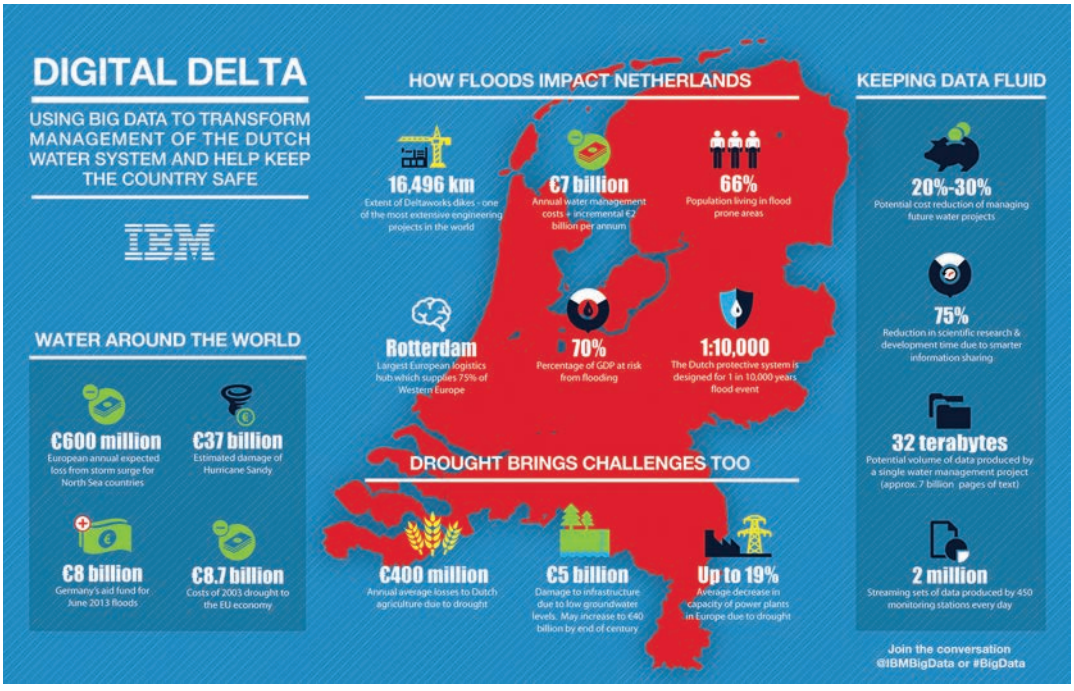

Figure 9: The Digital Delta approach

29 "Watershed Scale Platform for Research, Development, Testing & Demonstration of Water Technologies and Services." Southern Ontario Water Consortium. Accessed June 18, 2014. http://sowc.ca

30 "The Southern Ontario Water Consortium (SOWC). A major force in international water expertise." Ontario Business Report. Accessed June 20, 2014. www.mri.gov.on.ca/obr/2012/07/the-southern-ontario-water-consortium-sowc

The Southern Ontario Water Consortium uses a data integration and management platform for near real-time watershed monitoring and watershed management. The platform synthesizes numerous information sources and formats within the framework of the Grand River Watershed (CA). The data integration platform supports water management professionals and researchers to develop efficient tools to predict floods, protect the water supply sources and forecast the impact of growth and urbanization on vital ecosystems.

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Figure 10: The Rio de Janeiro operation center integrates data from the city's public agencies to improve response to events, such as floods and landslides

33 "Watershed Management: Guiding Principles for Integrated Management of Water in Switzerland." Federal Office for the Environment (FOEN). Swiss Confederation. 2011. Accessed June 19, 2014. www.bafu.admin.ch/publikationen/publikation/01576/index.html?lang=en

The referenced document provides an overview on how integrated watershed management is addressed in Switzerland. Water resources, water bodies and water infrastructure conditions are monitored. The information is used to evaluate actions' effectiveness, to help enhance system awareness and detect challenges early.

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35 "Integrated Water Resources Management (IWRM)." United Nations Department of Economic and Social Affairs (UNDESA). Accessed June 20, 2014. www.un.org/waterforlifedecade/iwrm.shtml

36 "Constructed Wetlands." United States Environmental Protection Agency. Accessed June 20, 2014. http://water.epa.gov/type/wetlands/restore/cwetlands.cfm

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D. Component Business Model

IBM uses a tool called a Component Business Model (CBM), which sets out a range of components for which an organization requires capability. It helps to provide a framework for an organization to assess current capability levels and future needs against proposed changes or future events. It can be used to help understand the gaps and define priority actions to build capabilities within the organization. It is commonly used in conjunction with a maturity matrix, which is a set of qualitative statements against key criteria, to help an organization assess its capabilities against accepted best practices.

Our CBM comprises five vertical silos that represent the key areas we believe are vital to water/wastewater management in Suffolk County:

1. Engagement and customer management
2. Water sourcing, distribution and treatment
3. Wastewater/recycling strategy
4. Resiliency and environmental management
5. Manage business

Within these silos, the different functions fall into one of three categories:

- **Direct —** These activities set direction and strategy
- **Control —** Actions that manage or monitor performance
- **Execute —** Transactional activities performed in execution of processes

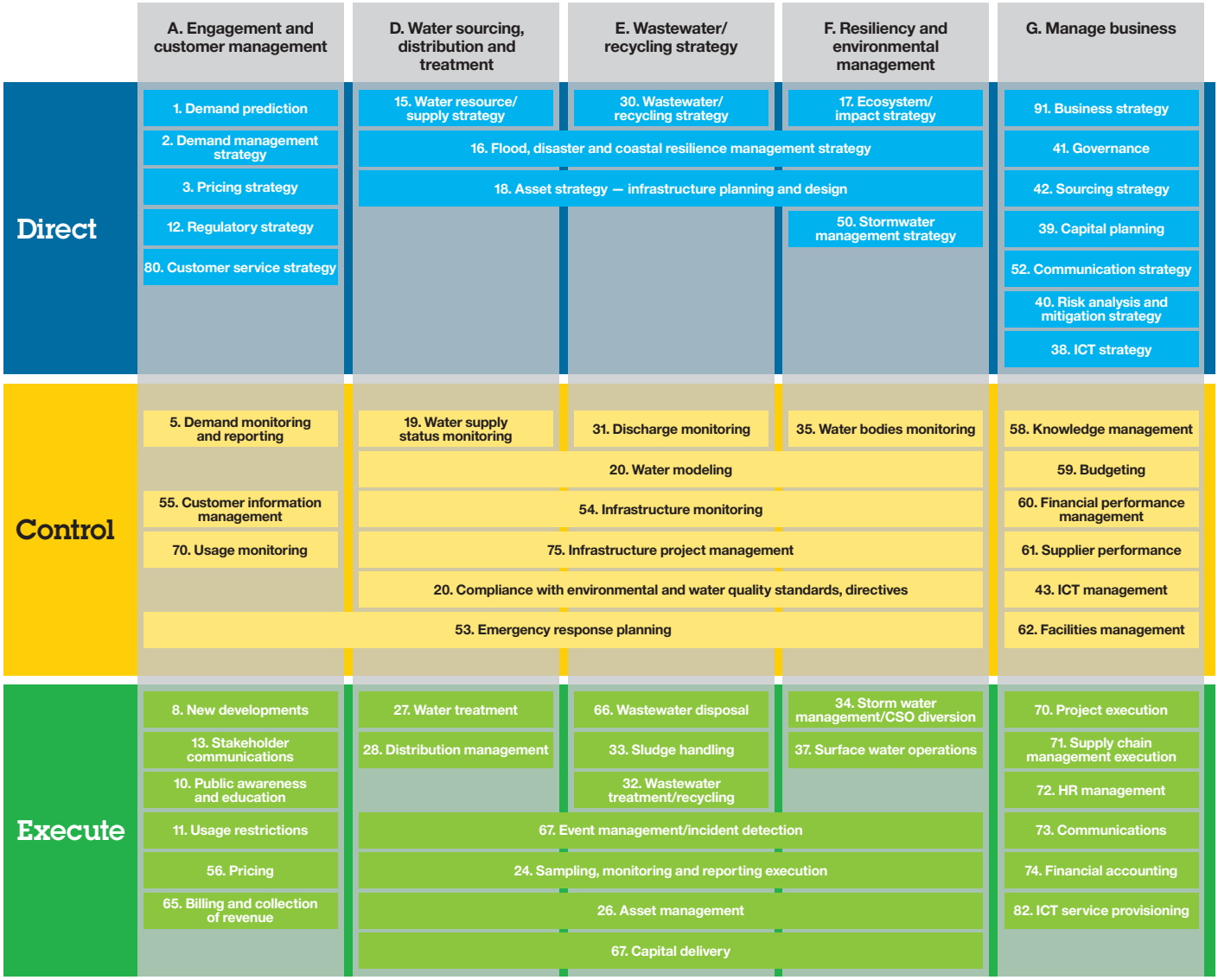


Figure 11: Our approach

Summary of the maturity matrix

A maturity matrix is a set of qualitative statements for defined criteria to assess a capability against known best practices. The statements describe different levels of maturity for organizations to help them understand current maturity levels and define objectives for improvement. A maturity matrix is a tool that helps organizations identify where change is necessary and aligns thinking on where to focus improvement.

The maturity matrix for Suffolk County highlights the County's six focal areas for water and wastewater management:

1. Water and wastewater resource planning
2. Infrastructure and asset management
3. Monitoring and meeting regulatory requirements
4. Customer/stakeholder management and engagement
5. Finance, planning and management
6. Governance and compliance

Suffolk County can use the following maturity matrices to gain a slightly more detailed perspective on how their water/wastewater management approach measures up. By benchmarking its maturity on the matrix, the County can begin to understand where it needs to prioritize and focus resources to improve water quality.

Criteria	Level 1	Level 2	Level 3	Level 4	Level 5
Water and wastewater resource planning	• Local or informal approach to planning not consistent • Lack of information on water systems and water cycle • No current management and progression plans	• Formation of plans for resources shared across districts/town boundaries • Limited alignment of career progression and performance management to future demand plans • Inconsistent and incomplete information in multiple systems	• Common and integrated plan for complete water cycle • Recognition of the importance of high-quality information • Plans for job rotation and cross skilling in place • Clear strategy on what technology is needed where for on-site wastewater and water treatment.	• Complete inventory of data, common format and shared information • Documented decision criteria and repeatable process to update investment plans and budgets • Job rotation and cross skilling fully aligned to future resource plans	• Use of analytical techniques to capacity plan all resource types for future use, with investment planning and funding aligned • Career progression and skills planning aligned to future demand • Clear goals and measures in place for water evaluation
Infrastructure and asset management	• Inconsistent and incomplete asset information in multiple systems (including paper-based data) • Maintenance and service decisions are reactive, not proactive • Wasted effort on accessing reporting; processes localized	• Recognition within the organization of the importance of high-quality and timely asset information to support strategy • Approach for specification, tracking, inventory and event history of assets under development • Initial ideas of proactive/ preventative asset maintenance plans	• Single integrated view of asset specification, location, history and inventory developed • Proactive/ preventative maintenance schedules established • Mechanisms in place to ensure collaboration and share learning between engineering and operations (for example, treatment and distribution) • Mobile working and optimization of field work	• Preventative maintenance schedules based on up-to-date and fact-based performance data • Asset specifications regularly reviewed and challenged to drive service and cost improvements • Mobile working with data capture at source • Standardized data dictionaries and information repositories	• Use of simulation tools to support asset investment decisions • Information available across organizations through end-to-end visibility • County can readily access data on asset trends, such as repair histories and so on • Proactive event management with full County view of infrastructure

Figure 12: Maturity matrix: Details

Criteria	Level 1	Level 2	Level 3	Level 4	Level 5
Monitoring and meeting regulatory requirements	• Limited/no monitoring of treatment facilities or natural systems — core mandatory only • Basic legislative compliance understood and achieved • No comprehensive and systematic reporting on quality • Informal discussions with regulators held — usually reactive • Treatment status is largely behind the fact, based on manual reading of the wastewater treatment process(s)	• Performance metrics around compliance and quality agreed across all functions but not fully monitored or enforced • Regulatory management seen as core competence • The agency gets regular data from treatment operations, supported by manual sampling	• Collaboration between central compliance teams and wider organization established • Performance metrics around compliance and quality agreed with all stakeholders and residents • Data model analysis associated KPIs defined and in use • County has target for nitrogen load	• Link training, leadership, values and performance metrics to establish and maintain a continuous improvement culture • Quality program defining all stakeholder requirements through information collaboration • Policies on customer revenue, environment and assets integrated and aligned • Collaboration among stakeholders for sampling and analysis	• Compliance and quality levels optimized with nearly real-time data • Influential, highly coordinated regulatory and stakeholder management • County tracks all wastewater/waste treatments activities, using automated sensors • Single, integrated platform sharing relevant information to applicable stakeholders
Customer/ stakeholder management and engagement	• County does not have a consolidated view of key stakeholders and interaction history • Limited awareness of how water quality can be addressed in the community • Limited communication from County — only on specific issues	• Discussions started with wider groups of stakeholders around collective action for water quality • County and key stakeholders provide some information available online, but not a complete picture, for addressing water quality • Feedback systematically acted on by County	• Understanding individual stakeholder positions on water quality and use these to drive engagement • Route customer feedback to process owners to drive continuous improvement • County has some water quality priorities with some actions started to support and execute against these	• Collaborative planning with key stakeholders to further optimize impact and motivation • Robust and centralized networks of key stakeholders to proactively leverage organizational strengths • Proactive use of social media and other collaboration platforms to capture water quality information and share	• Proactive communications to citizens regarding incidents and water quality issues • Water-centric culture, citizens "live" the values and are empowered to "go the extra mile" • Maximum use of stakeholders to engage and educate the public in an orchestrated and strategic way

Figure 12: Maturity matrix: Details (continued)

Criteria	Level 1	Level 2	Level 3	Level 4	Level 5
Finance, planning and management	• Planning and budgeting processes are separate, with minimal coordination • Manual compilation and validation of data for reporting • Pricing for water and wastewater does not link to usage • No structured approach to identity funding	• Planning and budgeting processes are separate, with moderate coordination • Some manual corrections/control in financial planning and data usage for decision making • County has some view of capital project priorities, but these are not fully informed	• Some alignment of planning and budgeting with strategic, long-term direction • Contains financial and non-financial data • Pricing for water links to usage; wastewater is not included in same billing system • Addresses priority projects for investment on a reactive basis • Basic KPIs in place	• Planning and budgeting aligned to strategize together for the long term • Key investment milestones are built into plans and budgets, with various options for funding streams and resource needs in place • Proactive management and diversified funding streams	• Planning and budgeting are web based, and processes are fully integrated reporting tools • Optimized pricing model that allows County to explore pricing and project scenarios • Pricing for water and wastewater directly linked to usage in the same billing system – parity across population
Governance and compliance	• Compliance reporting is manual • County stakeholders do not as a rule collaborate with water agencies • Enforcement of water quality regulation violations does not exist • Local regulations do not allow for innovative and new technologies to improve wastewater treatment processes • Informal and reactive discussions at the state level	• Delay in identifying compliance events, with moderate risk of legal or cost implications • Some exceptions given for new technology but after tedious application process • Enforcement for water quality regulation violations exists but is not regularly performed • Local initiatives to drive improvements in water quality and water use • Compliance management seen as core competence	• County shares compliance data between departments and water agencies • New technology permits issued in a timely manner • User's consumption is not fully customized or tied to wastewater treatment • Regular enforcement of treatment systems compliance occurs • Common understanding forming of how state, County and local entities work together	• An integrated view aligning financial, environmental and societal factors linked to citizen compliance for wastewater • County allows pilots for new and advanced technologies for wastewater • Enforcement and public awareness are linked and communicated regularly to citizens • Consistent levels of quality across County with systematic sharing • Informal collaboration between state, County and towns on compliance	• County manages enforcement by a predetermined schedule • County prioritizes key areas for enforcement and system upgrade • Stakeholders share data related to water quality compliance — two way sharing • Pull from communities to identify initiatives for improving water quality • Aligned and working closely at state level on common goals and compliance issues

Figure 12: Maturity matrix: Details (continued)

E. Estimates

The team estimated order of magnitude implementation costs for each of its 11 recommendations to Suffolk County. We categorized these implementations as low, medium and high. Low costs are under US $1 million, medium costs are up to US $10 million and high costs are up to US $30 million. These estimates are designed to help the County support its planning activities.

Recommendation description	Estimated cost of implementation	Potential benefit/revenue
1. Finalize and deploy a robust and integrated Water Resource Plan	< $10 m	
2. Operate the sewage treatment plant network under the control of the Department of Public Works	< $30 m	Revenue ~ $50 m
3. Integrate water and wastewater operations	< $10 m	Lab consolidation
4. Establish a framework to visualize, monitor and manage water quality	< $10 m	Savings in licenses, application support
5. Establish governance to enable the installation of appropriate technology and to motivate responsible behavior	< $1 m	
6. Excite communities to embrace the solutions for improving water quality	< $1 m	
7. Create a structure to drive compliance	< $1 m	
8. Continue to develop a funding mechanism	< $10 m	
9. Develop workforce model and practices to meet future needs	< $30 m	
10. Adapt the business processes in the Department of Public Works and the Department of Health Service to meet expanded integrated water management responsibilities	< $10 m	Process savings
11. Establish a framework for decentralized wastewater handling solutions	< $10 m	

Figure 13: Estimate of costs and potential benefits: Order of magnitude

F. The water cycle

We strongly recommend that Suffolk County consider the full water cycle in its future planning and management of water quality to help ensure an integrated approach. The water cycle is the full cycle of water, from precipitation through water treatment, distribution, use, collection, wastewater treatment and return to the source (see Figure 14).

We included a set of statements as suggestions for key objectives and outcomes that Suffolk County may want to adopt as a set of outcomes for an integrated approach to water and wastewater management.

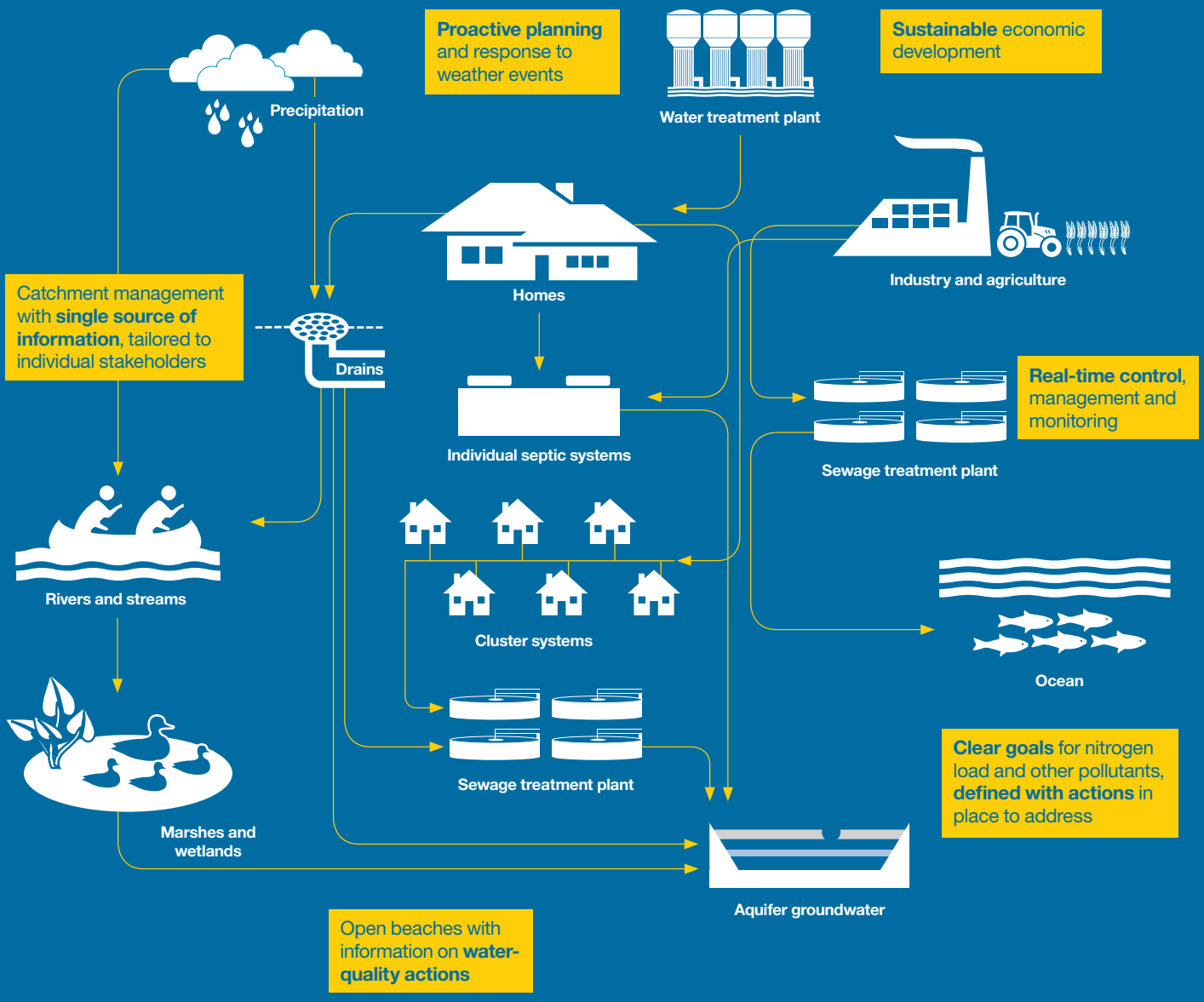


Figure 14: The water cycle with key objectives and outcomes from an integrated approach

G. Core operational and customer cycles for best practices in a combined water and wastewater company

In a combined water and wastewater company there are three core cycles:

1. The asset lifecycle

This cycle begins with long-term investment planning to determine capital needs. The next phase is the delivery of the capital assets, as prioritized during investment planning, and ongoing asset maintenance and operation. At the end of an asset's lifecycle, which is typically 30 years but varies depending on the asset, it is decommissioned.

2. The work management lifecycle

This cycle focuses on the daily activities behind the execution of planned and unplanned work. The goal is to operate and maintain the assets in a way that will ensure continued delivery of water and wastewater services while maximizing the life of the assets. This cycle integrates and optimizes the asset maintenance plans, addressing emergency and proactive work with the available skills, resources, materials and equipment.

3. The customer lifecycle

From meter reading to receiving and handling customer calls to processing bills, this lifecycle encompasses all customer contact.

These lifecycles are key to delivering best practices within water and wastewater utilities companies. In recent years, companies have focused on the following best practice areas:

- Integration across the three lifecycles to enable end-to-end visibility of processes to better serve customers
- Using a single asset hierarchy and integrated register to manage both financial and operational processes in an integrated manner
- Improving the customer experience and responsiveness to customer requests/complaints
- Integrated asset management for improved performance, proactive maintenance and reduced costs from installation through to decommission
- Increased mobile field work to capture data at its source
- Improved reporting to provide real-time or nearly real-time performance analysis to support decision making

Figures 15 and 16 illustrate these three lifecycles, as well as best practices in water utilities.

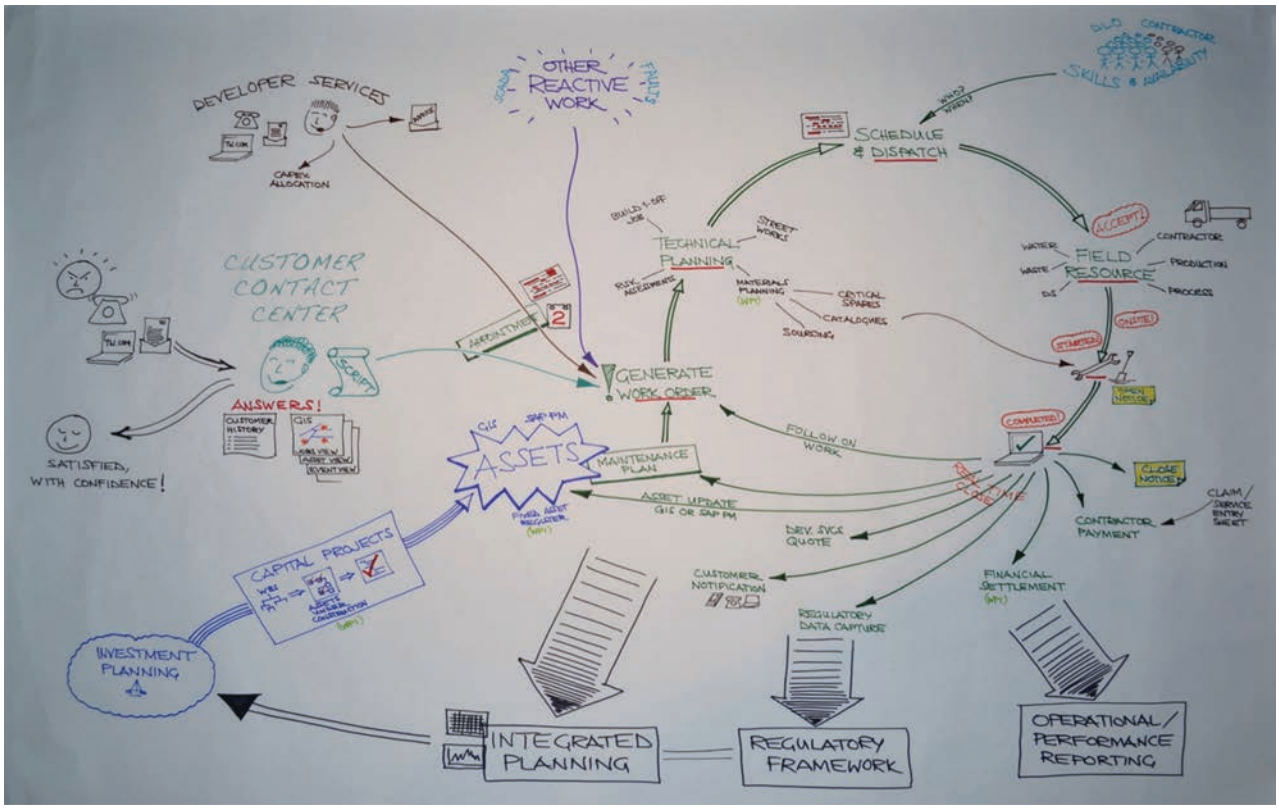
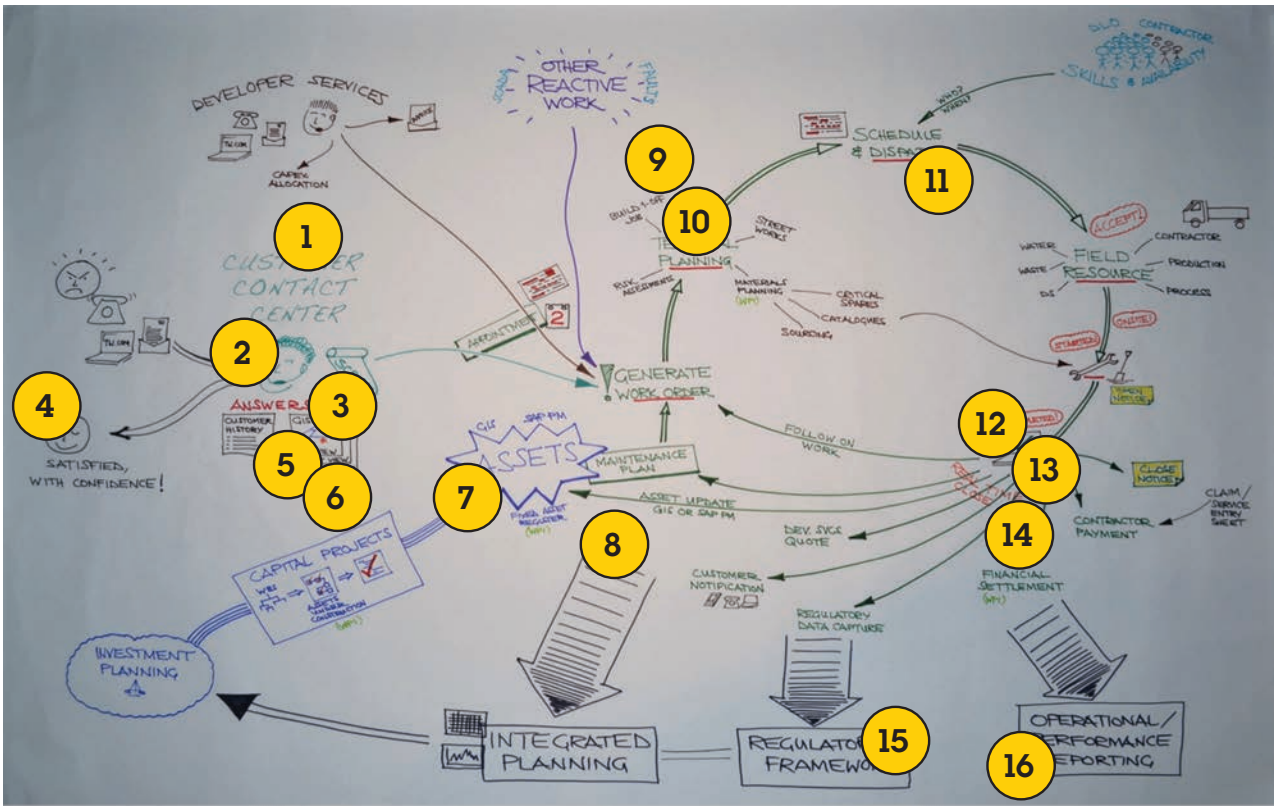


Figure 15: Managing water and wastewater services, from investment planning to work execution and billing



1. Booking appointments during the call based on the schedule
2. Structured scripts to improve the customer experience
3. Automation of penalty payments
4. Customer correspondence visible to agents
5. Real-time visibility of events and work for the contact
6. Integrated planning solution for waste process
7. Commissioning and depreciation of assets at an equipment level
8. Process-centric asset hierarchy integrated to fixed asset register
9. Using attachments via web services to help manage
10. Technical planning workbench provides an integrated solution to plan work in line with customer need, permitting, notices and availability of resource
11. Scheduling solution for sampling
12. Fully integrated purchase to pay for contract work
13. Mobile GIS and GPS integration data capture at source
14. Real-time visibility of work order status and data captured
15. Performance and monitoring framework
16. Daily dashboard to help drive performance

Figure 16: Best practices for managing water and wastewater services

H. Assessment of EPA management models for Suffolk County

Suffolk County should consider applying the EPA Management Model methodology for oversight of its decentralized wastewater treatment systems. In order to apply any of the models, it is critical that Suffolk County establish an inventory of on-site and cluster systems. For simplicity and efficiency, we recommend Suffolk County pursue one county-wide model described in the EPA Management Model Summary Assessment table below. The County should pursue Model 3 for its short-term goals. For cluster systems, we recommend Model 4 as a long-term goal. Program features that Suffolk County must develop to advance along the maturity curve are in red text.

Table 1: Summary of management models

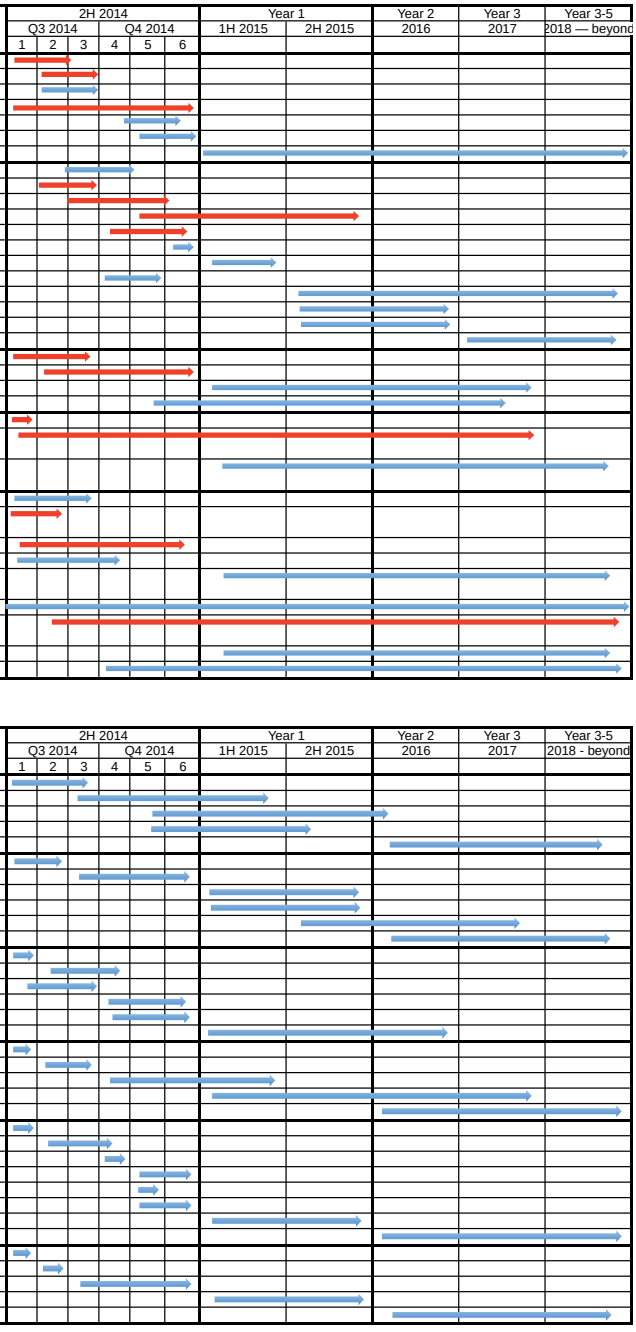
Typical applications	Program description	Comments
MODEL 1 — Homeowner awareness model		
• Areas of low environmental sensitivity where sites are suitable for conventional on-site systems.	• Systems properly sited and constructed based on prescribed criteria. • Owners made aware of maintenance needs through reminders. • Inventory of all systems.	As a baseline for implementing any EPA management model, Suffolk County should prioritize creating an inventory of all on-site systems in the county.
MODEL 2 — Maintenance contract model		
• Areas of low to moderate environmental sensitivity where sites are marginally suitable for conventional on-site systems due to small lots, shallow soils or low-permeability soils. • Small clustered systems.	• Systems properly sited and constructed. • More complex treatment options, including mechanical components or small clusters of homes. • Requires service contracts to be maintained. • Inventory of all systems. • Service contract tracking system.	This model is not recommended for Suffolk County.
MODEL 3 — Operating permit model		
• Areas of moderate environmental sensitivity, such as wellhead or source water protection zones, shellfish growing waters or bathing/water contact recreation. • Systems treating high-strength wastes or large-capacity systems.	• Establishes system performance and monitoring requirements. • Allows engineered designs but may provide prescriptive designs for specific receiving environments. • Regulatory oversight by issuing renewable operating permits that may be revoked for noncompliance. • Inventory of all systems. • Tracking system for operating permit and compliance monitoring. • Minimum for large capacity systems.	Model 3 is a recommended near-term model for Suffolk County. Tracking of performance and monitoring mechanisms must be developed in order to manage under this model.
MODEL 4 — Responsible management entity (RME) operation and maintenance model		
• Areas of moderate to high environmental sensitivity where reliable and sustainable system operation and maintenance (O&M) is required, e.g., sole source aquifers, wellhead or source water protection zones, critical aquatic habitats or outstanding value resource waters. • Clustered systems.	• Establishes system performance and monitoring requirements. • Professional O&M services through RME (either public or private). • Provides regulatory oversight by issuing operating or NPDES permits directly to the RME. (System ownership remains with the property owner.) • Inventory of all systems. • Tracking system for operating permit and compliance monitoring.	Model 4 is a recommended target model for Suffolk County. Robust inventory, performance requirements and monitoring mechanisms must be established. Once this baseline has been established, Suffolk County can consider defining an RME model to operate and maintain on-site systems.
MODEL 5 — Responsible management entity (RME) ownership model		
• Areas of greatest environmental sensitivity where reliable management is required. Includes sole source aquifers, wellhead or source water protection zones, critical aquatic habitats or outstanding value resource waters. • Preferred management program for clustered systems serving multiple properties under different ownership (e.g., subdivisions).	• Establishes system performance and monitoring requirements. • Professional management of all aspects of decentralized systems through public/private RMEs that own or manage individual systems. • Qualified, trained owners and licensed professional owners/operators. • Provides regulatory oversight by issuing operating or NPDES permit. • Inventory of all systems. • Tracking system for operating permit and compliance monitoring.	Model 5 is at the upper end of the maturity curve and may be assessed at a future date. A cost-benefit analysis should be conducted to understand if the cost of training and implementation for the entire population would support the benefit for the additional requirements of this model.

I. Roadmap of recommendations

The team defined key milestones and estimated timescales for each of the recommendations. We have not accounted for wider County timescales or initiatives in preparing this roadmap should more time be necessary. The intent of this roadmap is to provide input for the County's overall planning to develop an integrated plan.

#	Recommendation	Pr.	Owner/sponsor	Key milestones and action
1	Finalize and deploy a robust and integrated Water Resource Plan	1	Department of Economic Development and Planning	Fund and recruit transformation leader
				Establish goal for nitrogen load allocation
				Identify and agree other pollutant goals
				Build water resource plan
				Define plan's governance
				Define maintenance to keep the plan on track
				Deploy plan: launch actions and measure progress
4	Establish a framework to visualize, monitor and manage water quality	1	Deputy County Executive — Operations	Establish a new integrated IT Team
				Kick off data migration project
				Identify top priority data sources to integrate
				Implement model in phased approach
				Establish platform and tool for consolidation
				Enable access to integrated model
				Migrate applications
				Define overall data governance and objectives
				Continued integration of common information model
				Develop resilient disaster recovery strategy
				Consolidate distributed County data centers
				Enable mobility
6	Excite communities to embrace the solutions for improving water quality	1	Department of Economic Development and Planning	Establish metrics for Blue Flag
				Establish online water quality portal/social media strategy
				Provide data on beach environment/Blue Flag status to public
				Create long-term engagement plan for organizations
8	Continue to develop funding mechanism	1	Deputy County Executive — Finance	Appoint funding leader
				Explore and exercise all sources of funding immediately — ongoing until goals attained
				Establish ongoing management and tracking to targets of the funding structure
11	Establish a framework for decentralized wastewater handling solutions	1	Department of Health Services	Gather knowledge/provide information re: decentralized systems
				Define guideline for selection of appropriate on-site and cluster technology
				Establish a register of onsite/cluster
				Provide guidelines and training information for private operators
				Certification and inspection for ongoing management of quality and operation
				Establish inspection record information systems
				Establish a regulation ensuring the implementation or upgrade of onsite treatment when renovation/ownership changes
				Establish Low N Certified for properties
				Definition of long-term technology and innovation

#	Recommendation	Pr.	Owner/sponsor	Key milestones and action
2	Operate the STP network under the control of the SCDPW	2	Head of DPW	Develop criteria and priority for transfer
				Define approach to management and control of STPs
				High priority STPs transferred
				Service meetings in place with privately run STPs
				2nd tranche priority plants transferred
3	Integrate water and wastewater operations	4	Head of DPW and Head of SCWA	Develop business case
				Define target operating model
				Information plan/budget defined
				Agree with unions on working structures
				Transition and consolidation of shared services
				Transition and implementation of combined operations
5	Establish governance to enable the installation of appropriate technology and to motivate responsible behavior	3	Director of the Department of Health Services	Apply for septic repair program for pilot septic systems
				Select pilot technology system and residents to install new systems
				Communication strategy
				Construct governance structure to monitor, enforce
				Update DHS Sanitation Code for new tech
				Continue incentive programs for upgraded septic
7	Create a structure to drive compliance	3	Suffolk County Department of Health Services	Kick off compliance task force
				Confirm initial high-priority measures for compliance (align w/4)
				Measurement
				Execution of compliance
				Annually review critical KPIs, validate and modify as appropriate
9	Develop workforce model and practices to meet future needs	2	Director of the Department of Public Works and Director of the Department of Health Services	Establish staffing leader and kick off project
				Map workflow processes, determine inputs
				Gap analysis
				Develop strategy for supply of skills
				Succession planning
				Gain financial support
				Execute staffing plan
				Establish regular staffing cadence
10	Adapt the business processes in the SCDPW and the SCDHS to meet expanded integrated water management responsibilities	3	Director of the Department of Public Works and Director of the Department of Health Services	Assign process improvement leader, kick off
				Determine priority processes, change agent
				Run value stream mapping workshops
				Execute improvement actions
				Establish ongoing continuous improvement program



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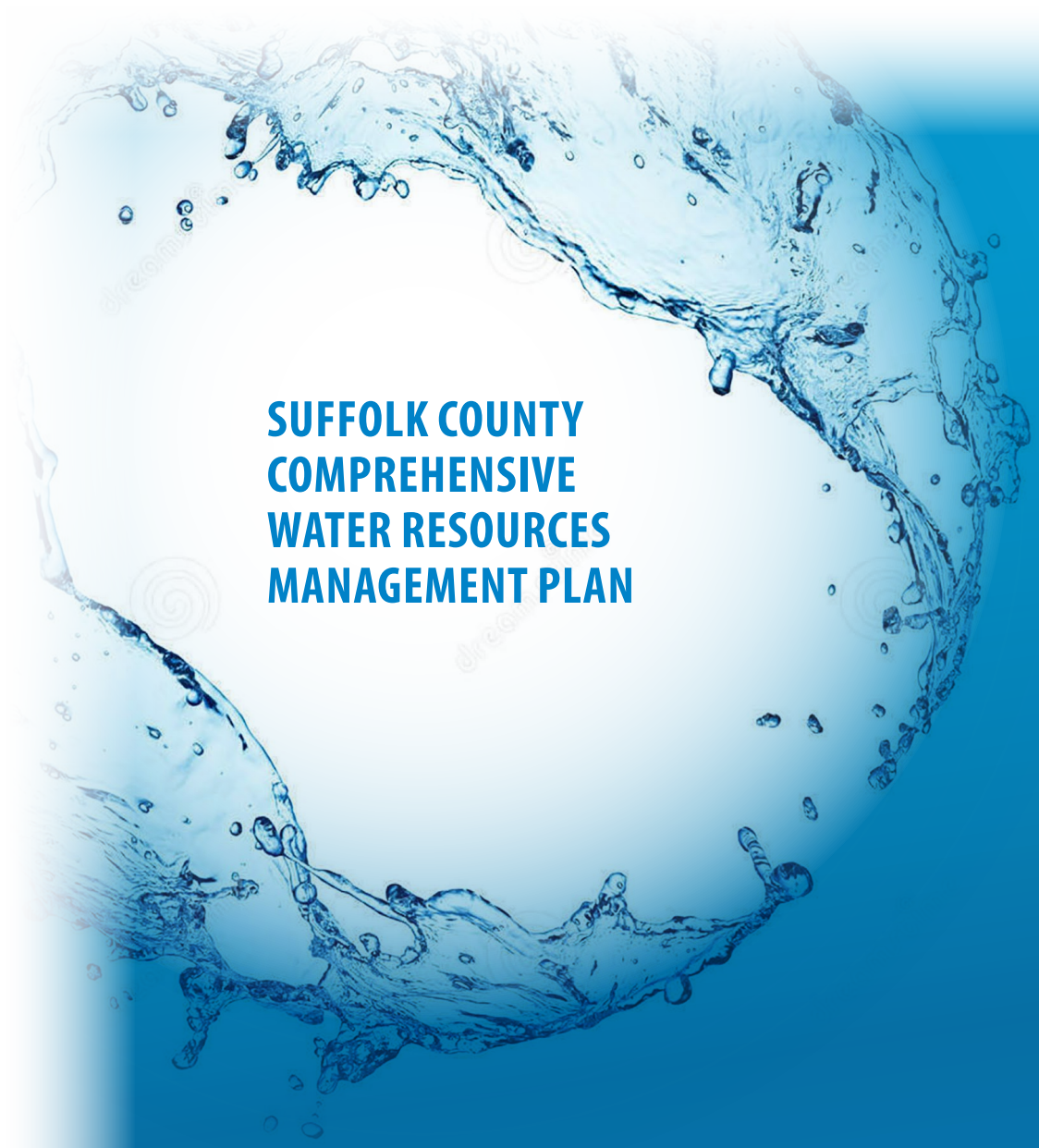


SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Section 3
GROUNDWATER RESOURCES

Source Water Assessments

Recognizing that activities in a water supply's source water area have a significant potential to affect water quality of the potable supply, the New York State Department of Health (NYSDOH) directed the development of Source Water Assessments for all public supply wells in Suffolk County in 2003.

As part of this Plan, updated source water assessments were completed for all community supply wells in Suffolk County. The source water assessments have three major components:

Use of three dimensional groundwater flow and contaminant transport models to delineate the area contributing recharge to each well (source water area), and to estimate the average time of travel from the water table to the well screen;

Use of GIS and extensive databases to identify the prevalence of each contaminant category within the source water area, based upon land uses and the presence of potential point sources of contamination;

Evaluation of the susceptibility of each well to potential contamination, based upon contaminant prevalence, contaminant fate and transport characteristics, and travel time from the water table to the well screen.

A sample source water assessment report for SCWA's Woodchuck Hollow Road is included at the end of this chapter.

Section 3
Groundwater Resources

3.1 Problem Identification

Protection of Suffolk County's groundwater resources has long been of concern in Suffolk County, both because groundwater provides the sole source of potable water supply to County residents, and because it provides baseflow to the County's surface waters. The 1987 Suffolk County Comprehensive Water Resources Management Plan (hereinafter referred to as the **1987 Comp Plan**) provided extensive documentation of the County's aquifer system, groundwater quantity, and groundwater quality that is not repeated here. This section describes how updated information, databases and new tools were used to build upon earlier studies, to enhance the understanding of the aquifer system, to define groundwater quality and quantity issues facing Suffolk County, and to begin to develop the information necessary to help to guide future resource management decisions.

3.1.1 Groundwater Quality

3.1.1.1 Background

Suffolk County's 1.5 million residents live directly on top of the County's water supply. It is not surprising that the impacts of human activities above ground are observed in the groundwater below. Due to the concerted efforts of water resource managers, in general, groundwater quality throughout most of Suffolk County continues to be very good. Potable water supplied by community water systems in Suffolk County meets all drinking water quality standards. However, review of water quality data reveals that concentrations of key contaminants found in groundwater have increased in some areas over the almost three decades since the **1987 Comp Plan** was completed.

Water resource managers have long recognized that land uses and activities occurring above ground can have a direct impact upon groundwater quality, as recharging precipitation can transport dissolved contaminants down through the unsaturated zone to the underlying aquifer. Currently, New York State Department of Environmental Conservation (NYSDEC) has established groundwater quality criteria for over one hundred contaminants, although improved analytical capabilities allow detection of hundreds more, at increasingly lower concentrations.

This study focused on those contaminants of potential concern that have been identified in Suffolk County groundwater. Nitrate has long been identified as

Timeline of Significant Legislation & Regulations

1948: Federal Water Pollution Control Act (Clean Water Act)

1972: Amendments to Clean Water Act
NPDES permit program

1974: Safe Drinking Water Act (SDWA)

1976: National Interim Primary Drinking Water Regulations
2,4-D, coliform bacteria, nitrate, others (total of 22)

1987: Regulation of Phase I VOCs
Benzene, carbon tetrachloride, 1,1,1-TCA, TCE, others

1991: Regulation of Phase II Contaminants
List expands to include aldicarb, atrazine, carbofuran, total nitrate -- nitrite, PCE, others (total of 61)

Lead and Copper Rule

1992: Regulation of Phase V
List expands to include dioxin, PAHs, simazine, others (84 total)

1995: New York State Action Level established for perchlorate at 18 µg/L

1996: Amendments to SDWA
Establishes SWAP

1998: Stage I Disinfection Byproducts Rule

2004: New York State Drinking Water Standard for MTBE established at 10 µg/L

2006: Groundwater Rule

2010: USEPA identifies testing of 134 chemicals as potential endocrine disruptors

the inorganic parameter causing the most widespread concern; increased levels of nitrates resulting from overlying land uses have been documented in Suffolk County for many years. Contamination by volatile organic compounds (VOCs) and pesticides has also previously been identified as a serious threat to groundwater quality (Dvirka and Bartilucci, 1987, CDM, 1998). Since 1987, additional contaminants of concern, such as perchlorate, 1,4-dioxane and pharmaceuticals and personal care products (PPCPs) have also been identified in groundwater.

A wide variety of regulatory programs have been developed and implemented over the years to address potential sources of groundwater contamination and to prevent pollutants from being introduced to the aquifers. The sanitary sewering program that was implemented in southwest Suffolk County and other densely developed parts of Suffolk County has been effective in reducing groundwater contamination from sanitary, commercial, and industrial wastewaters (**Task 1C Report, Groundwater Quality and Monitoring Programs**, Long Island Source Water Assessment Program, CDM, 2003). Sanitary sewers continue to reduce the levels of nitrates, detergents, and other contaminants associated with wastewater from reaching the groundwater in these areas. Discharges from industrial and commercial facilities are regulated, and monitoring and enforcement activities have been implemented to reduce the impacts of VOCs on groundwater supplies. Implementation of land use restrictions and the purchase of large tracts of open space for preservation and groundwater protection have also helped to protect groundwater quality in targeted areas. Regulatory bans and voluntary restrictions on products of concern such as phosphate detergents and certain pesticides have also been effective in reducing the amount of contaminants introduced to the aquifer.

Nevertheless, Suffolk County remains largely unsewered, and contamination of the County's groundwater resource remains a concern, particularly in the unsewered parts of the County. Existing data and tools were used to assess the impacts of various types of development on groundwater quality as described in the following pages. In particular, tools were developed to assess the impacts of proposed developments or changes in land use on nitrate levels, as described in more detail below.

During this study, groundwater quality data collected by Suffolk County Department of Health Services (SCDHS) and the Suffolk County Water Authority (SCWA) was used to characterize current groundwater conditions in the County. Changes in groundwater quality since completion of the **1987 Comp Plan,** as indicated by changes in the concentrations of representative water quality parameters measured at public supply wells, were documented to:

The Long Island Source Water Assessment Program (SWAP) evaluated the susceptibility of public supply wells to nitrate contamination by considering land uses and travel times within each supply well's recharge area. As discussed in the SWAP documentation and in the Task 5.5 memorandum entitled ***Refined Source Water Assessments*** (CDM, 2009), each land use type present in a well's source water area has a different potential to introduce specific contaminants to underlying groundwater. Both high density unsewered residential areas and agricultural areas were considered to have a high potential to release nitrate to the underlying groundwater.

At the time that the source water assessments were developed, SCDHS reported that approximately 75 percent of the County's population relied on on-site sanitary wastewater disposal systems for wastewater management (***Report on the Sewage Treatment Facilities of Suffolk County*, draft, SCDHS, 2006**). Because land uses and wastewater management in Suffolk County have a high potential to introduce nitrate to the groundwater system, and because of the persistence and mobility of nitrates in groundwater, sixty six percent of community supply wells have a high or very high susceptibility to nitrate contamination.

- Assess the impacts of continued development upon groundwater quality;
- Assess the effectiveness of existing groundwater resource protection programs, and
- Identify additional resource management needs.

The relationships between land use and groundwater quality assessments presented in this document are built upon the information developed during earlier studies using:

- More extensive information (the databases available to characterize water quality parameters measured at community, non-community and private supply wells and monitoring wells, land use maps and facility mappings) and
- More powerful tools (Geographic Information System capabilities and calibrated three dimensional groundwater flow and contaminant transport models).

SCDHS developed the assessments presented here to improve the understanding of the relationships between land use and groundwater quality that were presented in the **1987 Comp Plan,** and to develop the information necessary to help to guide future resource management decisions. A summary of these evaluations is presented in the following pages; more detailed information and reference materials are presented in the Task 4, Task 5 and Task 11 memoranda.

3.1.1.2 Contaminants of Concern

This study's assessment of groundwater quality focused upon both those contaminants that have historically been identified as contaminants of concern, and documented in the **1987 Comp Plan**, and contaminants of potential health concern that have been detected during the County's sampling programs. The contaminants evaluated during this study include:

- Nitrate;
- Three of the most commonly detected VOCs Suffolk County groundwater in 1987, 2005 and 2013 (tetrachloroethylene, trichloroethylene and 1,1,1-trichloroethane;
- MTBE;
- Perchlorate;

- Pesticides; and
- Emerging contaminants of concern including PPCPs, 1, 4-dioxane, chlorate and hexavalent chromium.

3.1.1.3 Nitrate

Susceptibility to Nitrate Contamination

The impacts of anthropogenic sources of nitrogen on groundwater quality are much greater than the impact of natural sources of nitrate in the environment, such as precipitation and decaying biological matter. Anthropogenic sources of nitrogen include on-site sanitary wastewater disposal in unsewered areas, sewage treatment plant discharges to groundwater, application of fertilizer to agricultural land, and use of turf care products on lawns and golf courses. Excess nitrogen in the environment can contaminate groundwater and the County's drinking water supplies. In addition, because the groundwater discharges to surface waters, high nitrogen levels can negatively impact marine and fresh water ecological resources by contributing to algal blooms that can reduce dissolved oxygen levels and result in fish kills.

Anthropogenic sources of nitrogen include on-site sanitary wastewater disposal in unsewered areas, sewage treatment plant discharges to groundwater, application of fertilizer to agricultural land, and use of turf care products on lawns and golf courses.

Pre-development nitrate (nitrate as nitrogen, referred to as "nitrate" throughout this Plan) levels in the upper glacial aquifer were less than 1 milligram per liter (mg/L), and pre-development nitrate levels in the deeper Magothy and Lloyd aquifers were less than 0.05 mg/L (**1987 Comp Plan**). In undeveloped areas of the County, nitrate concentrations generally remain less than 1 mg/L, but in densely developed unsewered areas, data shows that nitrate concentrations in groundwater can exceed the 10 mg/L Maximum Contaminant Level (MCL) drinking water standard for nitrate, and in some agricultural areas, nitrate levels in private wells can still exceed 20 mg/L.

Because groundwater discharges to surface waters, high nitrogen levels can negatively impact marine and fresh water resources by contributing to algal blooms that can reduce dissolved oxygen levels and result in fish kills.

Nitrogen contamination resulting from disposal of sanitary wastewater and fertilization (associated with both residential and agricultural land uses) has been studied extensively and documented in the past (e.g., **Long Island Comprehensive Waste Treatment Management Plan,** hereinafter identified as the **208 Plan,** the **1987 Comp Plan,** various research projects at Stony Brook University and Cornell Cooperative Extension).This study used the work presented in the **208 Plan** and the **1987 Comp Plan** as the foundation for updated evaluations, using the more comprehensive databases, Geographic Information Systems (GIS) coverages of historical and contemporary land uses, and three dimensional calibrated groundwater modeling tools that are now available.

Figure 3-1 illustrates the susceptibility ratings for nitrate at community supply wells identified by the updated 2009 source water assessment analyses. Since

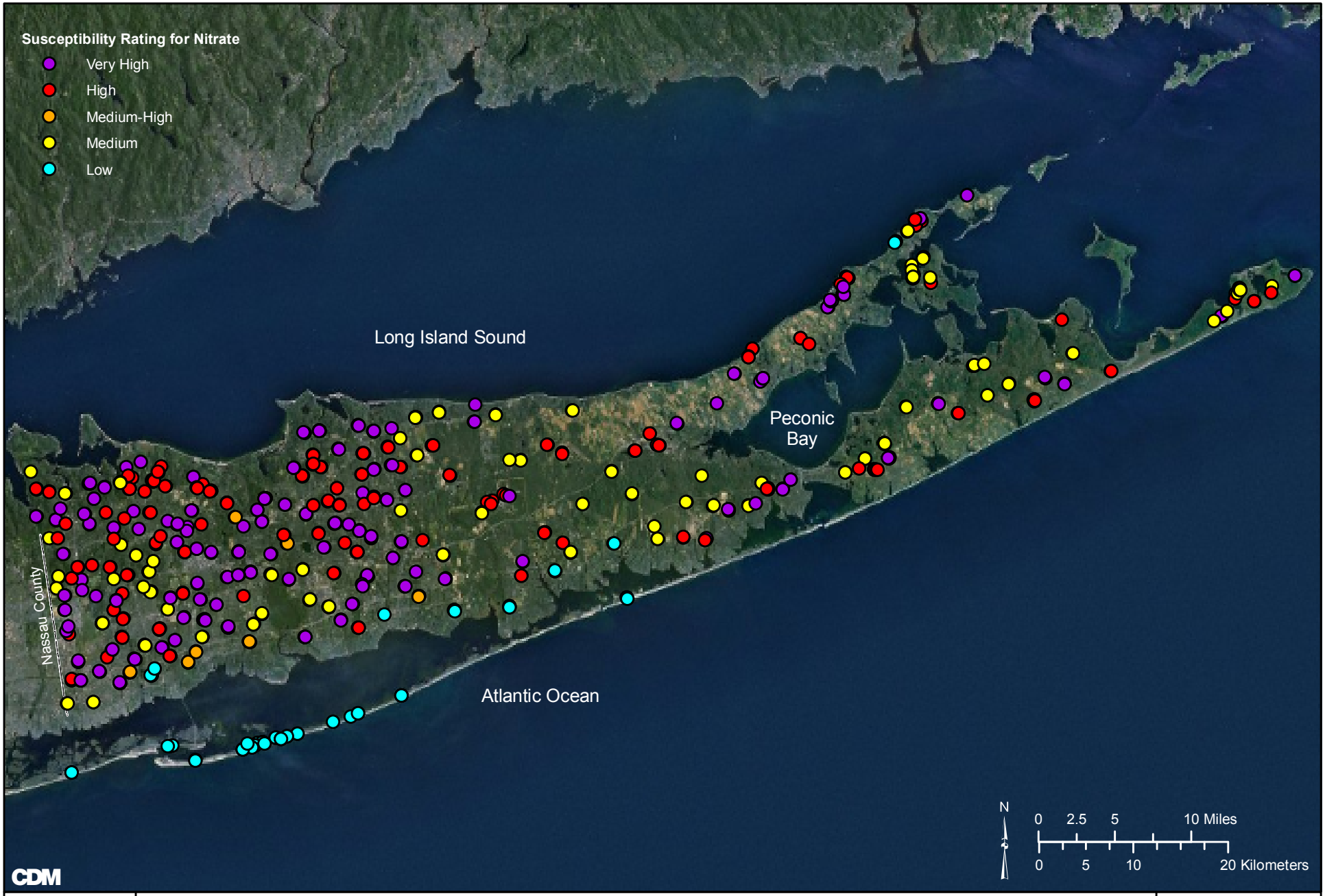
nitrate is a conservative contaminant in groundwater, these ratings are primarily a function of the land uses within the contributing areas (see the Task 5.5 memoranda).

Community supply wells with very high susceptibility to nitrate contamination are scattered throughout the County, including unsewered densely developed areas in the western part of the County, and agricultural areas of the North Fork. The high susceptibility ratings do not imply that the wells will eventually become contaminated by nitrate, as a variety of resource management and pollution prevention programs have been implemented to protect groundwater from nitrate contamination. Nonetheless, the pattern of measured nitrate levels in community supply wells was generally consistent with the susceptibility rating results, summarized on **Figure 3-2**, which shows that nitrate concentrations (as indicated by nitrate measurements from 2000 through 2005 data) are much lower in wells with a medium or low susceptibility rating for nitrate. While the average nitrate concentration for community supply wells with a very high or high susceptibility rating for nitrate was 4.75 mg/L, the average nitrate concentrations in supply wells with medium and low susceptibility ratings were 1 mg/L and 0.1 mg/L, respectively. The susceptibility ratings indicating that the majority of community supply wells are vulnerable to nitrate contamination identify a need for additional groundwater protection measures.

Current Nitrate Levels in Suffolk County Groundwater

To characterize nitrate concentrations in each of the County's three aquifers, data from SCDHS's community and non-community well databases were used, because they provide consistent long term records of water quality at the same depths and geographic locations from year to year. This data was supplemented by data that SCDHS collected from private wells from 1997 through 2013 and from monitoring wells installed during focused investigations of the impacts of land uses such as agriculture and golf courses.

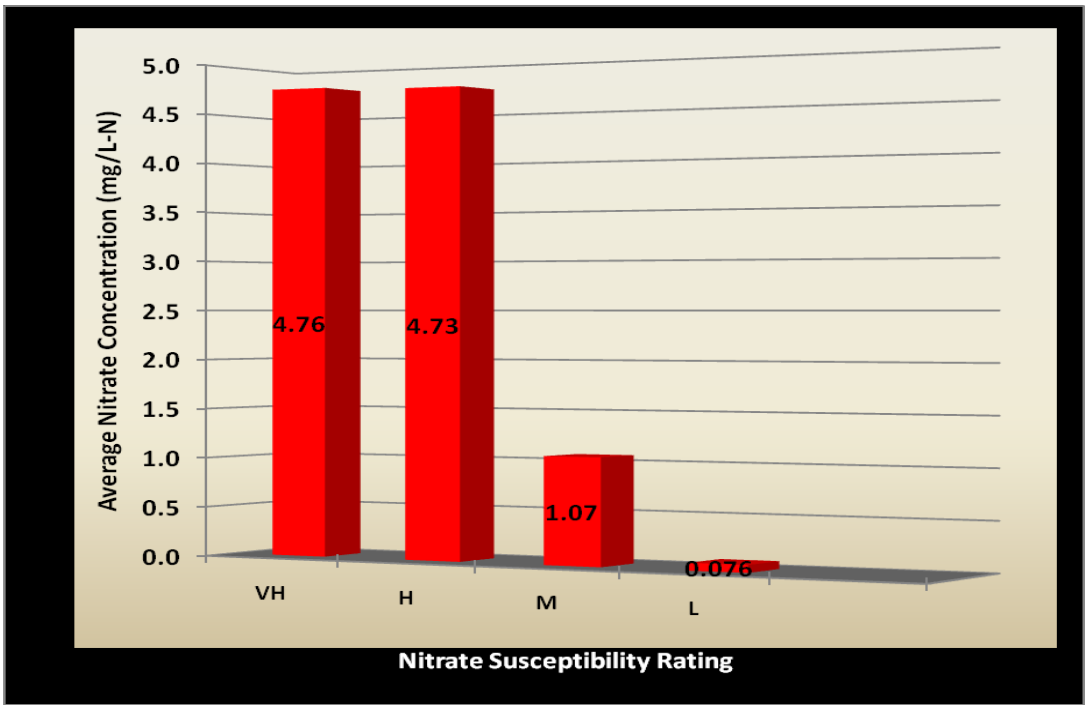
Average nitrate concentrations observed in community and non-community supply wells in 2013 are shown on **Figures 3-3a** through **3-3c** for the upper glacial, Magothy, and Lloyd aquifers respectively. Less than 1 mg/L of nitrate was reported in supply wells shown in blue, indicating very high quality groundwater. Nitrate concentrations are between 1 and 6 mg/L in wells shown in green, indicating some impact from development.



Community Supply Well Susceptibility Rating for Nitrate

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-1



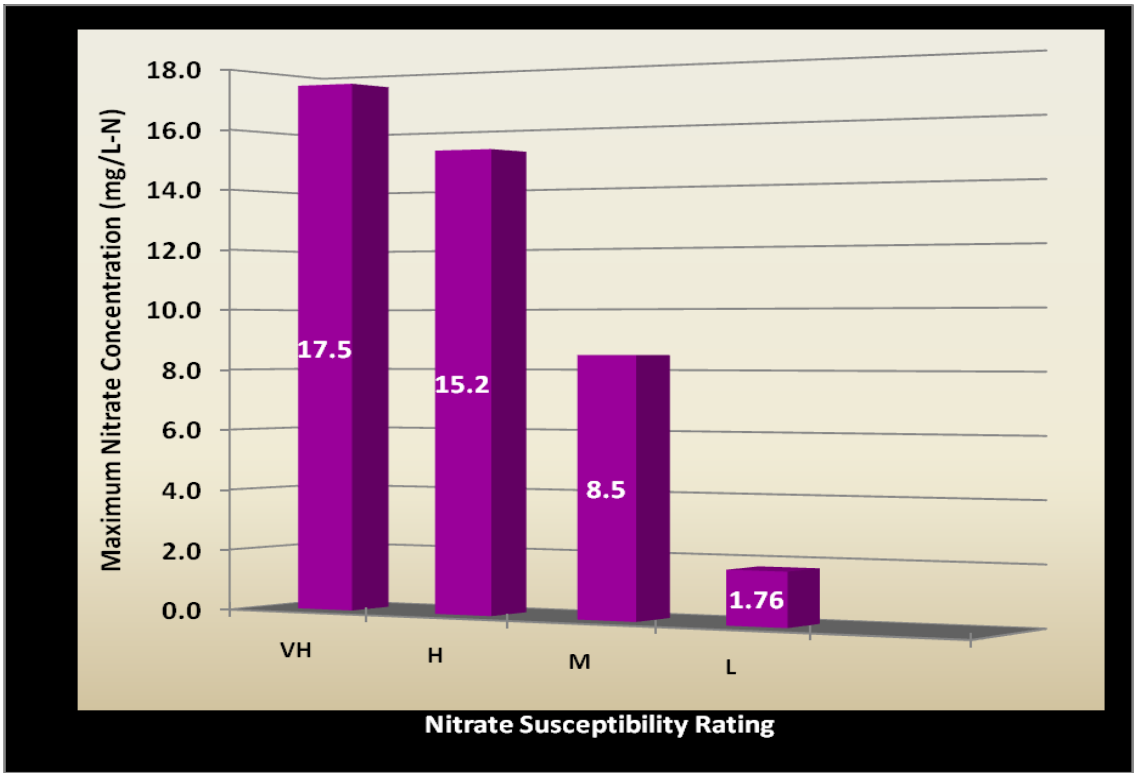


Figure 3-2 Relationship between Nitrate Susceptibility Ratings and Nitrate Concentrations in Community Supply Wells

Wells shown in yellow have reported nitrate concentrations between 6 and 10 mg/L; water from these wells is in compliance with the drinking water MCL of 10 mg/L, but has been clearly impacted by human activity. Samples collected from wells shown in red exceeded the drinking water MCL for nitrate - these wells have either been removed from service, or the water is treated to achieve drinking water standards before it is delivered to County residents.

To protect human health, Article 6 of the Suffolk County Sanitary Code established Groundwater Management Zones (GMZs) which seek to limit groundwater nitrogen concentrations to 4 mg/L in GMZs III, V, and VI and to 6 mg/L elsewhere, as shown on **Figure 3-4**.

Figure 3-3a shows that while nitrate levels in over 80 percent of the upper glacial supply wells are less than or equal to 6 mg/L, wells impacted by nitrate contamination are present throughout the County. Nitrate levels exceeding 6 mg/L were found in upper glacial supply wells located on the North Fork, an unsewered agricultural area, as well as the northwest and central parts of the County. **Figures 3-3b** and 3-**3c** show that in general, nitrate concentrations in the Magothy and Lloyd aquifers remain lower than in the upper glacial aquifer; ambient levels of less than 1 mg/L continue to be observed throughout the Magothy aquifer in the southern part of the County. Nitrate has been observed in excess of 6 mg/L in wells located in the unsewered areas of Huntington, Smithtown and northern Brookhaven.

Additional nitrate data was available from the private well testing program that SCDHS has implemented for five decades. **Figures 3-5a** and **3-5b**, a summary of nitrate levels measured in private wells by SCDHS from 1997 through 2006 and 2007 through 2013 respectively, provide additional information to characterize conditions within the upper glacial aquifer, where the vast majority of private wells are screened. While this large recent data set provides extensive information on the state of the upper glacial aquifer and contaminant occurrence in the County; there are several limitations associated with its use. Geographically, the monitoring is generally skewed to the eastern portions of the County where the majority of private wells exist. The data set is not random, as private wells are sampled by request and during surveys initiated by SCDHS in response to unusual or significant contaminant detections. In addition, repeat sampling of some wells may occur.

Private well sample results showed that almost a third of the private wells approached native groundwater quality, with nitrate levels less than 1 mg/L nitrate and nitrate concentrations in approximately 75 percent of the private wells sampled were less than or equal to 6 mg/L during both sampling periods.

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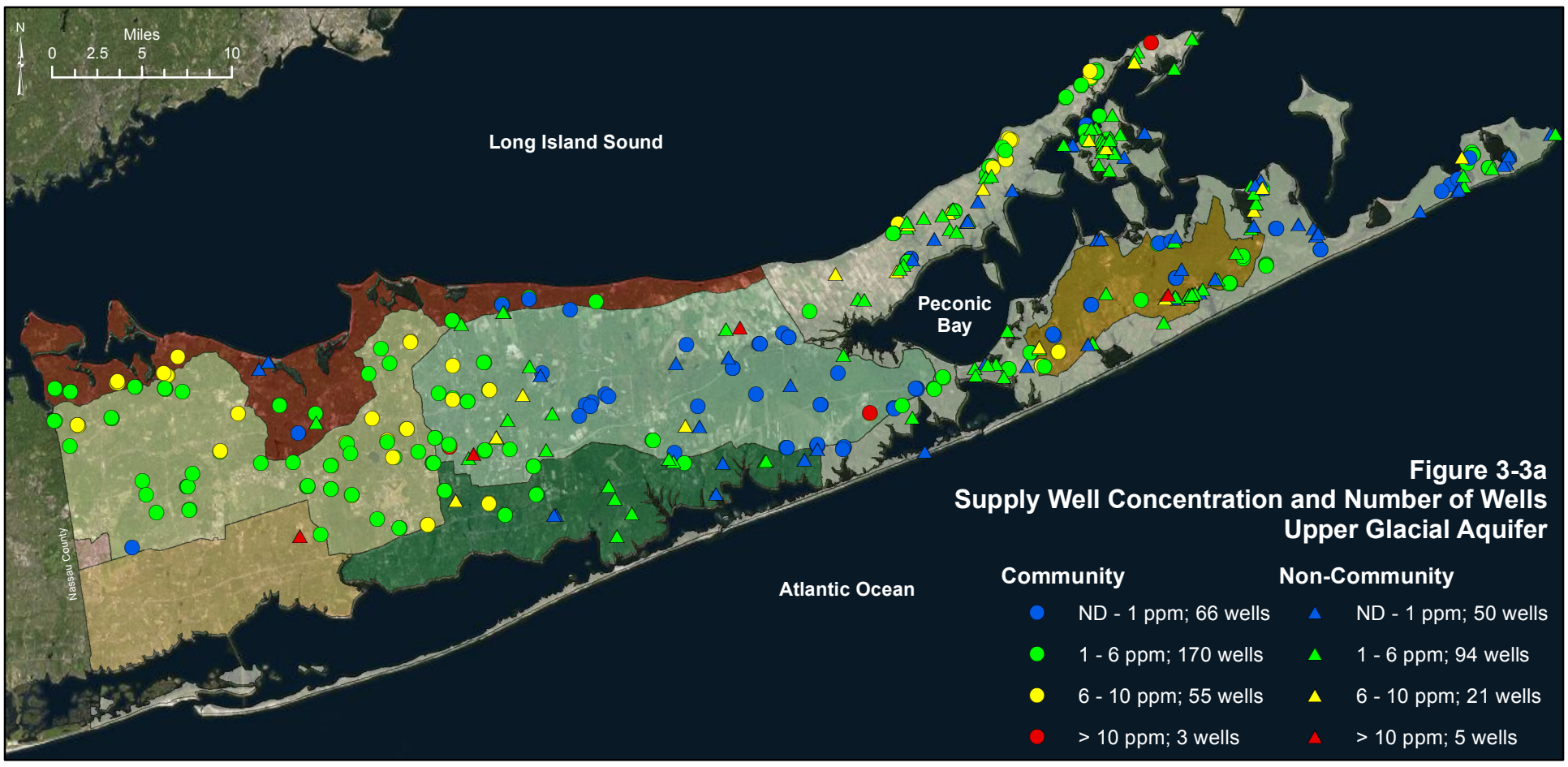
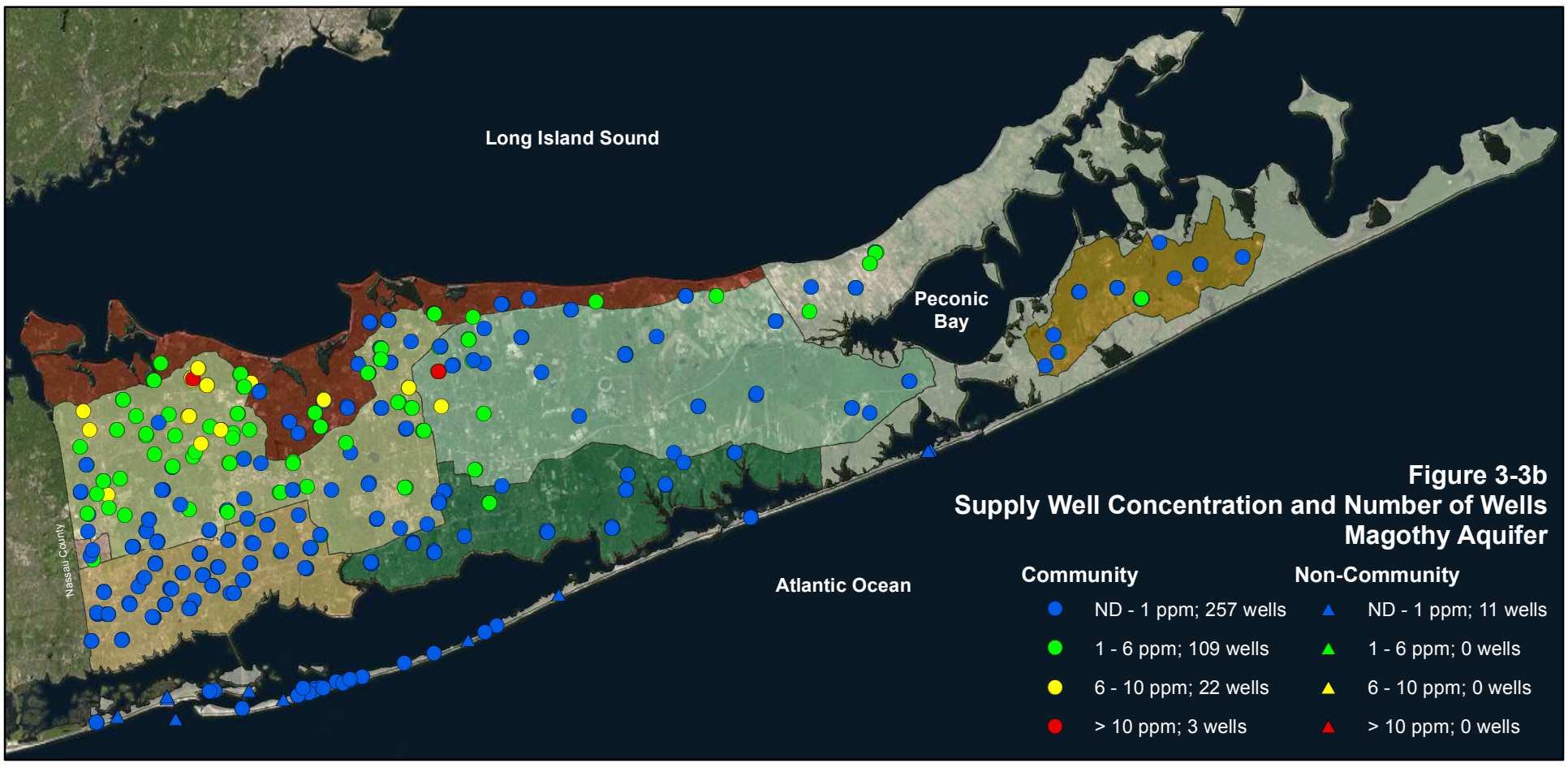
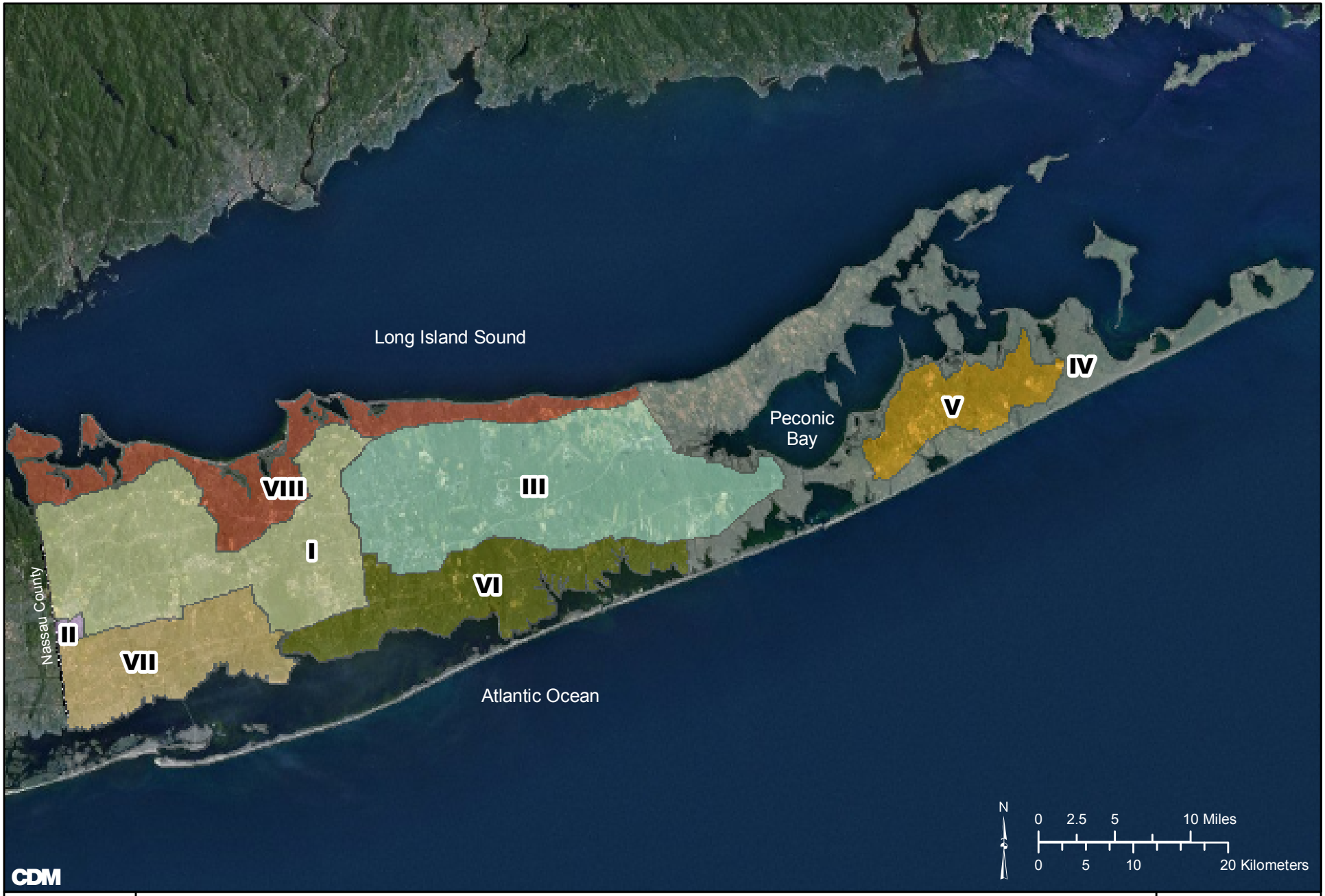




Average Nitrate Concentration in the Upper Glacial, Magothy & Lloyd Aquifers Community and Non-Community Supply Wells - 2013

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-3



Groundwater Management Zones

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-4

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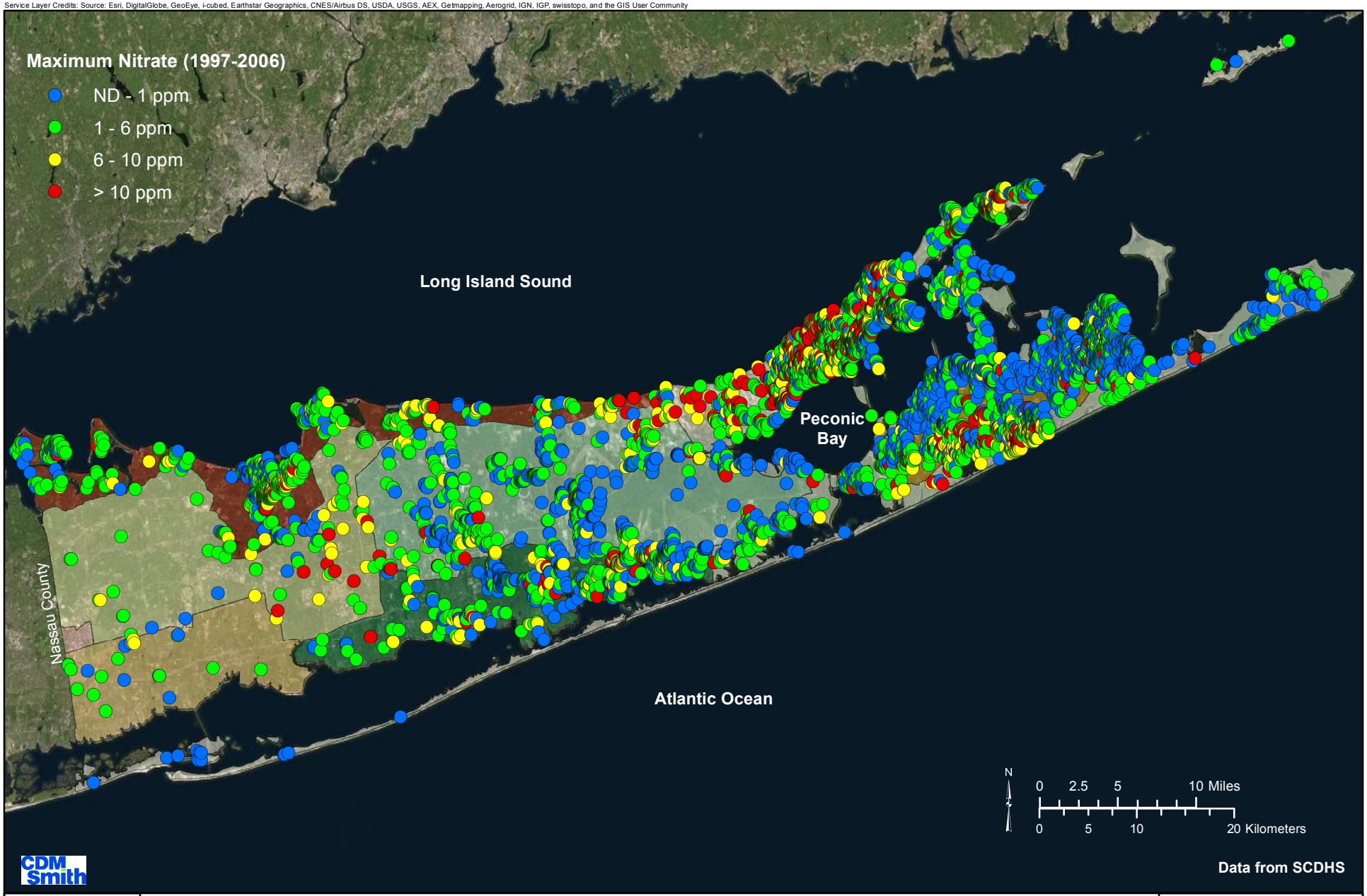

Maximum Nitrate Concentrations in Private Wells 1997 - 2006

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-5a

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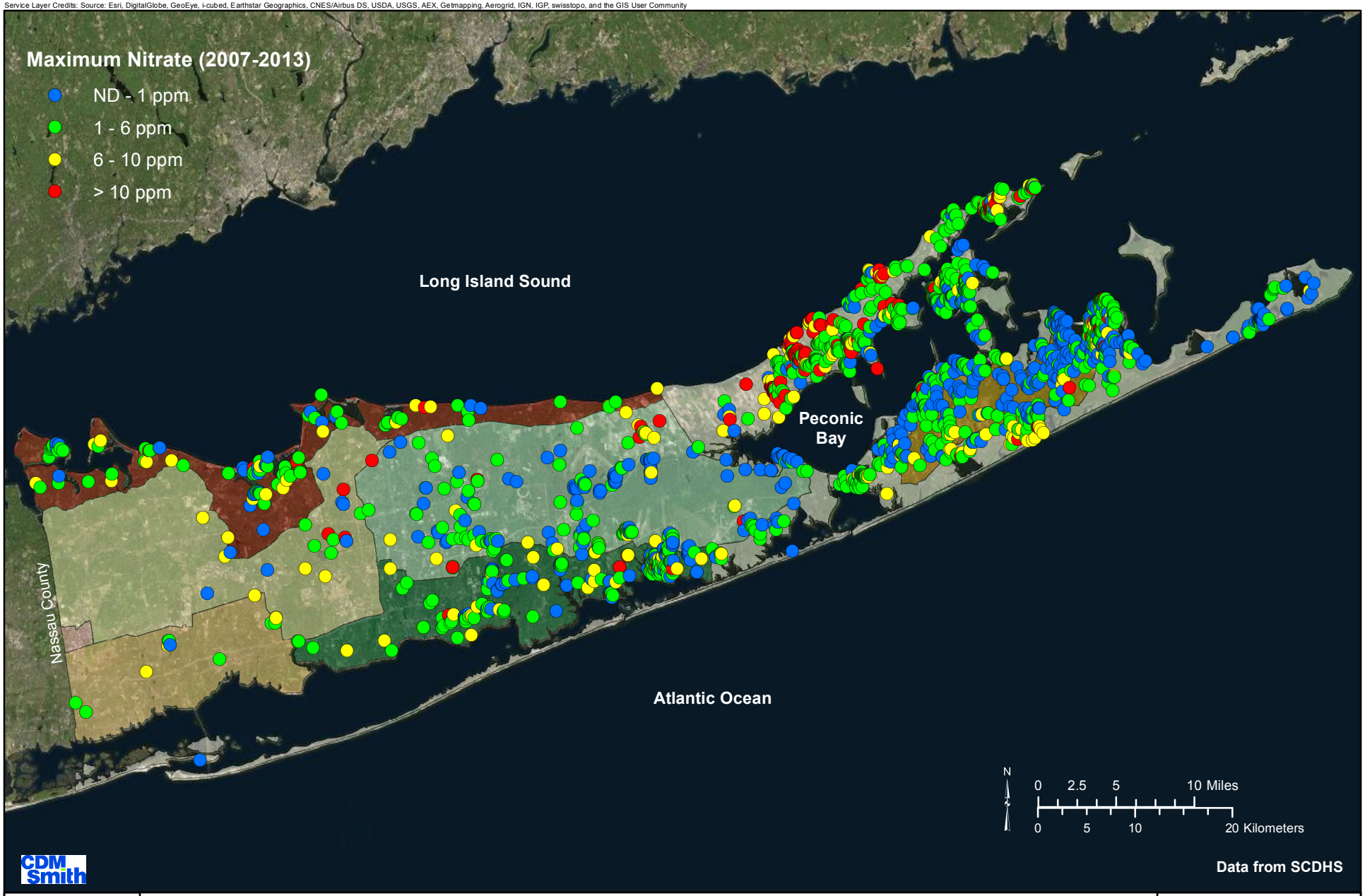


Maximum Nitrate Concentrations in Private Wells 2007 - 2013

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-5b

Nitrate levels in the same set of 175 public supply wells sampled in 1987 and 2013 have increased by an average of 1 mg/L, and nitrate levels in the same set of 213 Magothy public supply wells sampled in both 1987 and 2013 have increased by an average of 0.76 mg/L.

However, nitrate levels in nearly another third of the wells in the private well data base exceeded their respective GMZ target levels of 4 and 6 mg/L and nitrate levels in nearly ten percent of the 7,135 private wells sampled between 1997 and 2006 exceeded the 10 mg/L MCL. Fewer private wells were sampled between 2007 and 2013, but the pattern of contamination remained the same. Nitrate levels in nearly 25 percent of the wells for which coordinates were available (1,817) exceeded their respective GMZ target levels of 4 and 6 mg/L, and nitrate levels in approximately 7 percent of the 2,338 well samples collected from 2007 through 2013 exceeded the 10 mg/L MCL. Private wells impacted by nitrate contamination are located throughout the County, but most are found in agricultural areas of the North and South Forks and in pockets of the more densely developed unsewered areas of the north and south shores.

Changes in Nitrate Levels Since 1987

To assess changes in nitrate over time, average nitrate concentrations measured in community supply wells that were sampled in both 1987, (as documented in the ***1987 Comp Plan***) and in 2013 were compared. A summary of nitrate concentrations of samples taken from the same set of 390 public supply wells sampled in both 1987 and in 2013 is provided by **Table 3-1**. The data show that nitrate levels have increased in all three aquifers, and that nitrate concentrations in the same set of 175 upper glacial public supply wells sampled in both 1987 and 2013 have increased by an average of 1 mg/L as shown by **Figure 3-6a.** Nitrate concentrations in the same set of 213 Magothy public supply wells sampled in both 1987 and 2013 have increased by an average of 0.76 mg/L, as depicted by **Figure 3-6b.** Only one Lloyd aquifer well was sampled in both 1987 and 2013; the nitrate concentration in that well increased by 0.50 mg/L. **Figures 3-6a** and 3-**6b** also indicate that using data from all community supply wells to characterize aquifer conditions, nitrate levels, on average, have increased by nearly 0.4 mg/L in both the upper glacial and Magothy aquifers. Based on the limited data available to characterize the Lloyd aquifer, the average nitrate concentration has increased significantly. However, data was available from wells located in one general area on the north shore of the County and nitrate concentrations may not be representative of the Lloyd aquifer as a whole.

Nitrate levels in untreated groundwater samples collected from over 99 percent of all community supply wells complied with the 10 mg/L MCL in 2013; nevertheless, nitrate concentrations in all three aquifers continues to increase.

Overall, average nitrate concentrations remained less than or equal to 6 mg/L in nearly 83 percent of all community supply wells in 2013, and exceeded the drinking water MCL in untreated samples obtained from less than one percent of all community supply wells in 2013. While the overall assessment shows that nitrate levels remain in compliance with applicable standards in the majority of public supply wells, comparison of data collected from the same sampling

Table 3-1 Nitrate Concentration from Community and Non-Community Supply Wells

Aquifer	1987	2009-2013	2013	Same Set Wells 1987	Same Set Wells 2013
Upper Glacial Aquifer					
n (wells	714	570	477	175	175
Minimum (mg/L)	ND	ND	ND	ND	ND
Maximum (mg/L)	23.0	26.8	15.4	22.70	14.00
Average (mg/L)	3.05	3.40	3.44	2.63	3.69
10th Percentile (mg/L)	ND	0.14	ND	ND	ND
50th Percentile (mg/L)	1.90	3.00	3.10	1.80	3.55
90th Percentile (mg/L)	7.30	6.95	7.32	5.87	7.30
No. of Wells > 6 mg/L	135 / 116	133 / 91	86 / 82	20 / 17	37 / 35
Magothy Aquifer					
n (wells)	281	418	402	213	213
Minimum (mg/L)	ND	ND	ND	ND	ND
Maximum (mg/L)	12	10.9	10.2	12.00	10.20
Average (mg/L)	1.07	1.34	1.41	0.95	1.71
10th Percentile (mg/L)	ND	ND	ND	ND	ND
50th Percentile (mg/L)	ND	0.13	ND	ND	ND
90th Percentile (mg/L)	3.85	4.53	4.80	3.59	5.80
No. of Wells > 6 mg/L	18 / 13	39 / 23	29 / 26	12 / 8	21 / 19
Lloyd Aquifer					
n (wells)	4	6	5	1	1
Minimum (mg/L)	ND	1.90	2.1	1.60	2.10
Maximum (mg/L)	1.70	8.80	4.2	1.60	2.10
Average (mg/L)	1.24	3.72	3.18	1.60	2.10
10th Percentile (mg/L)	0.56	2.21	2.3	N/A	N/A
50th Percentile (mg/L)	1.55	3.15	3.50	N/A	N/A
90th Percentile (mg/L)	1.67	5.80	3.92	N/A	N/A
No. of Wells > 6 mg/L	0 / 0	2 / 1	0 / 0	0 / 0	0 / 0

Notes:
1. Data compiled from SCDHS databases.
2. Averages and percentiles calculated from annual well averages.
3. No. of wells > 6 mg/L is based on well maximum and averages, respectively (max/avg).

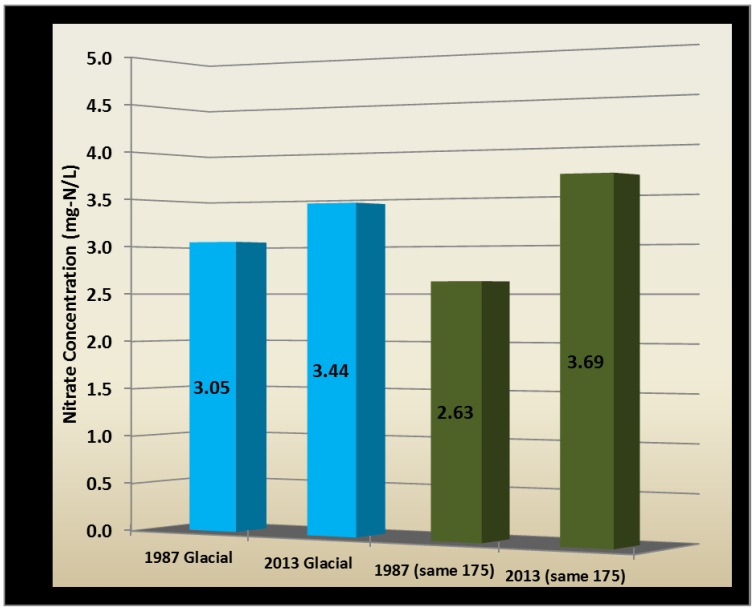


Figure 3-6a Nitrate Trends in Public Supply Wells Screened in the Upper Glacial Aquifer 1987-2013

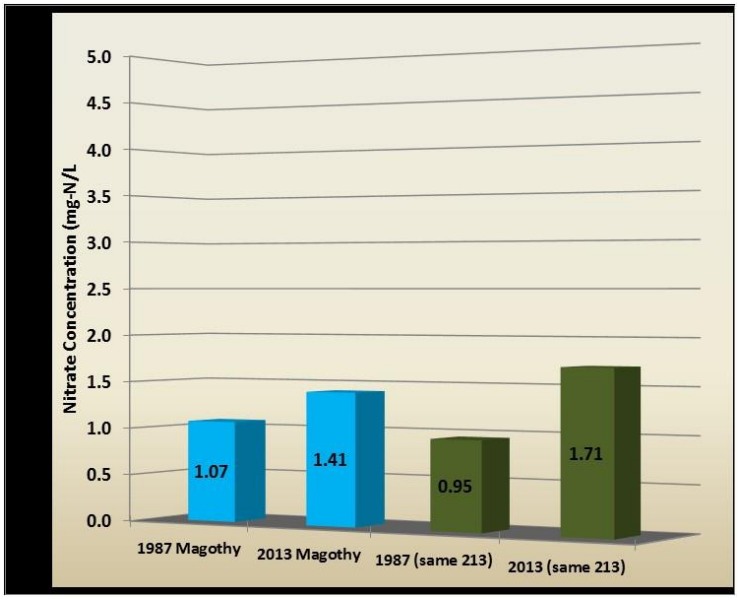


Figure 3-6b Nitrate Trends in Public Supply Wells Screened in the Magothy Aquifer 1987-2013

points in 1987 and in 2013 has revealed that nitrate concentrations have continued to increase in all aquifers, and that more deep public supply wells are being used to obtain better water quality.

Nitrate and Land Use

Several studies have investigated the impacts that various land use types have had on nitrate levels in Suffolk County groundwater, although a regional analysis has not been completed since the **1987 Comp Plan**. The **1987 Comp Plan** evaluated water quality from 25 shallow monitoring wells that were installed downgradient of specific land use types. **Table 3-2** summarizes the nitrate concentrations observed downgradient from the land uses studied. Results from the **1987 Comp Plan** study are shown graphically on **Figure 3-7** along with results from the **208 Study** (1978), based on nitrate data from wells in unsewered areas of Nassau County, and results from the WALRAS model developed by Cornell University (Dvirka and Bartilucci, 1987). This work was updated to consider more detailed assessments of land surface areas contributing recharge to public supply wells, historical land uses within the contributing or source water areas and estimated travel times from the water table to the supply well screen, as described below.

Historical Land Use and Nitrate Concentrations

The Suffolk County Department of Economic Development and Planning (formerly Suffolk County Planning Department) used historical aerial photographs to document changing land use within the contributing areas of 56 community supply wells located within 29 wellfields (please see Task 3 memoranda) over four historical time periods dating back to 1930. The Department of Economic Development and Planning (SCDEDP) used the contributing areas that were simulated during the Task 5.5 assessment of source water areas, based upon long term average conditions of precipitation and recharge and projected future water supply pumping rates, and intersected those source water areas with land use data from 1930, 1947, 1977 and 2004. The historical land uses were used to estimate the nitrate levels that could be expected in downgradient groundwater, and these estimates were compared to measured nitrate levels in the supply wells. Annual nitrate trend plots were developed for each of the 56 wells to qualitatively evaluate water quality trends resulting from changes in land use over time. The contributing area, historical land use data for each time period, and water quality data for SCWA's Woodchuck Hollow Road wellfield are included on the following page as **Figure 3-8**; the analysis of the other wellfields may be found in the Task 5.1 memorandum (**Past and Current Land Use Impacts**, CDM, 2010).

The average nitrate concentrations associated with each land use type that were documented in the **1987 Comp Plan** and the historical land use types

Table 3-2 Water Quality Summary for Nitrate (as Nitrogen), Ammonia and Total Nitrogen from the 1987 Comprehensive Water Resources Management Plan (from Dvirka and Bartilucci, 1987)

Land Use	Nitrate (as N)			Ammonia			Total Nitrogen		
	Mg/L			Mg/L			Mg/L		
	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max
Low Density Res.	3.35	2.97	3.70	0.36	0.06	0.68	3.88	3.02	4.75
Medium Density Res.	5.82	4.40	7.94	0.12	0.06	0.21	5.94	4.48	8.00
High Density Res.	2.60	0.34	8.03	5.32	2.94	9.55	7.92	3.59	11.50
Commercial	1.74	0.08	4.05	6.11	0.06	17.50	8.04	1.11	17.50
Industrial	4.25	1.13	6.99	2.96	0.06	5.12	7.13	1.18	10.80
Institutional	8.20	7.87	8.53	0.06	0.06	0.06	8.27	7.93	8.60
Recreation / Open Space	3.91	2.40	6.07	0.72	0.06	1.64	4.63	2.46	6.18
Agriculture	7.83	5.62	10.00	0.06	0.05	0.06	7.89	5.68	10.10
Vacant	1.15	1.00	1.30	0.05	0.05	0.06	1.21	1.05	1.35
Transportation	2.39	0.59	4.54	0.07	0.06	0.08	2.46	0.66	4.61

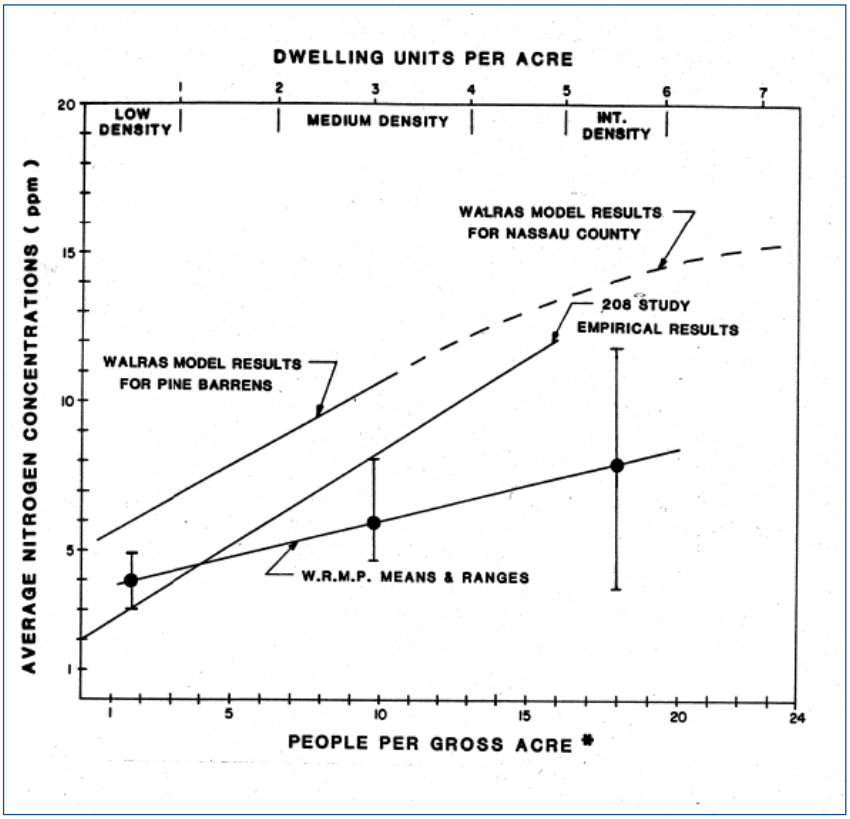
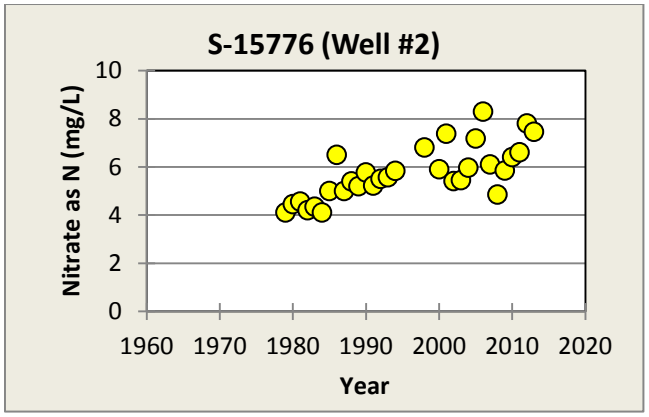
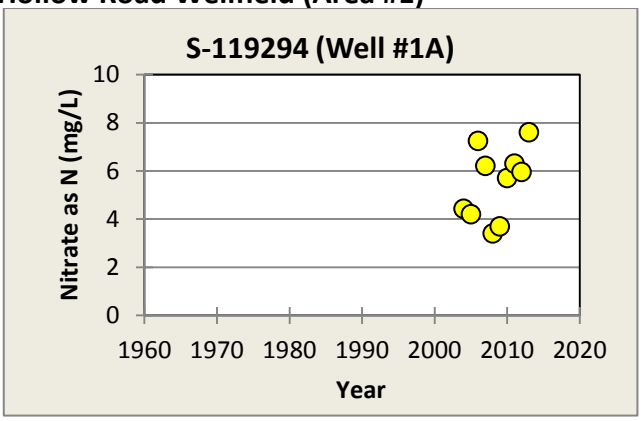
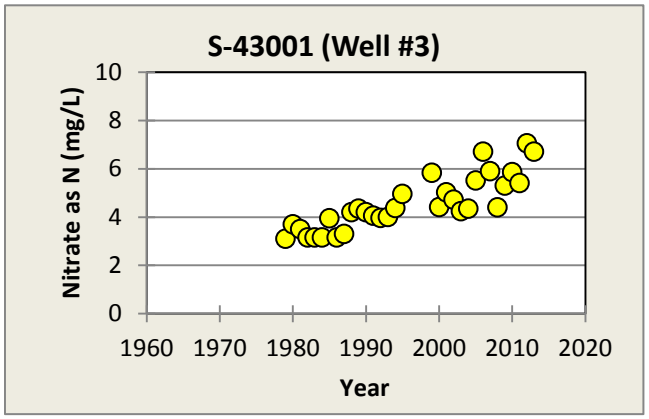


Figure 3-7 Density & Nitrogen Concentrations in Groundwater
(from 1987 Comp Plan, Dvirka and Bartilucci)

SCWA Woodchuck Hollow Road Wellfield (Area #1)







Well	Time of Travel (yrs) Minimum	Maximum	Pumping gpm	Depth (ft)
S-15776	9.8	35.6	300	507
S-43001	14.7	83	300	596
S-119294	28.3	91.3	300	604

Sewered: 1%
Unsewered: 99%

Wells are screened in the **upper glacial aquifer**

	1930		1947		1977		2004	
	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total
Low Density Res.	15	3.55%	16	3.78%	7	1.71%	2	0.38%
Medium Density Res.	53	12.53%	120	28.37%	223	54.39%	189	35.93%
High Density Res.	0	0.00%	0	0.00%	27	6.59%	88	16.73%
Commercial	7	1.65%	6	1.42%	66	16.10%	90	17.11%
Industrial	0	0.00%	0	0.00%	19	4.63%	18	3.42%
Institutional	4	0.95%	4	0.95%	10	2.44%	8	1.52%
Recreation & Open Space	0	0.00%	0	0.00%	0	0.00%	4	0.76%
Agriculture	140	33.10%	129	30.50%	4	0.98%	0	0.00%
Vacant	204	48.23%	148	34.99%	52	12.68%	7	1.33%
Transportation		0.00%		0.00%		0.00%	118	22.43%
Utilities	0	0.00%	0	0.00%	2	0.49%	2	0.38%
Waste Handling	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Total	423		423		410		526	

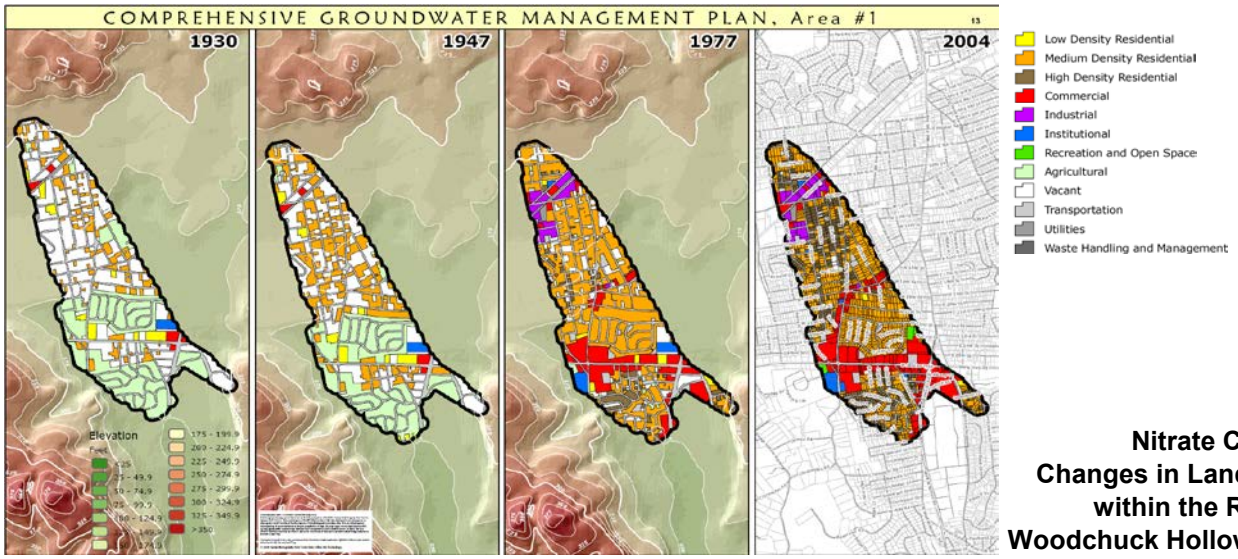


Figure 3-8
Nitrate Concentrations & Changes in Land Use Over Time within the Recharge Area to Woodchuck Hollow Road Wellfield

compiled for each well's contributing area were used to evaluate how the area-weighted concentrations predicted from the contributing area land use(s) would compare with actual nitrate data collected from the supply wells.

The evaluations considered the simulated travel time from the water table to each well screen, and the estimated nitrate loading from the variety of land use types existing through the range of travel times. Groundwater pumped from each supply well includes water originating over the entire contributing area, considering the range of travel times from the water table to the well screen. For example, if a well has contributing areas within the 0 to 2, 2 to 5, and 5 to 25 year travel time intervals, the water withdrawn from the well is a composite of water recharged from the land uses within each of these areas. Nitrate loads therefore reflect the land use types present over the entire 0 to 25 year travel time zone of contribution. Assessments of nitrogen levels in wells with even longer travel times considered the land uses documented in the aerial photos from several historical time periods, as land uses that existed decades ago can have an impact on water quality observed today. Clearly, this assessment provides only an estimate of nitrogen loading rates, as a variety of land use types exist within most contributing areas and nitrate loading rates can vary considerably over different parcels of the same land use type. However, although exceptions exist, in many instances, nitrate levels, and the change in nitrate concentration over time appears to correlate with land use patterns within the contributing area.

The results for all 29 wellfields are tabulated in **Table 3-3**. Nitrate is added to the aquifer by septic systems in unsewered areas and by lawn fertilization and agricultural practices. As expected, higher concentrations of nitrate are generally observed in wells with more densely developed and/or agricultural uses within the contributing areas. The range of land use-specific nitrate concentrations documented in the ***1987 Comp Plan*** appear to be representative of the water quality data observed in the wells included in this analysis. In general, the maximum nitrate concentrations from the ***1987 Comp Plan*** provide a closer approximation to observed data for many of the wells. The results are site-specific and matched better for some wellfields than others due to a variety of factors, some of which are identified below.

More than fifty percent of the contributing areas for five of the twenty-nine areas evaluated are served by sanitary sewers. As expected, nitrate concentrations are generally lower in sewered areas than in unsewered areas. For example, the contributing area for the Strathmore Court Drive wellfield is essentially entirely sewered and nitrate concentrations are generally low (below 4 mg/L), whereas average concentrations for wellfields with unsewered contributing areas often exceed 5 or 6 mg/L.

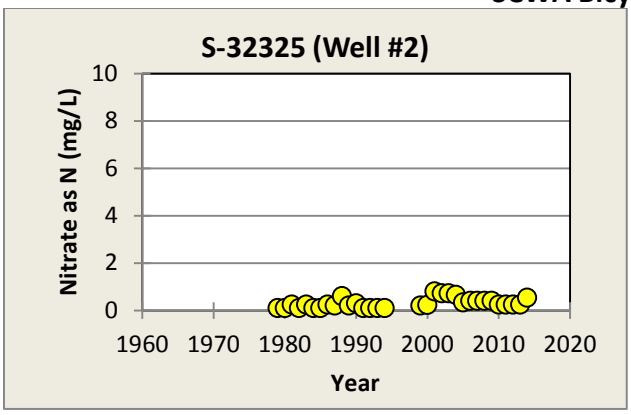
Table 3-3
Summary of Calculated (using 1987 Comp Plan Concentrations) and Observed Nitrate Concentrations

Area	Wellfield	% Sewered	Average Nitrate as Nitrogen (mg/L) 2004-2009		Analytical Calcs			Notes
			Low	High	Average	Minimum	Maximum	
1	**Woodchuck Hollow Road**	1%	3.60	6.37	3.99	2.45	6.36	Average and maximum concentrations from the 1987 Comp Plan are within the range of observed nitrate concentrations.
2	**Waterside Road**	0%	7.39	7.39	4.81	3.38	6.82	This contributing area has a relatively high percentage of high density residential. Maximum 1987 Comp Plan concentrations are close to observed, but an increase in the repersentative concentration for high density residential may provide a closer approximation.
3	**Laurel Hill Road**	0%	3.39	3.81	5.43	4.04	7.06	This contributing area has a relatively high % of agriculture. Since observed concentrations are approximately 4 mg/L, it is possible that the type of agriculture is not fertilizer intensive and therefore does not contribute significant nitrogen loading to groundwater. Using minimum 1987 concentrations, the calcualted values are within the range of concentrations observed from the three wells from 2000 to present.
4	**Belle Rose Avenue**	0%	5.70	5.70	7.04	5.14	9.19	Concentrations have approached 9 mg/L in early 1990s. Supports Article 6 standards as medium density lots average approximately 20,000 sq. feet (see Table 4) and concentrations are near the target of 6 mg/L.
5	**Larkfield Road / South Spur**	0%	7.95	7.95	5.79	4.19	7.83	Using maximum concentrations provides a reasonable approximation to observed data, although the observed data appear to be increasing over time
6	**Schuyler Drive**	0%	4.96	9.33	4.77	3.53	6.27	Well 1 shows a good approximation, although well 2 has shown concentrations > 10 mg/L.
7	**Vanderbilt Parkway**	0%	1.83	1.83	3.92	3.09	4.96	Large parcel size for medium density residential. Also may have well maintained septic systems and/or low rates of fertilization. However, concentrations in early 2000s approach analytical
8	**Ryder Avenue**	0%	2.30	2.30	4.20	3.18	5.44	High relative percenage of low density residential. Maybe reduce impact from LDR.
9	**Wheeler Road**	0%	2.57	5.00	4.33	3.45	5.53	Concentrations from the 1987 Comp Plan provide a close approximation to observed nitrate concentrations.
10	**Oval Drive**	0%	5.04	5.65	3.62	1.83	5.57	Using maximum concentrations, the analysis provides a good approximation. Concentrations appear relatively stable for nitrate.
11	**Wheat Path**	0%	2.17	4.21	3.76	2.80	5.11	Concentrations from the 1987 Comp Plan provide a close approximation to observed nitrate concentrations.
12	**Mt. Sinai-Coram Road**	56%	8.59	8.59	3.32	2.38	4.52	Concentrations have exceeded the drinking water standard and unsewered portions of the contributing area may have poorly maintained septic systems or excessive fertilization. In addition, the high concentrations could represent the flushing of former agricultural source water (with a high nitrogen load) as concentrations seem to be decreasing since 2001.
13	**Bicycle Path**	60%	0.43	5.82	3.95	2.90	5.45	The range of concentrations from the 1987 Plan provide a reasonalbe approximation to well #1, but is a little low. Most of the contributing area to well #1 is also in unsewered area, while much larger portion of well #2 in a sewered area, which has much lower concentrations of nitrate.
14	**Chestnut Street**	58%	0.50	1.07	2.40	1.79	3.24	Minimum concentrations provides a reasonable approximation. The wells in this wellfield are almost 600 feet deep, so it is possible that more dilution is occuring in the vertical profile of the aquifer as opposed to a shallow upper glacial well. In addition, the maximum time of travel for all three wells is near 100 years and the water pumped from the well may have a significant percentage which is older than 33 years, when much of the land use was vacant.
15	**Strathmore Court Drive**	99%	0.13	2.98	3.38	2.37	4.83	Sewered (calcs slightly higher than observed). Wells 1 and 3 are significantly more shallow and concentrations approach 4 in these 2 wells. Concentrations in well 3 may be stablizing, or at least approaching stable concentrations.
16	**Hawkins Road**	0%	8.95	8.95	3.42	2.53	4.68	Calculated data are lower than observed. Although there is an apparent sharp increasing trend between 1980 and 2002, concentration data between 2002 and 2008 appear to have stabilized near 9 mg/L. Regardless, the observed concentrations are much higher than calculated, perhaps due to excessive fertilization.

Table 3-3
Summary of Calculated (using 1987 Comp Plan Concentrations) and Observed Nitrate Concentrations

Area	Wellfield	% Sewered	Average Nitrate as Nitrogen (mg/L) 2004-2009		Analytical Calcs			Notes
			Low	High	Average	Minimum	Maximum	
17	**Eastwood Boulevard**	0%	4.69	4.69	5.65	4.52	7.31	Using minimum or average concentrations from the 1987 Plan provide a good approximation of observed data.
18	**Boyle Road South**	0%	5.03	5.03	3.22	2.25	4.43	Calculated values are an underestimate of observed data and the observed data appear to be increasing over time. This may be due to excessive fertilization within the area.
19	**Dare Road**	2%	5.75	5.75	4.26	3.17	5.71	Using maximum concentrations appear to provide a good approximation of observed data. Although early data indicate an increasing trend, concentrations appear relatively stable between 1999-2009.
20	**Flint Lane**	78%	2.22	3.33	3.09	2.20	4.33	Calculated concentrations are within the range of observed data between 2004-2009, although a significant portion of the contributing area is sewered. Regarding the concentrations in the individual wells, 68% of the contributing area to well #2 is sewered while 88% of the area in well #1 is sewered and this is represented in the observed concentration data. Although differences in concentration are relatively slight, concentrations in well #2 are approximately 1 ppm higher than well #1.
21	**Meehan Lane**	17%	6.20	8.24	3.71	2.83	4.89	Calculated data are lower than observed. Recent data have been higher than 5 mg/L and a portion of the contributing area is sewered, and anticipated to yield lower concentrations of nitrate. The portion of the contributing area that is recreation / open space may be a golf course or septic systems may be somewhat poorly maintained or the area undergoes excessive fertilization.
22	**Pleasant Avenue**	0%	7.03	7.19	4.08	3.07	5.52	Observed concentrations are slightly higher than target for GWMZ I. Average parcel size slightly smaller than Article 6 standards, but may be due to a few inadequate septic systems or over-fertilization. Concentrations approaching 10 mg/L in Well 1 (ultimately blended with Well #4 (not included in analysis)).
23	**Morris Avenue**	27%	3.52	4.92	3.89	2.94	5.14	Using average and maximum concentrations is within the range of observed data. Calculated values are slightly higher using maximum concentratins, although a portion of the contributing area is sewered and expected to have a lower nitrogen load.
24	**Barton Avenue**	0%	6.61	6.85	4.95	3.79	6.62	Using maximum concentrations from the 1987 Comp Plan, the calculated concentrations are within the range of observed.
25	**North Country Road**	0%	3.58	3.58	3.44	2.45	4.71	Using average concentrations appears to be slightly lower than observed concentrations. Nitrate concentrations have been above near and above 5 mg/L in the 1990s, or close to the predicted nitrate concentration using maximum values from the 1987 Plan.
26	**Moriches Riverhead Road**	0%	0.11	0.21	2.33	1.58	3.36	Approximately 85% of the contributing area is classified as recreation / open space. Review of aerial photography indicates that the area is open space and does not contain a golf course or any other recreational parcel that may utilize fertilization. Qualifying as vacant land will give a better approximation to observed data.
27	**Old North Road (Greenport)**	0%	8.16	8.89	6.27	4.48	8.10	Using maximum concentrations, the analysis provides a good approximation. Elevated nitrate concentrations likely attributed to high percentage of agriculture in the well contributing areas.
28	**Ackerly Pond Lane**	0%	6.19	6.94	7.13	5.08	9.24	Much of this contributing area is agricultural. However, BMPs may have been implemented as the increasing trend in the late 1980s into the 1990s appears to have reversed in which average concentrations have decreased to below 7 mg/L.
29	**Bridgehampton Road**	0%	2.74	8.05	3.33	2.45	4.40	The range of concentrations from the 1987 Plan provide a reasonalbe approximation to wells 2A and 3A, but are significantly low for well #1. Well #1 has a higher percentage of agriculture than the other 2 wells which may explain the higher observed nitrate concentrations.

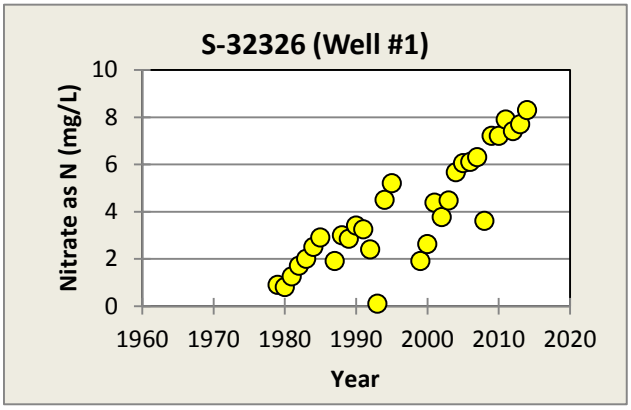
SCWA Bicycle Path Wellfield (Area #13)



Well	Time of Travel (yrs) Minimum	Maximum	Pumping gpm	Depth (ft)
S-32325	0.63	25.9	400.00	353.00
S-32526	0.71	11.5	166.00	159.00

Sewered: 60%
Unsewered: 40%

Wells are screened in the **upper glacial aquifer**



	1930		1947		1977		2004	
	Acres	% of Total	Acres	% of Total	Acres	% of Total	Acres	% of Total
Low Density Res.	0	0.00%	1	0.56%	1	0.57%	2	0.92%
Medium Density Res.	0	0.00%	2	1.13%	81	46.29%	143	65.60%
High Density Res.	0	0.00%	0	0.00%	0	0.00%	1	0.46%
Commercial	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Industrial	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Institutional	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Recreation & Open Space	0	0.00%	0	0.00%	0	0.00%	6	2.75%
Agriculture	0	0.00%	0	0.00%	1	0.57%	0	0.00%
Vacant	178	100.00%	174	98.31%	92	52.57%	20	9.17%
Transportation		0.00%		0.00%		0.00%	43	19.72%
Utilities	0	0.00%	0	0.00%	0	0.00%	3	1.38%
Waste Handling	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Total	178		177		175		218	

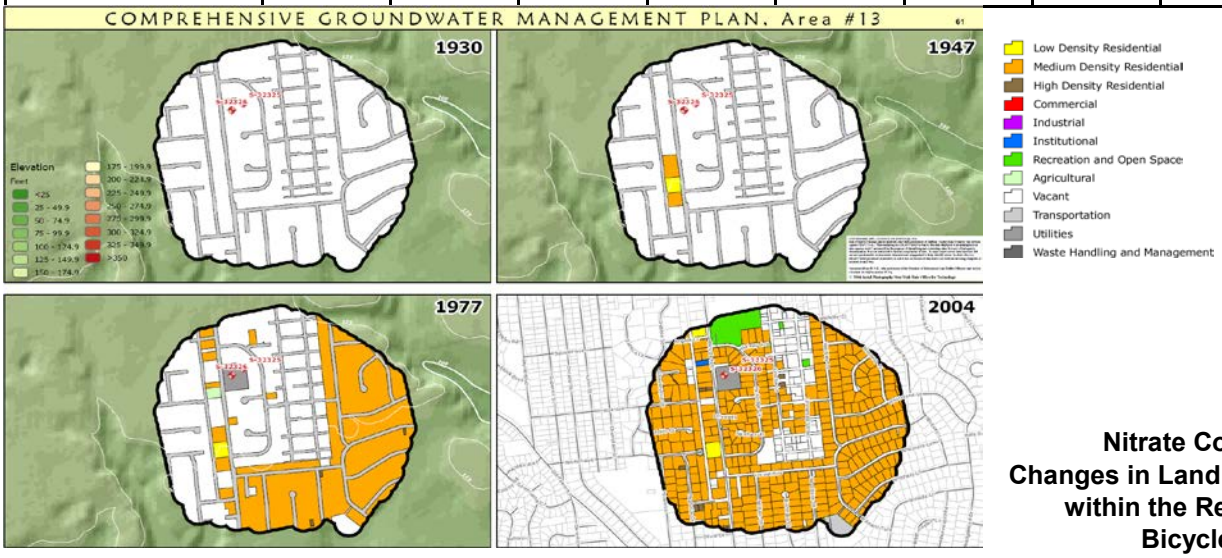


Figure 3-9
Nitrate Concentrations & Changes in Land Use Over Time within the Recharge Area to Bicycle Path Wellfield

Historical Land Use and Nitrate Concentration Assessment

The evaluation of the impacts of historical land uses and downgradient nitrate levels were based on available information; the assessment necessarily incorporated some assumptions that are worthy of note.

The Suffolk County Department of Economic Development and Planning evaluation is based on the available aerial photographs and land use documentation, which is somewhat limited – for example, the available historical documentation may not capture the significant differences in land uses that occurred during the thirty year time periods between 1947 and 1977 or 1977 and 2004 in some study areas.

The contributing areas used for this analysis were based on water supplier-projected future average annual pumping rates, which may be very different than historical pumping rates and/or supply well locations. Changes in pumping rates and well locations and/or depths will have a significant influence on a contributing area; this is a significant source of uncertainty for the wells with longer travel times.

The land use analysis is based on the combined contributing areas for all wells of interest for a particular wellfield. In some instances, the difference in land use is minimal, whereas in others, the differences in land uses in the well-specific contributing area are better indicators of individual well water quality.

Estimated nitrate concentrations do not exceed 10 mg/L using the average (or even the maximum) nitrate concentrations associated with each land use type as reported in the 1987 Comp Plan – however nitrate concentrations exceeding 10 mg/L were observed in some supply wells, indicating that the nitrate concentrations resulting from some land use types may have been may have been greater, particularly those from agriculture.

An example of the effectiveness of sewers in reducing nitrate concentrations can be seen in the two wells located at the Bicycle Path wellfield (**Figure 3-9**). The relative percentages of land use types are similar for both wells, although the contributing area to well #1, an upper glacial aquifer well, is only 4 percent sewered while the contributing area to well #2 is 57 percent sewered. Nitrate

concentrations in well #2, a Magothy well screened 200 feet deeper than well #1 are less than 1 mg/L, while concentrations in well #1 have continued to increase and exceed 8 mg/L.

A qualitative assessment of the nitrate levels over the years shows that increasing trends in nitrogen levels were observed in approximately half of the wellfields evaluated in this task. Nitrate levels in seven additional wellfields exceeded 6 mg/L, and showed the impact of human activity throughout the period of record. In fact, average annual nitrate concentrations have exceeded the 10 mg/L drinking water standard for nitrate at four wellfields during the evaluation period (Hawkins Road, Mt. Sinai Coram Road, Old North Road and Schulyer Drive wellfields; water from these wells was blended to reduce nitrogen levels prior to distribution). The increasing trend in nitrate concentrations has been attributed to the increase in residential development.

The evaluation of the impacts of historical land uses on nitrate levels yielded the following conclusions:

- Nitrate levels were lowest in wells with contributing areas comprised primarily of open space.
- In general, nitrate levels in wells with sewered contributing areas were lower than nitrate levels in unsewered areas.
- Groundwater nitrogen levels increase in unsewered areas as housing density increases.
- Wellfields with contributing areas that comply with the population density goals established by Article 6 all meet the target nitrate concentrations.
- Agriculture remains a major source of nitrogen contamination of the aquifer, particularly on the North Fork. The type of agriculture present within the contributing area affects the resulting groundwater nitrate level, since nitrogen loading can vary considerably depending on crop-specific fertilization requirements. The data shows average nitrogen concentrations in groundwater for row crops at 13.4 mg/L and average nitrogen concentrations in groundwater for vineyards at 5.1 mg/L.
- A limited set of wells screened in the Magothy aquifer with unsewered contributing areas was evaluated; the data shows an increasing trend in nitrate concentrations. In general, wells screened

in the Magothy aquifer had lower nitrate concentrations than those screened in the upper glacial aquifer.

- The land use-specific range of nitrate concentrations identified in the 1987 Comp Plan represented the observed water quality in the supply wells studied during this analysis reasonably well, although projected and observed nitrate levels matched better for some wellfields than others. In general, it appears that the maximum concentrations from the 1987 Comp Plan provide a better representation of the observed nitrate concentrations for many of the wells than do the average or minimum values.

In summary, nitrate concentrations at the wells are, in most cases, reflective of the type of land use found in the contributing area. Nitrate levels in samples collected from these 29 wellfields reflect the land uses that existed throughout the historical period defined by the maximum and minimum times of travel to the well, not just the most recent land use. Use of the contributing area assessments under the projected pumping conditions should be more useful in evaluating the impacts of land use moving forward.

Effectiveness of Existing Nitrate Management Programs

Discharge of sanitary wastewater and fertilization have been identified as the two most significant sources of anthropogenic nitrogen to groundwater.

Since the 1970s, a wide variety of regulatory programs have been developed and implemented to control the amount of nitrate that is introduced to the aquifer system. Discharge of sanitary wastewater and fertilization have been identified as the two most significant sources of anthropogenic nitrogen to groundwater. Sanitary sewering that has been implemented in southwest Suffolk County and other densely developed parts of Suffolk County has been effective in reducing groundwater contamination from sanitary, commercial, and industrial wastewaters. Implementation of land use restrictions, the purchase of large tracts of open space for preservation and groundwater protection, and limiting fertilization have also helped to protect groundwater quality in targeted areas.

Sanitary wastewater management is the most important factor affecting nitrate levels in groundwater throughout most of the County. Due to the significant contribution of groundwater baseflow to the County's surface waters, improved sanitary wastewater management practices can also have a positive impact on nitrate levels in surface waters. Sanitary wastewater management options were implemented to protect the groundwater resource, as indicated by compliance with the 10 mg/L drinking water standard for nitrogen. In 1980, Suffolk County amended Article 6 of the Suffolk County Sanitary Code to specifically address the impacts of sanitary wastewater on the County's groundwater. Since 1980, in accordance with Article 6, on-site wastewater

disposal is permitted for residential parcels greater than or equal to one acre in the deep recharge zone (Groundwater Management Zones III, V and VI), and on-site wastewater disposal is permitted for residential parcels greater than or equal to one half acre in all other GMZs. Residential development on lot sizes smaller than one acre within the deep recharge zone and one half acre outside of the deep recharge zone require a use of a community sewage system for wastewater treatment and disposal.

There are generally three sanitary wastewater management options currently utilized in Suffolk County:

- Discharge to a centralized sewage collection and treatment system, such as Southwest Sewer District No. 3;
- Discharge to an alternative treatment system, in accordance with Article 6 requirements; or
- Discharge on-site via septic systems/cesspools/leaching fields in accordance with Article 6 density requirements.

Provision of a centralized sanitary wastewater collection and treatment system is an effective way to reduce the impacts of development on ground and surface water resources.

Centralized sewage treatment and collection systems such as Southwest Sewer District No. 3 (SWSD) were established to reduce levels of wastewater contaminants in groundwater located beneath densely developed areas. Provision of a centralized sanitary wastewater collection and treatment system is an effective way to reduce the impacts of development on ground and surface water resources; conventional treatment schemes remove suspended solids, organic material, and deactivate pathogens via disinfection. More advanced treatment processes can be used to remove nutrients such as nitrogen to protect drinking water and prevent eutrophication and degradation of ecological communities. Nitrogen levels in sanitary wastewater vary considerably; typical secondary wastewater treatment processes reduce influent total nitrogen concentrations by 50 percent or less. Additional treatment processes utilized at biological nutrient removal (BNR) facilities can further reduce nitrogen levels to less than 10 mg/L, and sometimes to 4 to 6 mg/L.

Suffolk County and NYSDEC also permit the use of alternative treatment systems for flows up to 15,000 gallons per day (gpd); these systems are required to meet effluent nitrogen limits of 10 mg/L. These systems have previously been discussed in the SCDHS report entitled **Report on the Sewage Treatment Plants of Suffolk County** (Doroski and Olsen, November 2006); their effectiveness was summarized in the Task 5.2 memorandum.

BROOKHAVEN CASE STUDY
Montauk Highway Corridor

As part of this study, a modeling approach to simulate the impacts of proposed development upon nitrate groundwater levels was developed and applied to the Montauk Highway Corridor, to serve as an example of how the impacts of future proposed land use scenarios on downgradient groundwater quality can be evaluated. A subregional groundwater model was developed to evaluate the area of the Montauk Highway corridor that the Town of Brookhaven has proposed for redevelopment. A nitrogen loading spreadsheet model was developed to utilize Suffolk County Department of Economic Development and Planning (SCDEDP) land use files and assemble groundwater model input files for thousands of nitrogen point sources, which were used to represent the nitrogen loading associated with individual parcels within the study area. This nitrogen loading spreadsheet can be readily applied to other areas of the County by incorporating minor study area-specific changes.

Groundwater model simulations were conducted for both existing conditions and proposed future development scenarios based on a parcel-specific contaminant transport simulation over the region. Water quality data collected from recently installed SCDHS monitoring wells were used as targets to verify the model's ability to represent existing nitrogen transport, and loading parameters were varied until simulated and observed nitrogen concentrations were in general agreement. Using documented nitrogen loading assumptions for on-site wastewater treatment systems, simulated nitrogen concentrations at the monitoring wells successfully represented the observed concentrations.

Groundwater modeling evaluations of the Montauk Highway Corridor concluded that:

- The average simulated concentration of total nitrogen in the shallow groundwater beneath the medium-high density study area from on-site wastewater disposal was 12.5 mg/L, which is consistent with water quality data collected from nearby monitoring wells;
- The total nitrogen concentration in shallow groundwater resulting from the proposed development is projected to increase to 14.5 mg/L;
- Both existing development and the proposed development scenario result in nitrate levels that exceed 10 mg/L;
- As the Forge River already experiences severe water quality degradation (e.g., eutrophication), increased development of the Montauk Highway Corridor without sewering would be expected to exacerbate the observed problems.

The development and application of the modeling tools that have been produced during this study to enable planners and water resource managers to assess the impacts of proposed development alternatives on groundwater quality are described in the Task 5.2 memorandum. The evaluation approach, which was demonstrated for a pilot area in the Town of Brookhaven, will enable detailed, objective evaluation of the impacts of proposed changes in land use upon downgradient groundwater nitrate levels.

There are close to 200 of these small facilities operating in Suffolk County today. When successfully operated and maintained, these systems are, in many cases, capable of significantly reducing the nitrogen load to groundwater. However, they do require considerable operator attention to consistently and successfully operate, they require SCDHS oversight, and they do not necessarily remove organics and PPCPs that may be contained in the effluent. As of 2013, 197 sewage treatment plants were located in Suffolk County, sixteen of which discharged to surface waters. SCDHS records indicate that 139 of the sewage treatment plants are privately owned and inspected by SCDHS on a quarterly basis; the 33 municipal plants are inspected by NYSDEC. All of the sewage treatment plants are required to operate in compliance with a State Pollutant Discharge Elimination System (SPDES) permit and Suffolk County Article 7 requirements. As of 2013, 171 of the sewage treatment plants were designed to remove nitrogen from the wastewater to comply with SPDES permit discharge limits of 10 mg/L. Monitoring wells are sited at the plants discharging to groundwater to monitor the impacts of the treated effluent upon groundwater quality; samples are collected and analyzed on a quarterly basis from these wells.

Nitrogen removal at the sewage treatment plants is accomplished via denitrification; two of the systems currently employed in the County are sequencing batch reactors (SBRs) and Cromaglass systems. SCDHS collects and analyzes samples from the sewage treatment plants and from downgradient monitoring wells for nitrogen. The Task 5.2 memorandum documented the challenges faced by the SCDHS Office of Wastewater Management (OWM) in obtaining compliance with the 10 mg/L effluent limit – at that time, fewer than 50 percent of the plants (66 out of the 138 monitored at that time) maintained average effluent nitrogen concentrations less than or equal to the 10 mg/L limit.

The impact of both operations and the alternative technologies on performance was also considered. The small treatment systems are complicated to operate and treatment efficiency can be affected by diurnal flow variation and temperature. While operators of these community wastewater treatment systems are required to be certified New York State operators, effluent quality varies widely. Nonetheless, all fifteen of the Suffolk County Sewer District plants discharging to groundwater that were operated by the Suffolk County Department of Public Works (SCDPW) successfully maintained average effluent nitrogen concentrations of less than 10 mg/L; the average effluent nitrogen level from these facilities was 5.2 mg/L. Differences in technology performance were also evident. Out of sixty operating SBR facilities, fifty five percent had average effluent nitrogen levels less than or equal to the 10 mg/L limit, but the average effluent nitrogen level was 13 mg/L.

Only 25 percent of the sixteen Cromaglass facilities operating at the time that the document was prepared had average effluent nitrogen levels below the 10 mg/L limit. The average level of nitrogen in Cromaglass effluent was 22.3 mg/L. Considering all other types of treatment systems, less than fifty percent (28 out of 58) had average effluent nitrogen levels of less than or equal to 10 mg/L; the average effluent nitrogen concentration was 13.3 mg/L.

In 2007, SCDHS OWM initiated several actions to improve the effectiveness of the Cromaglass systems, which are currently approved for community sewage treatment in Suffolk County. SCDHS identified both mechanical and electrical problems and the Cromaglass maintenance challenges that caused the non-compliance. Working with Cromaglass owners and operators to improve system performance, more recent SCDHS data shows that average effluent nitrogen levels from facilities that have implemented the required improvements have been significantly reduced. Five year service contracts with Cromaglass are now required to improve operational reliability, and immediate fines are levied for violations.

By 2008, the following year, Cromaglass system operations had been improved such that two thirds of the operating systems complied with the 10 mg/L effluent limit and the average effluent nitrogen concentration of all Cromaglass systems had been reduced by more than 50 percent to 10.6 mg/L. At that time, SCDHS had initiated legal action against additional systems that were not in compliance, and treatment effectiveness has continued to improve.

In 2008, SCDHS OWM continued to work with treatment plant owners and operators to improve facility operations, and implemented a new policy requiring legal action and mandatory fines for violations. The policy also required issuance of Consent Orders for facilities requiring substantial upgrade, to require completion without unnecessary delays. Effluent quality data available from 2008 showed that within that first year, treatment had improved such that nearly 70 percent of the plants had achieved the 10 mg/L discharge limit for nitrogen. SCDHS OWM is also revising Suffolk County Sanitary Code Article 7 Sewage or Industrial Waste Treatment Facilities Operation and Maintenance Standards. These revised standards, which will clearly define the increased responsibilities of plant operators, engineers of record and owners, will also help to continue to improve effluent quality.

SCDHS OWM's **Report on the Sewage Treatment Plants of Suffolk County 2013 Performance Evaluation** reported that the average effluent total nitrogen concentration of the 128 plants that were not under consent order or were not operating in a steady state condition was 5.9 mg/L, while the overall effluent nitrogen concentration for all operational plants was 8.7 mg/L.

SCDHS's OWM's efforts have clearly been successful in improving wastewater treatment facility effectiveness.

The last sanitary wastewater management alternative, currently utilized by approximately 74 percent of County residents, is on-site wastewater disposal systems, typically consisting of a cesspool or a septic tank and leaching pools. Septic systems are widely used throughout the world; they are passive systems that successfully reduce organic loading to the environment. However, reported nitrogen removal rates within household systems vary widely and are not always easy to assess. Reported nitrogen removal rates vary from ten to fifty percent.

When properly sited, designed and maintained, all three of these approaches are capable of enabling the groundwater resource to achieve the 10 mg/L groundwater standard for nitrate on a regional basis.

Effectiveness of Article 6

Article 6 of the Suffolk County Sanitary Code allows on-site wastewater disposal systems for new residential subdivisions with lot sizes greater than or equal to one acre in Groundwater Management Zones III, V and VI and greater than or equal to one half acre in all other zones (please refer to **Figure 3-4**); undersized lots existing prior to 1981 are exempt.

New residential development on lot sizes smaller than one acre within the deep recharge zone and one half acre outside of the deep recharge zone requires use of a community sewage system for wastewater treatment and disposal. As nitrogen levels in groundwater (as characterized by measured concentrations in public supply wells) have continued to increase, the relationship between unsewered residential development density and nitrogen levels, and the adequacy of the Article 6 density restrictions in protecting groundwater quality have been questioned and were evaluated during this study.

By the time that Article 6 was enacted in 1980, a number of existing residences with on-site wastewater disposal systems had already been constructed on parcels smaller than ½ acre and 1 acre as specified in Article 6. While sufficient information to quantify the number of residential parcels that were developed with on-site sanitary wastewater disposal prior to enactment of Article 6 was not available, the number of parcels less than or equal to one half acre and zoned for residential use was identified. Data provided by the Suffolk County Department of Economic Development and Planning showed that almost 53 percent of unsewered residential parcels in the County are less than or equal to one half acre. Because the populations of the west end towns have not increased significantly since 1970, it is evident that a large portion of the

smaller parcels do rely upon on-site septic systems for wastewater disposal, and nitrate levels in groundwater reflect these conditions. Residential parcels that are less than or equal to ½ acre are illustrated on **Figure 3-10** and summarized by Town on **Table 3-4**.

In fact, residentially zoned properties in the western towns are even smaller; the locations of residential properties less than or equal to one quarter acre are shown on **Figure 3-11** and summarized by Town on **Table 3-5**.

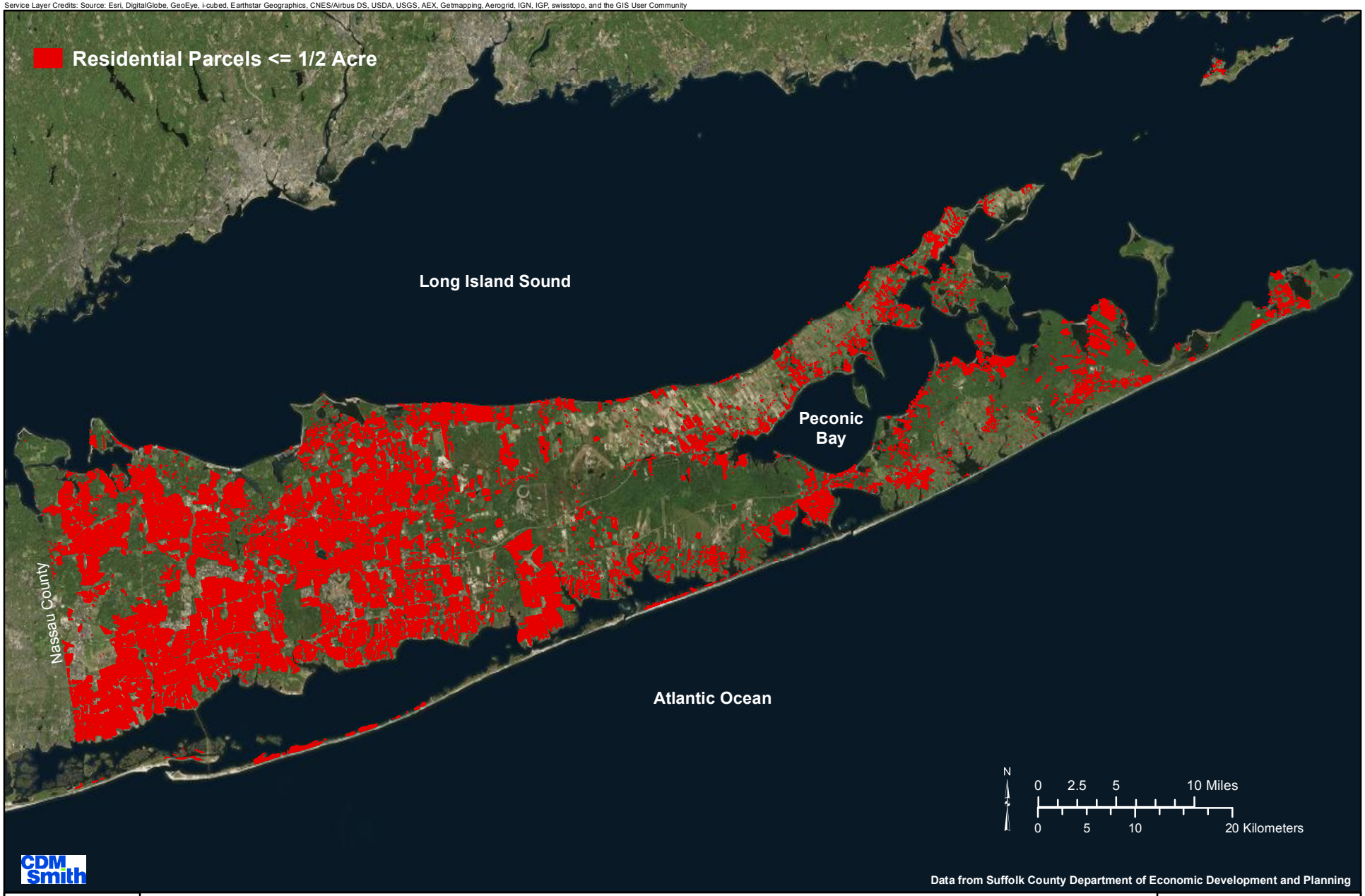
Table 3-4 Residential Parcels Smaller than or Equal to One-Half Acre

Town	Number of Residential Parcels Less than or Equal 1/2 Acre	Number of Unsewered Residential Parcels Less than or Equal to ½ Acre	Total Residential Parcels	% of Unsewered Parcels Less than or Equal to 1/2 Acre
Babylon	58,377	15,291	59,485	25.7%
Brookhaven	119,535	92,253	151,672	60.8%
East Hampton	9,452	9,157	19,342	47.3%
Huntington	44,952	39,566	64,747	61.1%
Islip	78,796	47,143	88,138	53.5%
Riverhead	6,996	5,276	11,957	44.1%
Shelter Island	491	384	2,498	15.4%
Smithtown	28,181	24,985	37,643	66.4%
Southampton	17,776	17,114	37,365	45.8%
Southold	7,462	6,457	14,235	45.4%
Totals	**372,018**	**257,626**	**487,082**	**52.9%**

Source: Suffolk County Department of Economic Development and Planning

Over one third of the unsewered residential properties in Brookhaven and Huntington are less than or equal to one quarter acre. Approximately one quarter of the unsewered residential properties in Riverhead and Smithtown are less than or equal to one quarter acre, and over fifteen percent of unsewered residential properties in the east end towns of East Hampton and Southampton are also less than or equal to one quarter acre. Over eighty percent of the total residential properties in Babylon are less than or equal to one quarter acre; groundwater contamination resulting from the on-site septic systems prompted the implementation of the Southwest Sewer District in the 1970s.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

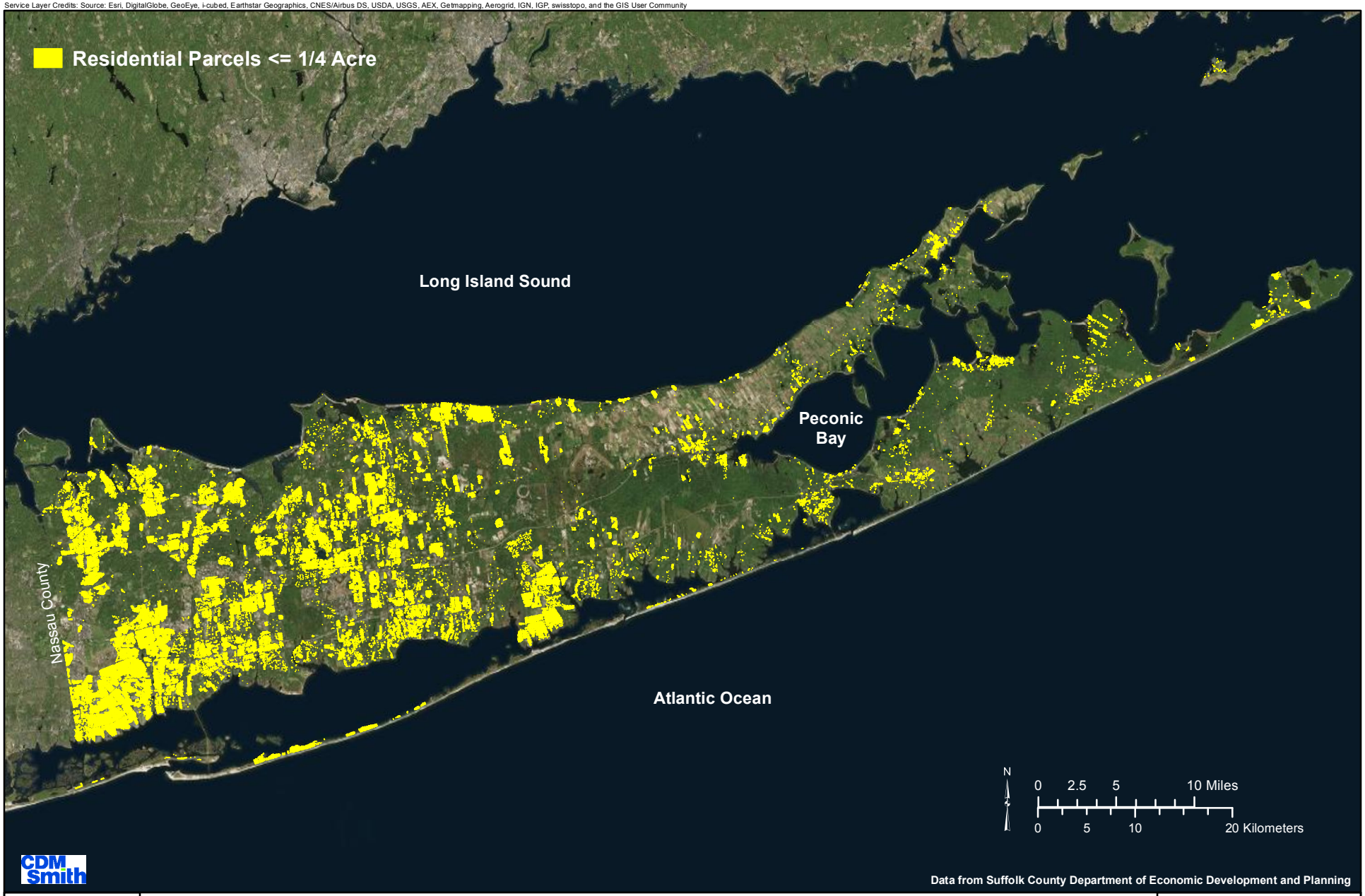


Residential Parcels Less Than or Equal to 1/2 Acre

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-10

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Residential Parcels Less Than or Equal to 1/4 Acre

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-11

Table 3-5 Residential Parcels Smaller than or Equal to One-Quarter Acre

Town	Number of Residential Parcels Less than or Equal ¼ Acre	Number of Unsewered Residential Parcels Less than or Equal to ¼ Acre	Total Residential Parcels	% of Unsewered Parcels Less than or Equal to ¼ Acre
Babylon	50,094	12,381	59,485	20.8%
Brookhaven	67,423	50,334	151,672	33.2%
East Hampton	3,479	3,186	19,342	16.5%
Huntington	27,373	22,608	64,747	34.9%
Islip	38,994	19,577	88,138	22.2%
Riverhead	4,064	2,926	11,957	24.5%
Shelter Island	128	53	2,498	2.12%
Smithtown	13,766	10,823	37,643	28.8%
Southampton	6,791	6,132	37,365	16.4%
Southold	2,791	1,927	14,235	13.5%
Totals	**214,903**	**129,947**	**487,082**	**26.7%**

Source: Suffolk County Department of Economic Development and Planning

While the exact number of on-site sanitary wastewater disposal systems that had been constructed prior to Article 6 could not be verified, it is evident that a significant number of smaller parcels do rely upon on-site septic systems for wastewater disposal, and nitrate levels in groundwater reflect these conditions. This is further corroborated by census data provided by SCDHS documenting the presence of over 340,000 on-site septic systems in Suffolk County in 1990, and SCDEDP estimates indicating that wastewater disposal for approximately 74 percent of County properties is provided by individual on-site sanitary systems consisting either of septic tanks or septic tanks and/or leaching pools.

A summary table showing the average parcel size for each residential land use category in each of the 29 wellfields that was evaluated for this study is summarized on **Table 3-6**, along with the percentage of residential parcels served by sanitary sewers, the GMZ in which the contributing area is located, the associated nitrate target concentration, and the average recent supply well nitrate concentrations. The target GMZ-specific nitrogen concentration is exceeded in groundwater from 16 of the 29 wellfields.

Table 6

Summary of Residential Parcel Size for All Parcels Intersecting the Water Table Contributing Areas for the 29 Identified Wellfields

Area	Wellfield	% Residential (2004)	Count of Parcels			Average Size of Parcels (sq ft)			Average Nitrate as Nitrogen (mg/L) 2004-2009			
			Low Density	Medium Density	High Density	Low Density	Medium Density	High Density	Low	High	GWMZ	Target (mg/L)
1	**Woodchuck Hollow Road**	53.04%	3	777	566	44,555	11,602	7,197	3.60	6.37	1	6
2	**Waterside Road**	74.52%	3	464	337	65,812	15,532	7,207	7.39	7.39	1	6
3	**Laurel Hill Road**	47.21%	43	119	53	57,907	23,883	5,779	3.39	3.81	1	6
4	**Belle Rose Avenue**	82.35%	1	81	0	49,157	20,743	0	5.70	5.70	1	6
5	**Larkfield Road / South Spur**	71.25%	3	158	7	48,023	20,142	6,191	7.95	7.95	1	6
6	**Schuyler Drive**	30.55%	8	612	18	43,318	11,871	5,985	4.96	9.33	1	6
7	**Vanderbilt Parkway**	89.61%	39	45	0	55,271	42,482	0	1.83	1.83	1	6
8	**Ryder Avenue**	70.32%	57	114	1	47,617	26,368	366	2.30	2.30	1	6
9	**Wheeler Road**	16.67%	1	44	1	71,632	21,560	201,516	2.57	5.00	1	6
10	**Oval Drive**	25.00%	6	59	2	48,462	27,059	52,922	5.04	5.65	1	6
11	**Wheat Path**	73.63%	59	487	22	56,883	20,682	5,094	2.17	4.21	3	4
12	**Mt. Sinai-Coram Road**	62.16%							8.59	8.59	8	6
	sewered		0	82	17	0	22,157	24,961				
	unsewered		7	68	5	47,717	25,659	2,384				
	% sewered (residential; area)		0	51%	97%							
13	**Bicycle Path**	66.97%							0.43	5.82	3	4
	sewered		0	217	3	0	16,478	6,388				
	unsewered		2	193	9	47,564	17,622	4,409				
	% sewered (residential; area)		0	51%	33%							
14	**Chestnut Street**	57.14%							0.50	1.07	3	4
	sewered		1	353	2	60,496	16,616	1,468,315				
	unsewered		10	376	17	52,501	18,047	4,644				
	% sewered (residential; area)		10%	46%	97%							
15	**Strathmore Court Drive**	61.78%							0.13	2.98	3	4
	sewered		0	455	205	0	16,801	26,226				
	unsewered		0	6	13	0	16,385	2,520				
	% sewered (residential; area)		0%	99%	99%							
16	**Hawkins Road**	54.30%							8.95	8.95	1	6
	sewered		0	2	0	0	17,269	0				
	unsewered		0	536	13	0	10,292	7,429				
	% sewered (residential; area)		0%	1%	0%							
17	**Eastwood Boulevard**	54.29%	0	93	0	0	10,913	0	4.69	4.69	1	6
18	**Boyle Road South**	52.94%	11	314	26	61,663	14,088	7,188	5.03	5.03	3	4
19	**Dare Road**	70.73%							5.75	5.75	3	4
	sewered		1	2	0	43,898	32,838	0				
	unsewered		8	171	12	49,299	23,006	6,595				
	% sewered (residential; area)		10%	2%	0%							
20	**Flint Lane**	43.18%							2.22	3.33	3	4
	sewered		0	206	97	0	16,485	16,869				
	unsewered		2	131	125	57,196	16,304	2,372				
	% sewered (residential; area)		0%	61%	85%							
21	**Meehan Lane**	64.22%							6.20	8.24	3	4
	sewered		10	3	1	87,284	24,932	6,579				
	unsewered		6	367	1	49,207	16,249	401,417				
	% sewered (residential; area)		75%	1%	1%							
22	**Pleasant Avenue**	76.19%	3	124	1	74,863	18,959	3,697	7.03	7.19	1	6
23	**Morris Avenue**	52.98%							3.52	4.92	1	6
	sewered		6	303	1	91,484	16,852	8,474				
	unsewered		7	452	7	75,195	18,698	5,168				
	% sewered (residential; area)		51%	38%	19%							
24	**Barton Avenue**	61.39%	15	229	10	57,815	19,043	5,003	6.61	6.85	3, 6	4
25	**North Country Road**	51.69%	2	103	1	112,681	22,700	7,987	3.58	3.58	3, 8	4, 6
26	**Moriches Riverhead Road**	0.00%	0	0	0	0	0	0	0.11	0.21	3	4
27	**Old North Road (Greenport)**	12.07%	4	3	0	104,996	23,577	0	8.16	8.89	4	6
28	**Ackerly Pond Lane**	4.67%	2	4	0	83,166	29,637	0	6.19	6.94	4	6
29	**Bridgehampton Road**	33.53%	10	117	2	55,252	29,381	8,154	2.74	8.05	5	4

Recognizing the impacts of fertilizer on our water resources, in 2007 Suffolk County passed Local Law 41-2007 to reduce the impacts of improper lawn fertilization on nitrogen loading to ground and surface waters.

The law prohibits fertilization from November 1st to April 1st, and allows imposition of fines of up to $1,000 for violations.

In addition, all new applicants or renewals for Suffolk County Home Improvement Contractors Licenses who apply fertilizer must take a Suffolk County-approved turf management class. As of 2014, 28 classes providing information on the proper use, application and timing of fertilization, native planting alternatives to fertilized landscapes, and the environmental consequences of nitrogen runoff were offered and 1,470 certificates have been issued.

Signs and brochures publicizing the prohibition of fertilization between November 1st and April 1st, describing appropriate fertilization techniques and explaining the impacts of nitrogen on water resources were updated, translated into Spanish and redistributed to all retail locations in Suffolk County where fertilizer is sold.

The contributing areas of eleven of the wellfields that currently exceed the GMZ nitrate target concentrations for nitrate include medium or high density residential parcels that are smaller than the 20,000 or 40,000 ft² designation established by Article 6. These sites are in towns that were developed long before the adoption of Article 6. The elevated nitrate concentrations in three of the other five wellfields appear to result from agricultural use within the contributing area; nitrate levels in a fourth wellfield also appear to result from historical agricultural use in the contributing area.

The data shows that a significant number of on-site sanitary wastewater disposal systems do serve properties that are less than the minimum lot sizes designated in Article 6; observed nitrogen levels in Suffolk County groundwater result from a combination of the Article 6-compliant and the older non-compliant parcels. In general, GMZ target nitrogen levels are achieved in areas where unsewered residential density is compliant with Article 6 density requirements; GMZ target nitrogen levels are exceeded in unsewered areas developed at higher densities prior to enactment of Article 6. Regulation of residential density in areas relying upon on-site wastewater disposal is widely implemented across the country to manage impacts on groundwater quality. In order to provide further perspective on the adequacy of the residential density limits included in the Suffolk County Sanitary Code, housing density limits in similar unsewered areas relying upon groundwater for potable supply elsewhere throughout the country were reviewed. Information available to characterize residential density restrictions based upon nitrogen loadings across the country identified a minimum lot size of one half acre for unsewered areas, although minimum lot size requirements in some areas of the country were larger. The half-acre minimum lot size is consistent with Article 6 requirements.

While not exhaustive, information on permissible residential densities in unsewered areas was collected from other sources throughout the country, with the following results:

- No communities were identified that allow a development density greater than 2 dwelling units per acre in areas that are both unsewered and rely upon groundwater for water supply.

- Unsewered areas that historically allowed greater than 2 dwelling units per acre report groundwater and/or surface water contamination that led to either code changes or subsequent construction of sanitary sewers.

Nitrate levels remained less than or equal to 6 mg/L in nearly 88 percent of all public supply wells tested in 2013; the 10 mg/L MCL was exceeded in untreated water from less than one percent of public supply wells.

Nitrate levels have continued to increase in all three aquifers over the study period from 1987 to 2013. Nitrates were detected in more wells, and generally at higher concentrations in 2013 than in the past. Significant increases in nitrogen levels have been observed in groundwater in parts of Huntington, Smithtown and northern Brookhaven.

The average nitrate concentration, and the number of public supply wells with nitrate concentrations in excess of 6 mg/L have increased, based on a comparison of nitrate levels measured in the same set of public supply wells in 1987 and again in 2013.

Article 6 of the Sanitary Code has been successful in achieving target nitrate levels in areas that have been developed subsequent to enactment in 1980 – however observed nitrate levels in groundwater result from a combination of Article 6-compliant and older non-compliant parcels.

Existing regulatory programs have been successful in limiting the impacts of the County's 1.5 million residents on nitrate levels; however, additional efforts to reduce nitrogen loading to the aquifer will be required to maintain the integrity of the groundwater supply for future generations and reduce the loading and subsequent impacts to Suffolk's water resources.

- Additional details can be found in the Task 5.2 memorandum (**Future Land Use Impacts**, CDM, 2008).

The observed nitrogen levels in groundwater, which have increased in some areas since the ***1987 Comp Plan***, result from a combination of the Article 6-compliant and the older non-compliant parcels. Building upon the work documented in the ***1987 Comp Plan***, several evaluations of parcel size and downgradient groundwater nitrogen concentration have been conducted which demonstrate that nitrate levels increase with increasing density. However, existing water quality data and land use information are not always straightforward to interpret, given the variation in land use, density, household size and nitrogen loading in any given area of interest. Therefore, an assessment of the impacts of hypothetical unsewered areas of various densities on nitrogen levels in groundwater was performed for an area in southern Brookhaven, using the detailed modeling framework previously established during the task 5.5 modeling effort. The modeling assessment was a hypothetical exercise, in that it assumed that the study area was comprised completely of developments of uniform lot sizes of ¼ acre, ½ acre, 1 acre and 2 acres.

The groundwater flow model was run using the model inputs, stresses, and boundary conditions that have been documented in the Task 5.5 Memorandum, **Refined Source Water Assessments** (CDM, 2009) and nitrogen loading rates documented in the Task 5.2 Memorandum. From within the modeled region, a pilot area covering approximately 8,000 acres was selected to examine the effects of nitrogen loading resulting from various uniform residential densities on groundwater quality. This pilot area was chosen to be within the relatively undeveloped Pine Barrens Region and beyond the influence of streams. The pilot area contains five public supply wells screened in the upper glacial aquifer. A series of model simulations was performed to assess the groundwater nitrogen levels associated with hypothetical unsewered residential developments of uniform densities of 2 acres, 1 acre, ½ acre and ¼ acre, respectively. The household nitrogen loading rate was assumed to be based upon a 3.1 person household, with each person discharging 10 pounds of nitrogen each year to the septic system; furthermore thirty-five percent of the discharged nitrogen load was assumed to be removed within the septic system. In addition, for the purposes of this exercise, all of the simulated nitrogen was assumed to be nitrate as

nitrogen.

Fertilizer use is a second significant source of nitrate to the aquifer system. Suffolk County has implemented a plan to reduce the impacts of fertilizer on ground and surface water features. Recognizing the impacts of fertilizer on our water resources, in 2007 Suffolk County passed Local Law 41-2007 to reduce the impacts of improper lawn fertilization on nitrogen loading to ground and surface waters. The law, which went into effect in 2009, includes a variety of components, including prohibition of fertilization from November 1st to April 1st, a requirement that licensed landscapers (approximately 1,200 in Suffolk County in 2010) complete a turf management course, and allows imposition of fines of up to $1,000 for violations.

Signs and brochures publicizing the prohibition of fertilization between November 1st and April 1st, describing appropriate fertilization techniques and explaining the impacts of nitrogen on water resources were updated, translated into Spanish and redistributed to all retail locations in Suffolk County where fertilizer is sold.

Fertilizer sales in Suffolk County have declined by over 11 percent since the law took effect in 2009, however they still significantly higher than fertilizer sales in other counties within New York State.

A second set of model simulations was used to assess the effects of nitrate released from fertilizer on nitrate levels in unsewered areas of various densities; in all cases, this assessment assumed that 2.5 pounds of nitrogen is applied each year for each 1,000 ft^2, that 23 percent of each parcel is fertilized, and that 20 percent of the applied nitrate reaches the water table.

The simulated nodal concentrations representing nitrate concentrations averaged over the top 40 feet of saturated aquifer thickness throughout the pilot area are shown for 4, 10, and 20 year intervals for each of the development densities considered on **Figures 3-12** through **3-15**. Consistent with observed data throughout the County, **Figure 3-12** shows that nitrate concentrations resulting from discharge of sanitary wastewater via on-site septic systems in areas with ¼ acre zoning exceed the drinking water standard of 10 mg/L in the shallow aquifer. **Figure 3-13** shows that ½ acre lots are successful in maintaining groundwater nitrate levels at less than 10 mg/L. Nitrate levels resulting from on-site wastewater disposal on 1 acre and 2 acre properties remain less than 4 mg/L in downgradient groundwater as shown by **Figures 3-14** and **3-15**.

Time histories of simulated nitrate concentrations pumped out of three centrally located public supply wells within the pilot area were also evaluated.

The simulated pumped nitrate concentrations for each of the eight scenarios simulated are shown in **Figure 3-16**. The results, which assumed an initial background nitrate concentration of zero, illustrate that it can take years for the impacts of a development to be manifested at a downgradient wellfield. Shallow supply wells with contributing areas within the developed zone will show increased nitrate levels more quickly, while it may take many years for deeper supply wells located miles downgradient of their contributing areas to reach equilibrium nitrate concentrations.

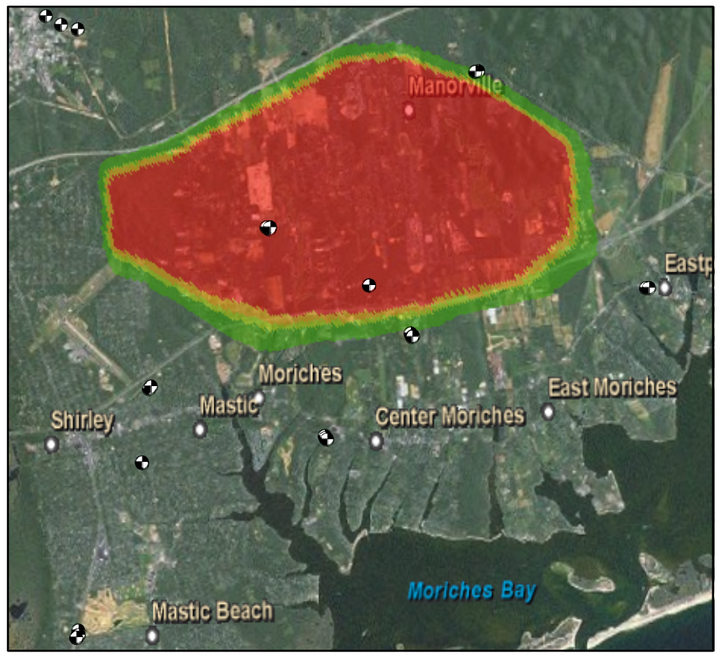
This hypothetical evaluation did not include allowance for streets; incorporation of roadway areas within a development would tend to reduce the simulated concentrations that are shown here. However, the evaluation was also based upon a background nitrate concentration of zero. In actuality, depending upon the previous land use, background nitrate levels could range from 0.5 mg/L (undeveloped) to over 10 mg/L (historical agricultural use); which would increase the final nitrate levels shown.

It is recommended that an evaluation of modifying Article 6 to require a minimum lot size of one acre for new development utilizing on-site sewage disposal systems be considered for other areas, such as Zone IV, to reduce nitrogen loading to surface waters from groundwater baseflow.

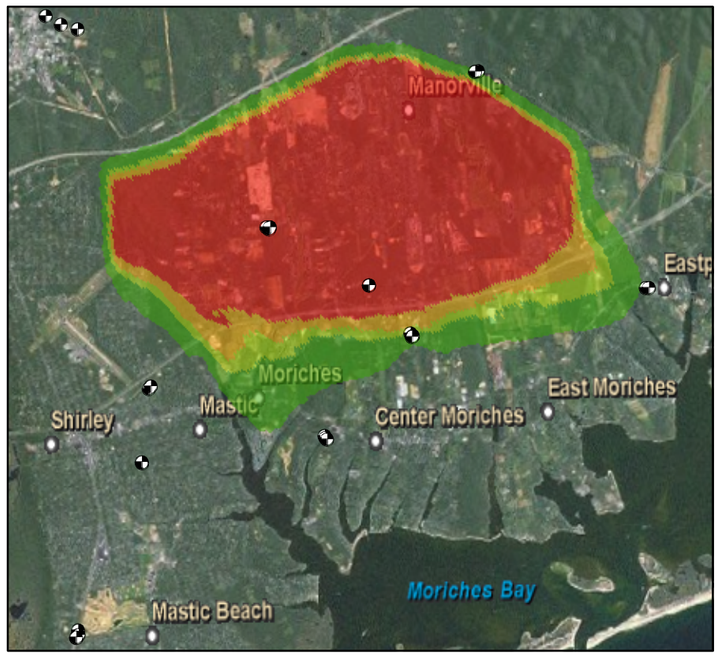
Building upon the body of SCDHS work over the past decades, the evaluations relating land use to observed nitrate levels completed as part of this study (e.g., documented in task memoranda 5.1, 5.2, and 18), review of density/nitrate relationships established elsewhere in the country, and these most recent model results, it is recommended that the Suffolk County Board of Health consider modifying Article 6 to require a minimum lot size of one acre for the use of individual on-site sewage disposal systems in realty subdivisions and developments in additional areas of the County. While nitrate concentrations resulting from an area of uniform ½ acre density are simulated to be close to 6 mg/L, new development occurs within the framework of properties that have already been developed; many pre-1980 developments include parcels that are less than ½ acre or even ¼ acre in size.

The North Shore Embayment Watershed Management Plan (SCDHS, 2007) reported that groundwater was the greatest contributor of nitrogen to the embayments within the study area; this appears to be the case along the entire north shore. The recommended minimum of one acre zoning in unsewered areas of Hydrogeologic Zone IV will also reduce nitrogen loading to surface waters from groundwater baseflow. While this recommendation focuses upon nitrogen criteria, it was also developed in recognition of the fact that many other contaminants of potential concern can also be introduced to the subsurface from on-site wastewater disposal.

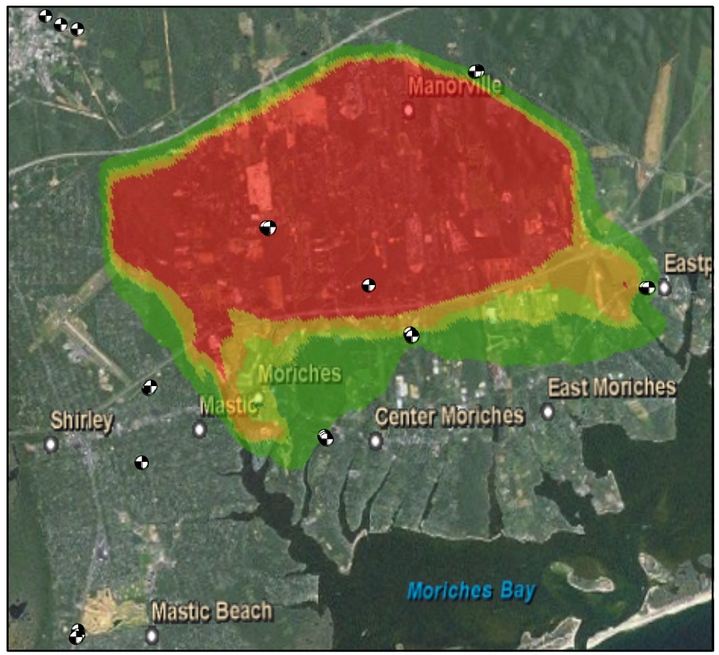
Quarter Acre Density 4 yr No Fertilizer



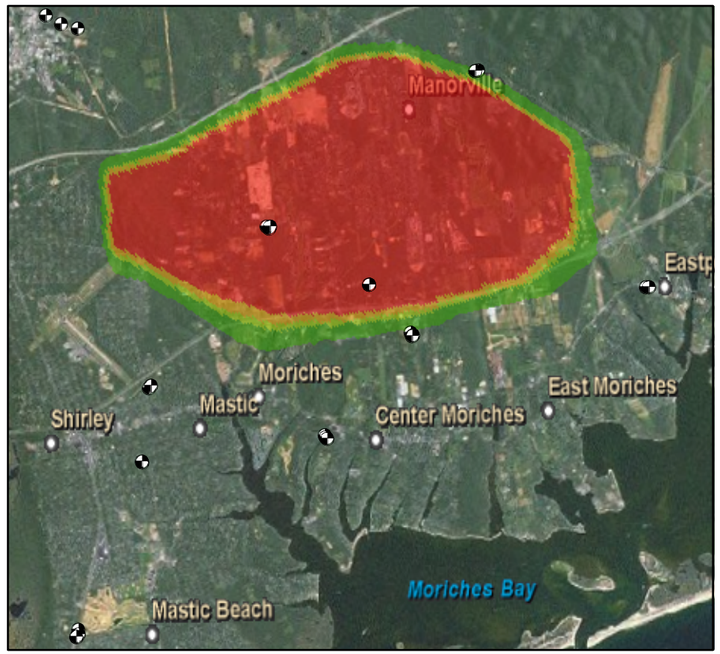
Quarter Acre Density 10 yr No Fertilizer



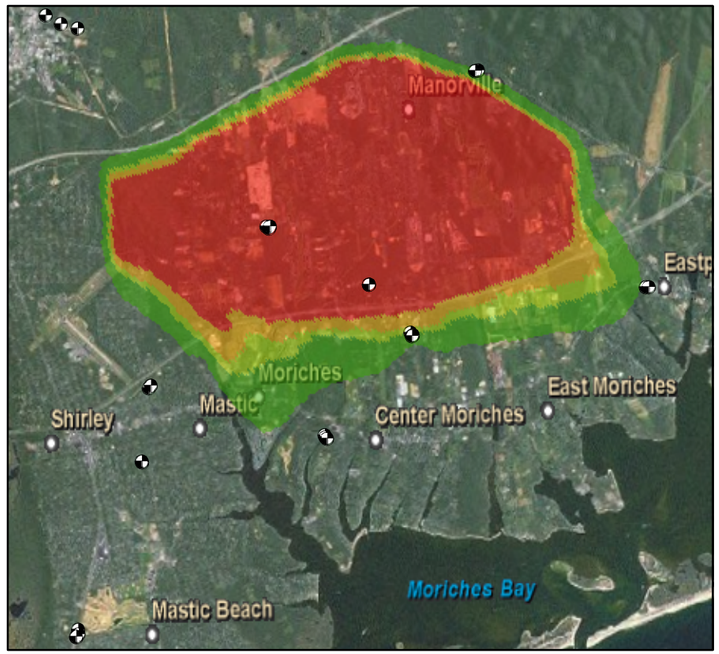
Quarter Acre Density 20 yr No Fertilizer



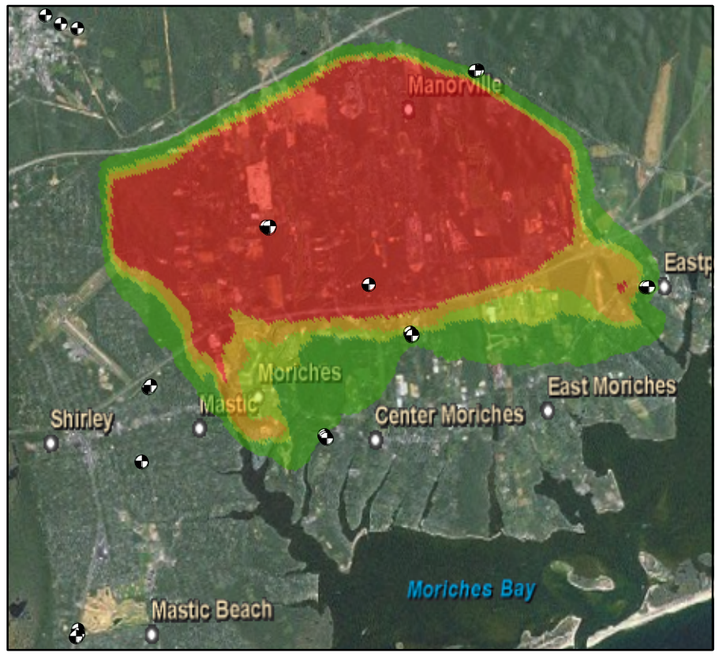
Quarter Acre Density 4 yr Fertilizer



Quarter Acre Density 10 yr Fertilizer



Quarter Acre Density 20 yr Fertilizer



CDM

Nitrogen (mg/l)

- 0.5 - 4
- 4 - 6
- 6 - 10
- > 10

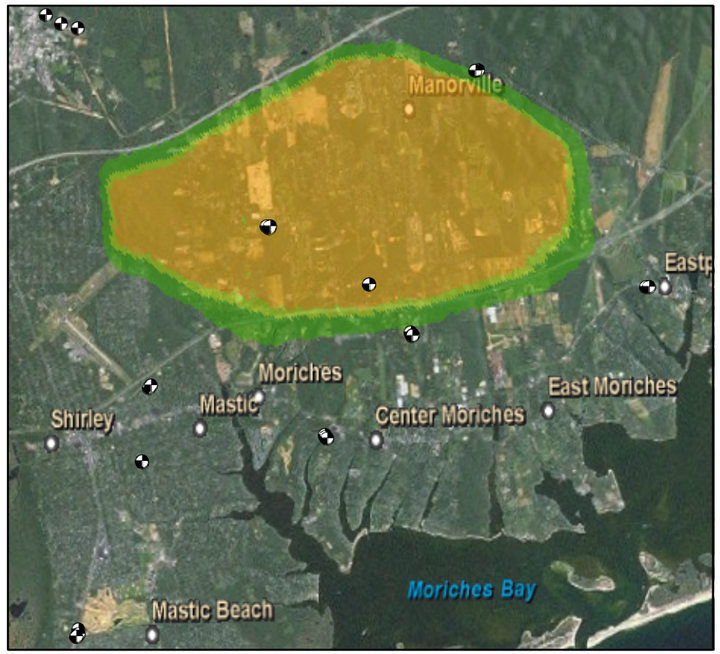
Supply Well

Nitrogen Loading Simulation - 1/4 Acre Density

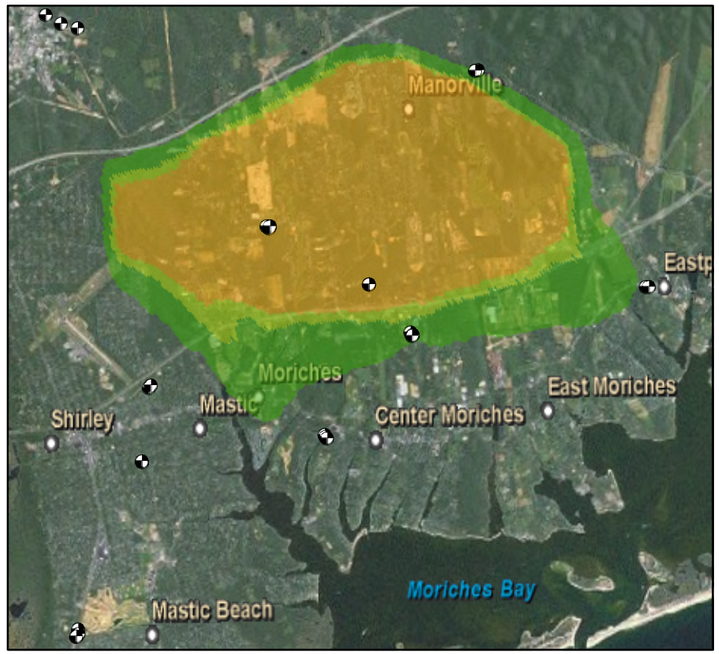
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-12

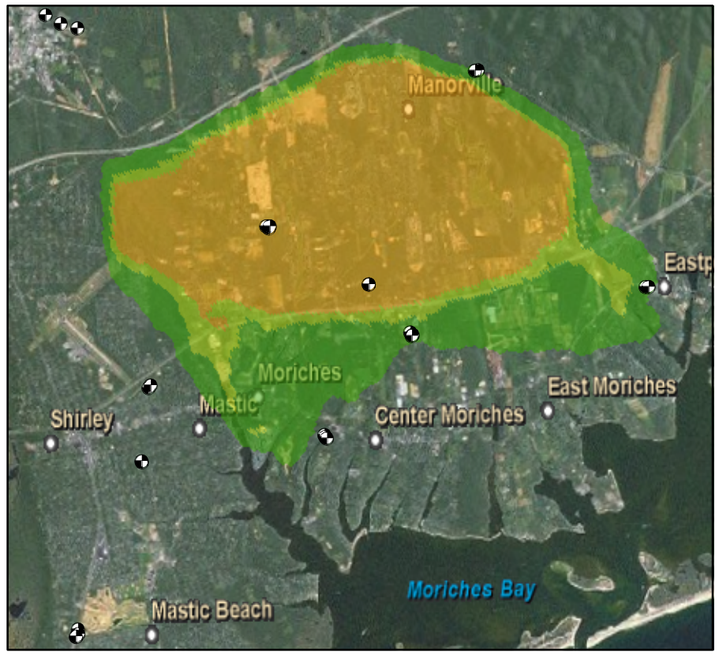
Half Acre Density 4 yr No Fertilizer



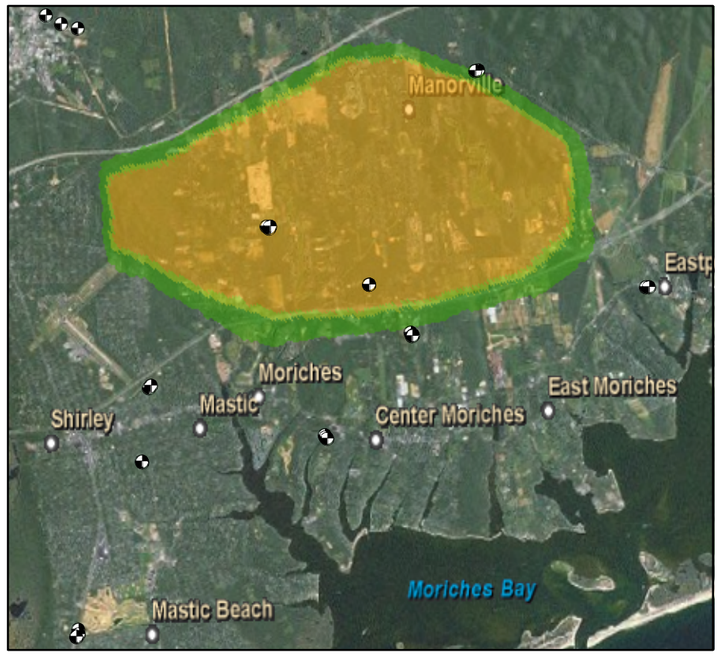
Half Acre Density 10 yr No Fertilizer



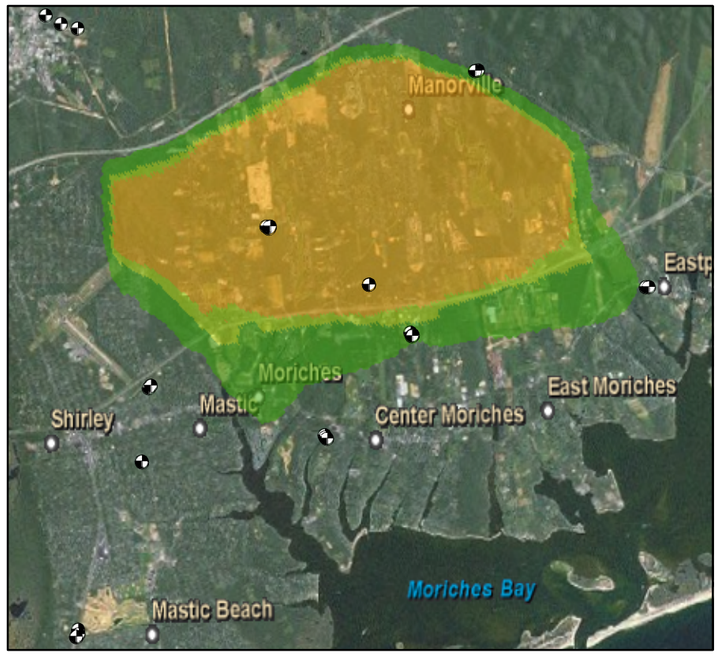
Half Acre Density 20 yr No Fertilizer



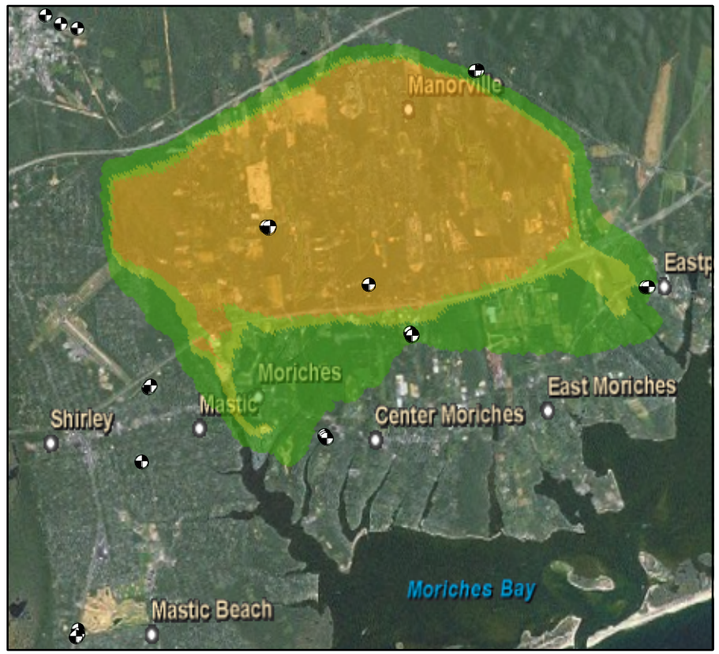
Half Acre Density 4 yr Fertilizer



Half Acre Density 10 yr Fertilizer



Half Acre Density 20 yr Fertilizer



CDM

Nitrogen (mg/l)

- 0.5 - 4
- 4 - 6
- 6 - 10
- > 10

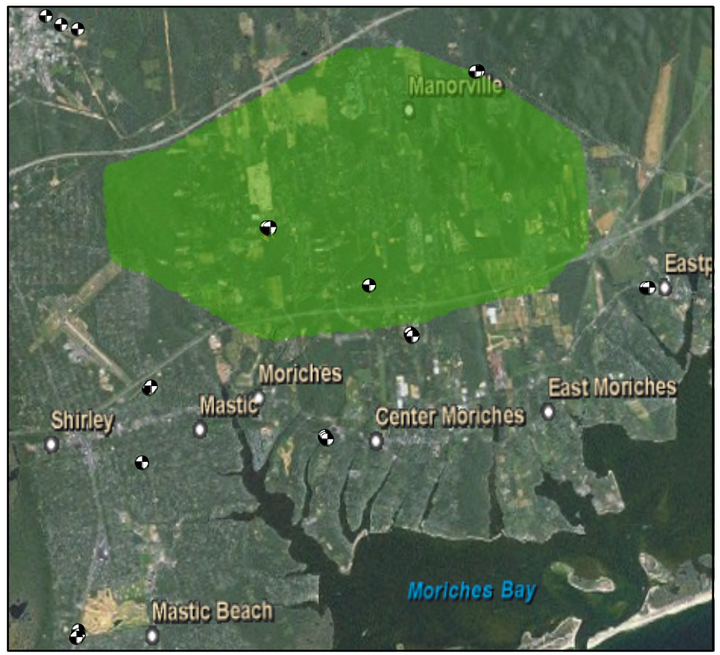
Supply Well

Nitrogen Loading Simulation - 1/2 Acre Density

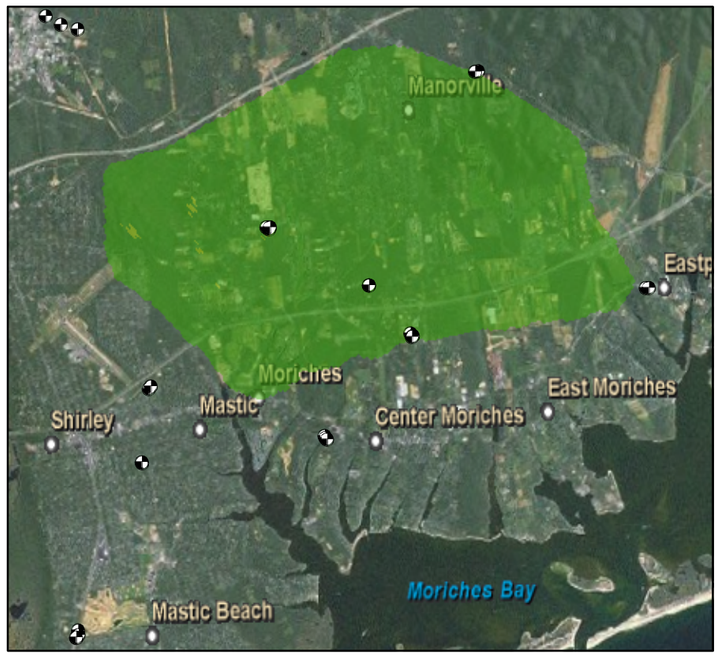
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-13

1 Acre Density 4 yr No Fertilizer



1 Acre Density 10 yr No Fertilizer



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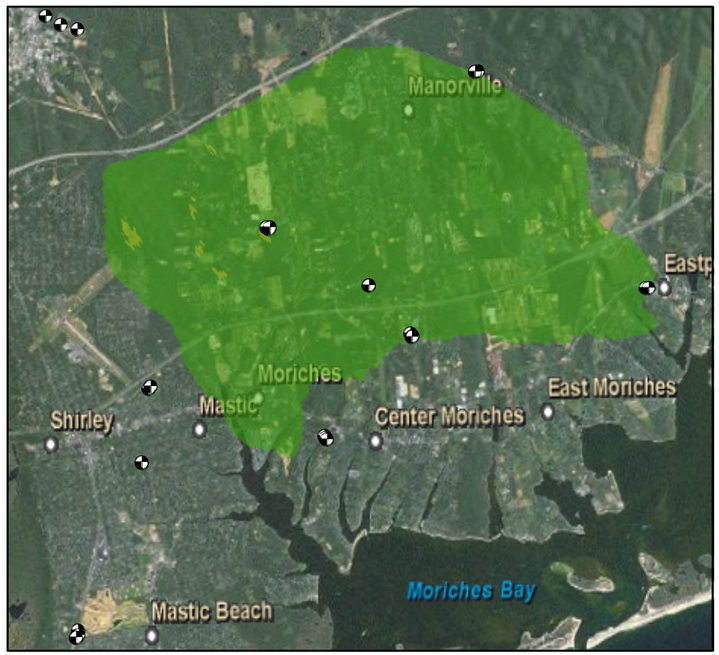
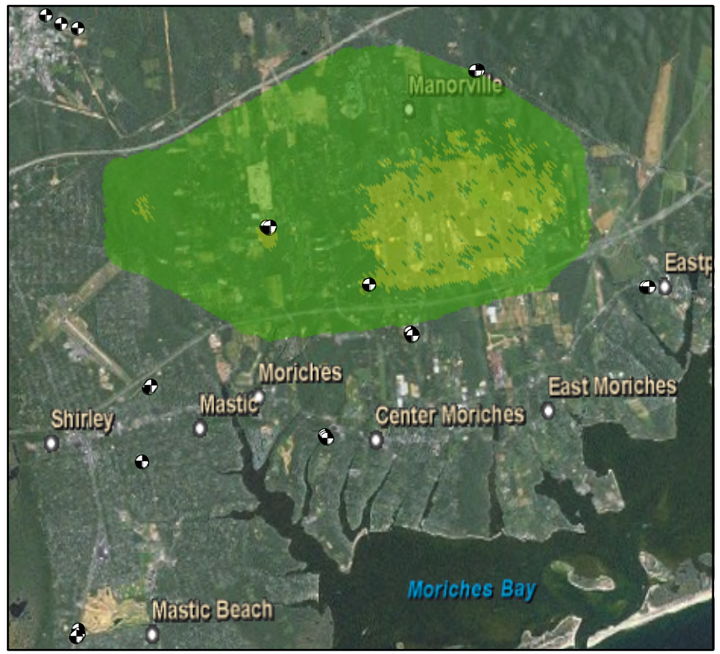
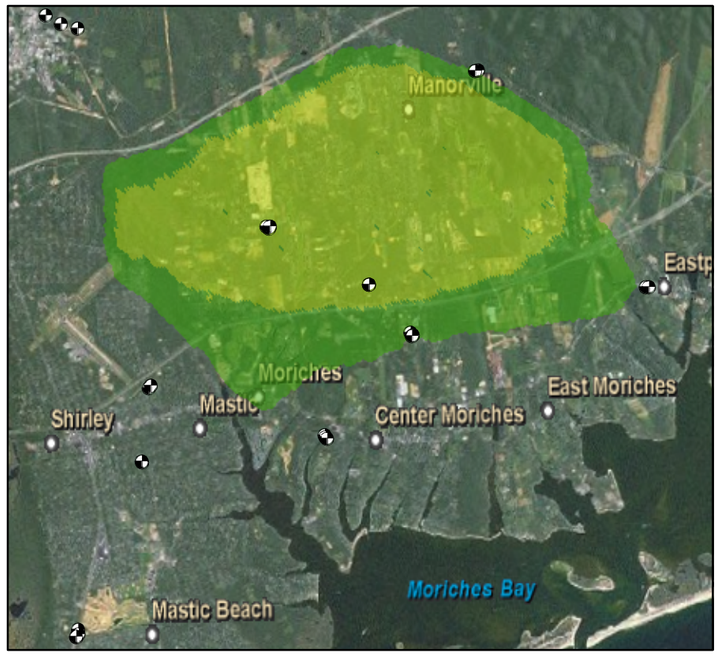


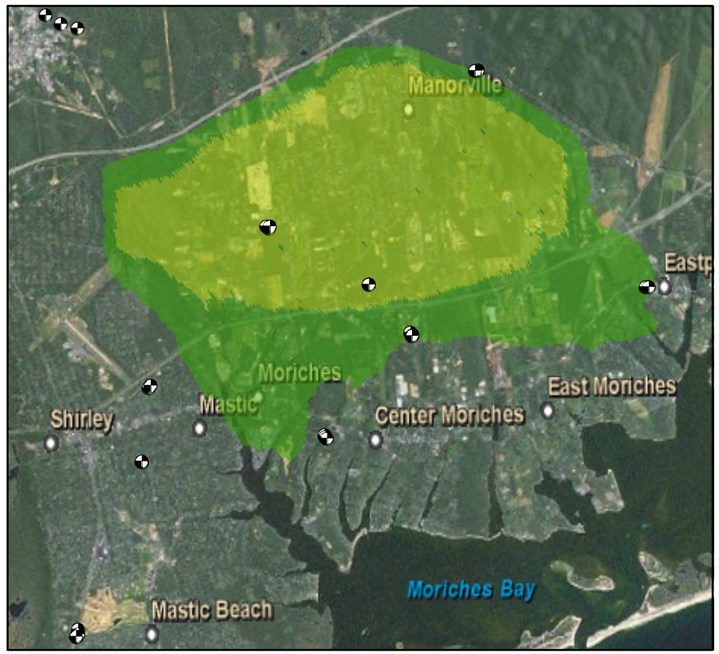
1 Acre Density 4 yr Fertilizer



1 Acre Density 10 yr Fertilizer



1 Acre Density 20 yr Fertilizer



CDM

Nitrogen (mg/l)

- 0.5 - 4
- 4 - 6
- 6 - 10
- > 10

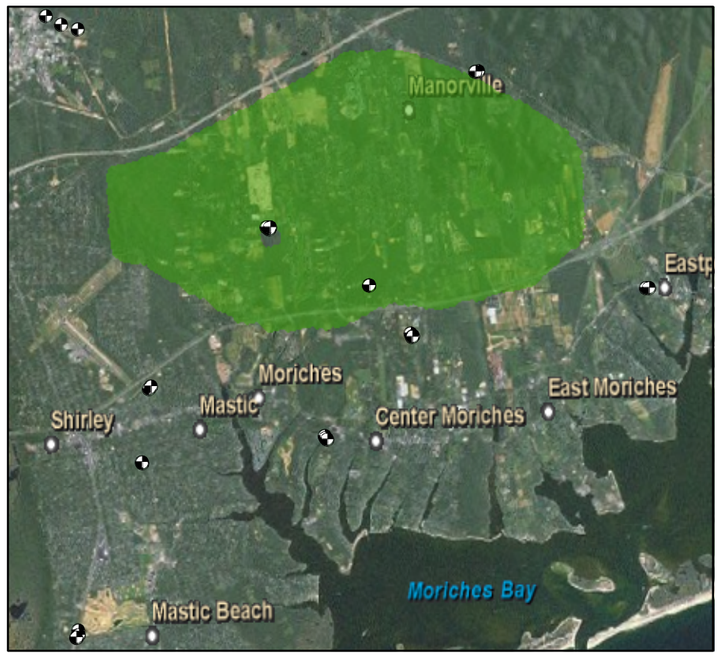
Supply Well

Nitrogen Loading Simulation - 1 Acre Density

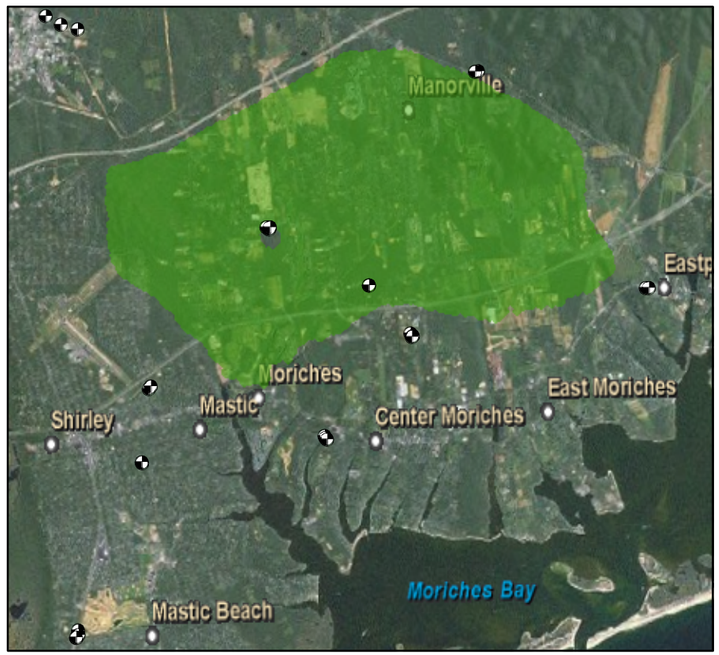
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-14

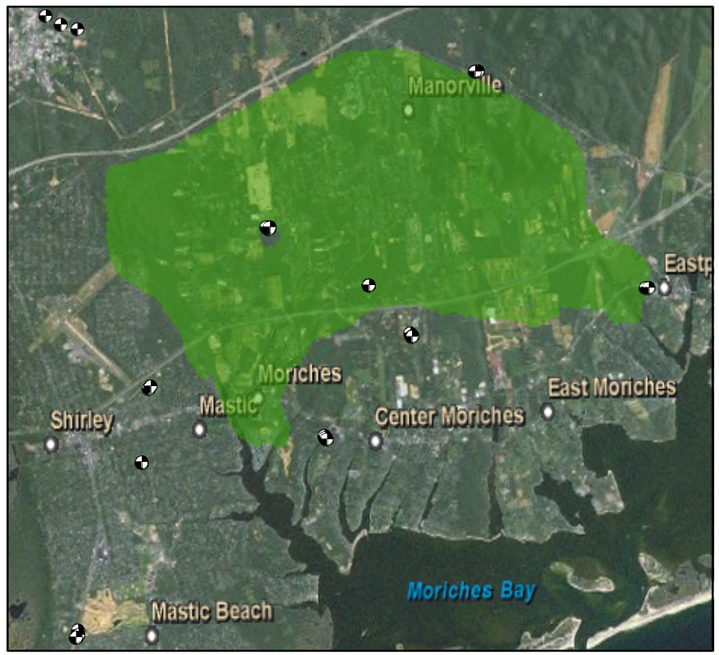
2 Acre Density 4 yr No Fertilizer



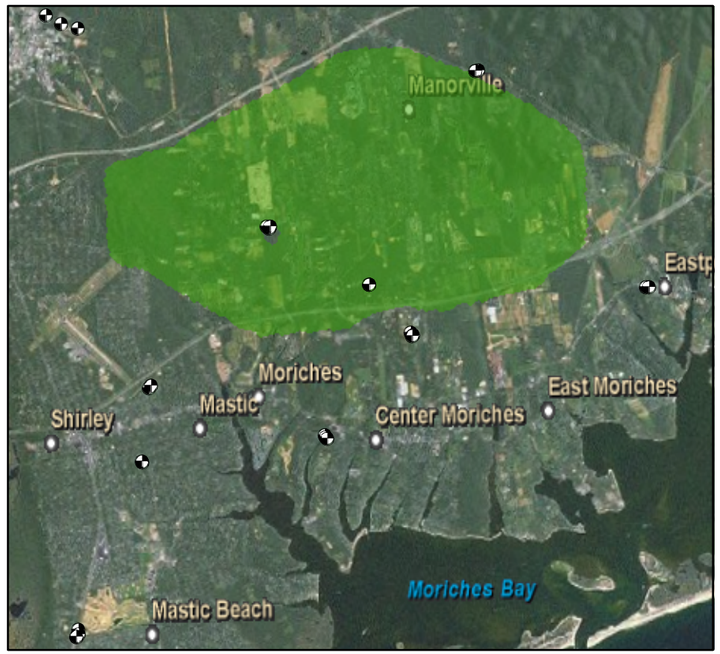
2 Acre Density 10 yr No Fertilizer



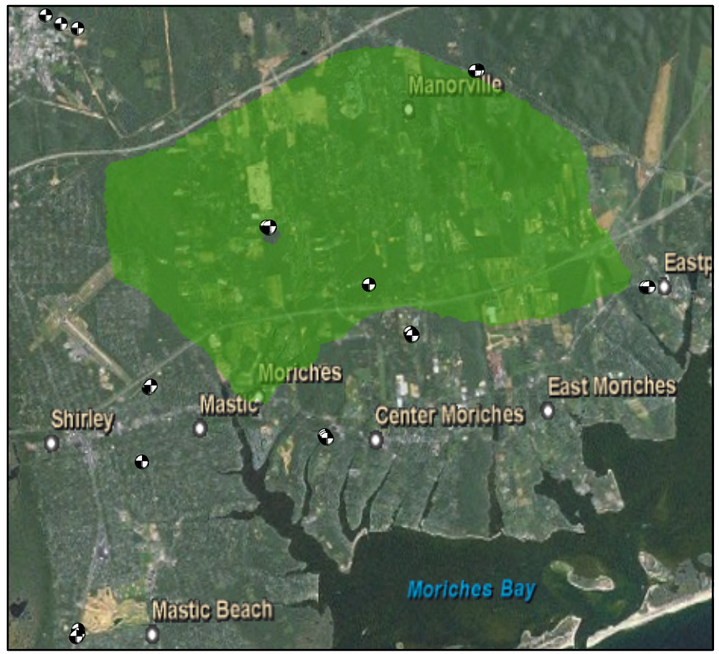
2 Acre Density 20 yr No Fertilizer



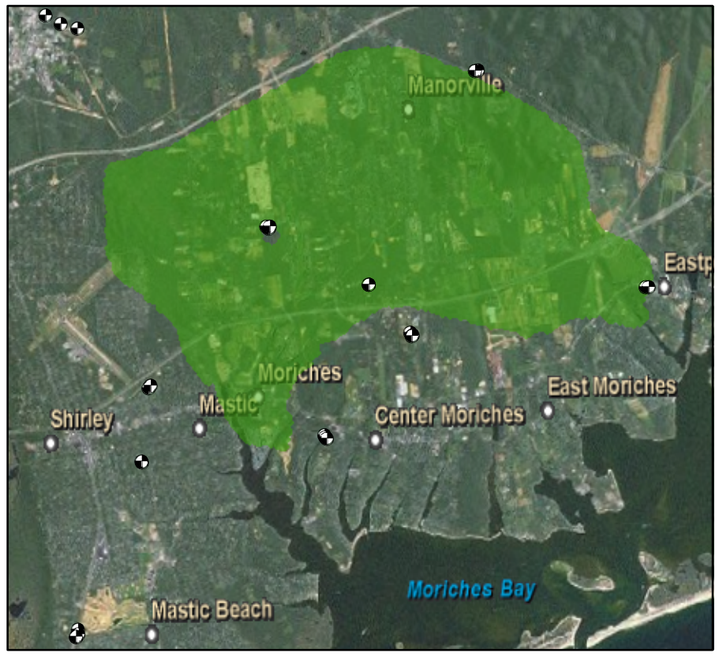
2 Acre Density 4 yr Fertilizer



2 Acre Density 10 yr Fertilizer



2 Acre Density 20 yr Fertilizer



CDM

Nitrogen (mg/l)

- 0.5 - 4
- 4 - 6
- 6 - 10
- > 10

Supply Well

Nitrogen Loading Simulation - 2 Acre Density

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-15

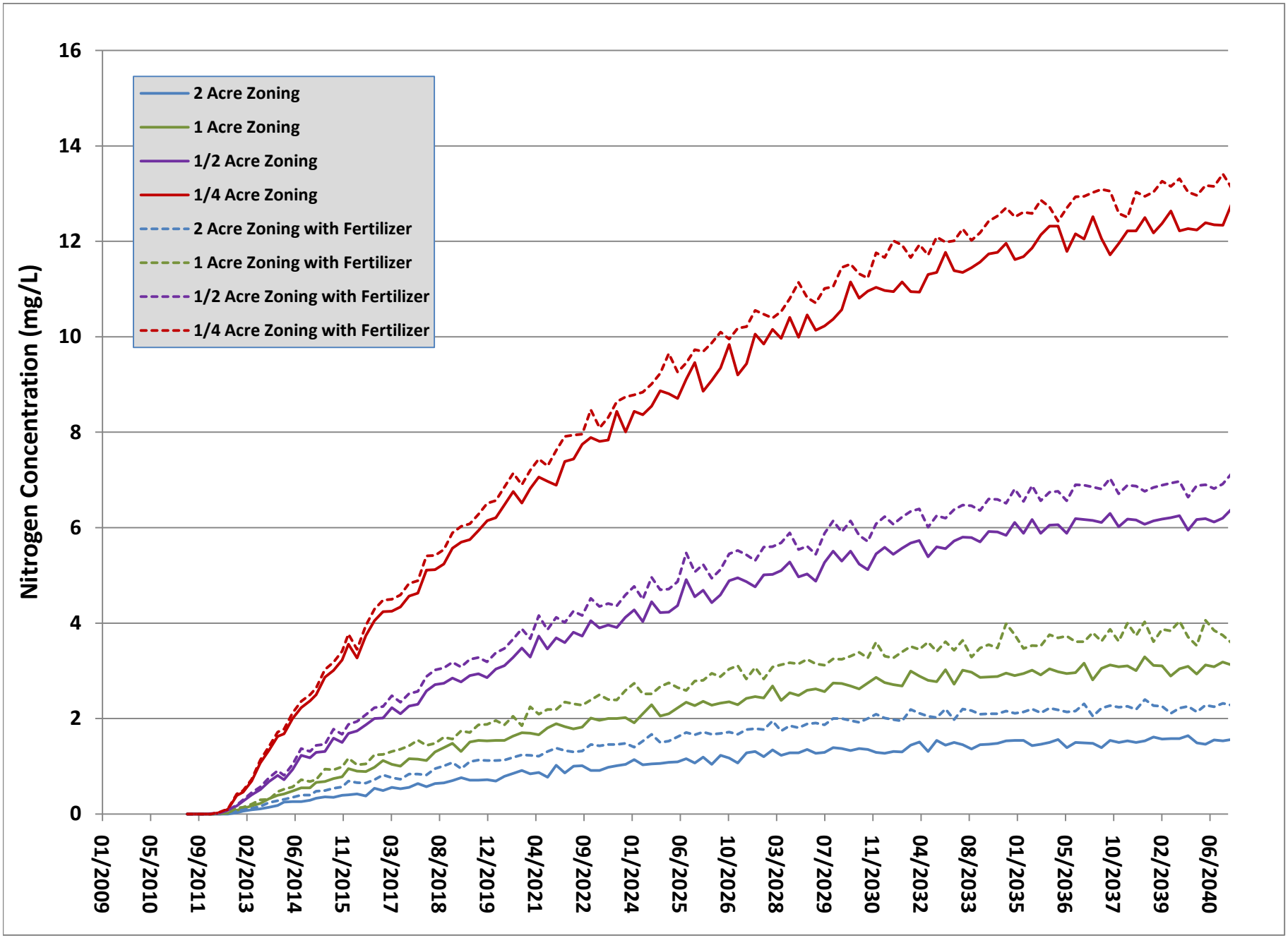


Figure 3-16
Simulated Hypothetical Nitrogen Concentrations at SCWA Country Club Drive Wellfield

The source water assessments considered each community supply well's susceptibility to contamination by VOCs.

The potential for VOCs to be used, stored or disposed of in areas used for commercial, industrial, or transportation purposes was presumed to be greater than for areas with residential uses. The presence of a variety of potential point sources within a contributing area to introduce VOC contamination to the aquifer was also assessed, using databases available from Suffolk County and NYSDEC.

VOCs are widely detected in community and non-community supply wells throughout the County and there are more than 125 VOC removal plants in the form of granular activated carbon (GAC) or air strippers. Although raw water detections are generally below the current MCL of 5 µg/L, water suppliers construct the VOC removal plants as a proactive approach to remove even low level contaminants to provide the best water quality possible.

Although the VOC removal plants exist throughout the County, they are costly to construct and to operate.

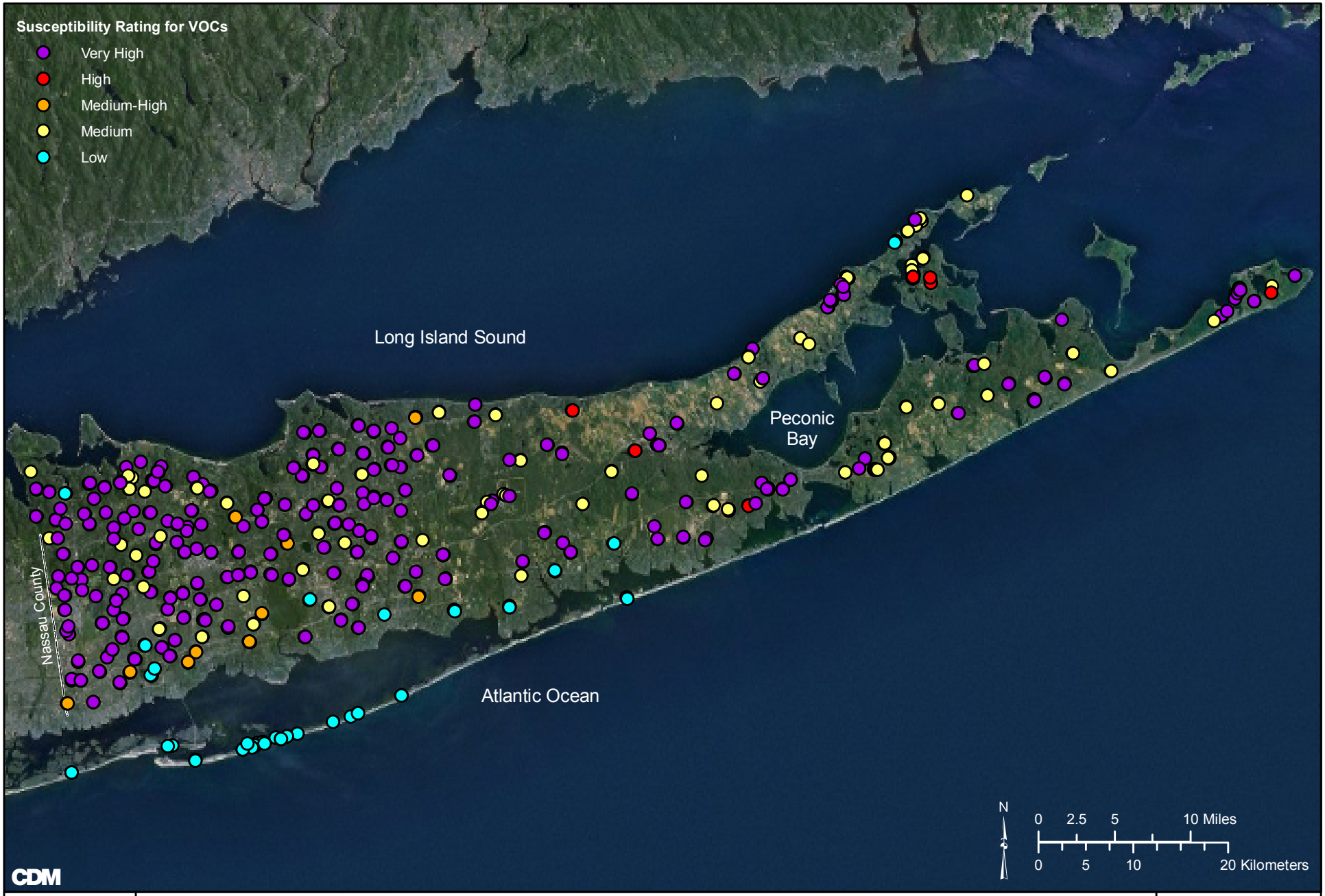
Although residential development can have an adverse impact on groundwater quality, particularly with regard to nitrate, land use impacts to groundwater are certainly not limited to residential development. Agricultural practices in the eastern part of the County also adversely impact groundwater by introducing nitrate to underlying groundwater supplies.

3.1.1.4 Volatile Organic Compounds

The ***1987 Comp Plan*** identified contamination by synthetic organic chemicals as the greatest threat to Suffolk County groundwater quality; volatile organics (solvents and degreasers such as tetrachloroethylene, trichloroethylene and trichloroethane) and hydrocarbons associated with fuel (benzene, toluene and xylene) were identified as the most commonly detected VOCs. Use of VOCs as solvents and degreasers became widespread beginning in the mid-1940s. VOCs are also present in products such as paint, cleaning agents, deodorants, adhesives, and polishing products that were commonly used by industries, commercial establishments, and homeowners without disposal restrictions until the mid-1970s, when VOCs began to be detected in groundwater. VOCs can be both mobile and persistent in the natural environment and many are known carcinogens.

As described in the Task 5.5 memorandum, the susceptibility of nearly seventy percent of community supply wells in the County was rated as high or very high for contamination by VOCs. Although the very high susceptibility rating does not mean that these wells will be impacted by VOCs, it indicates that a potential source of VOC contamination is present in the area contributing recharge to the supply well. Susceptibility ratings for VOCs at community supply wells located throughout the County are shown on **Figure 3-17**.

Although SCDHS, the SCWA and all other community suppliers routinely analyze groundwater for a large number of VOCs, most are not detected in Suffolk County groundwater. This study focused on three of the VOCs that have been most frequently detected in Suffolk County groundwater through the years - tetrachloroethene (PCE), trichloroethene (TCE) and 1,1,1-trichloroethane (TCA), along with MTBE, a gasoline additive that was widely detected in groundwater samples in recent years. The evaluations are based primarily upon samples collected by SCDHS and SCWA from public supply wells, supplemented by SCDHS private well sampling data.



Community Supply Well Susceptibility Rating for VOCs

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-17

PCE has been detected most frequently in the western part of the County, with increased levels observed in unsewered areas of Huntington and Smithtown.

South Huntington Water Plant

PCE was not detected in 92% of the public supply wells sampled from 2009 through 2013.

Average PCE concentrations in the same set of 160 upper glacial aquifer supply wells sampled in both 1987 and 2013 increased from 0.30 µg/L to 0.58 µg/L; the average PCE concentrations in the same set of 210 Magothy supply wells increased from 0.31 µg/L to 0.71 µg/L.

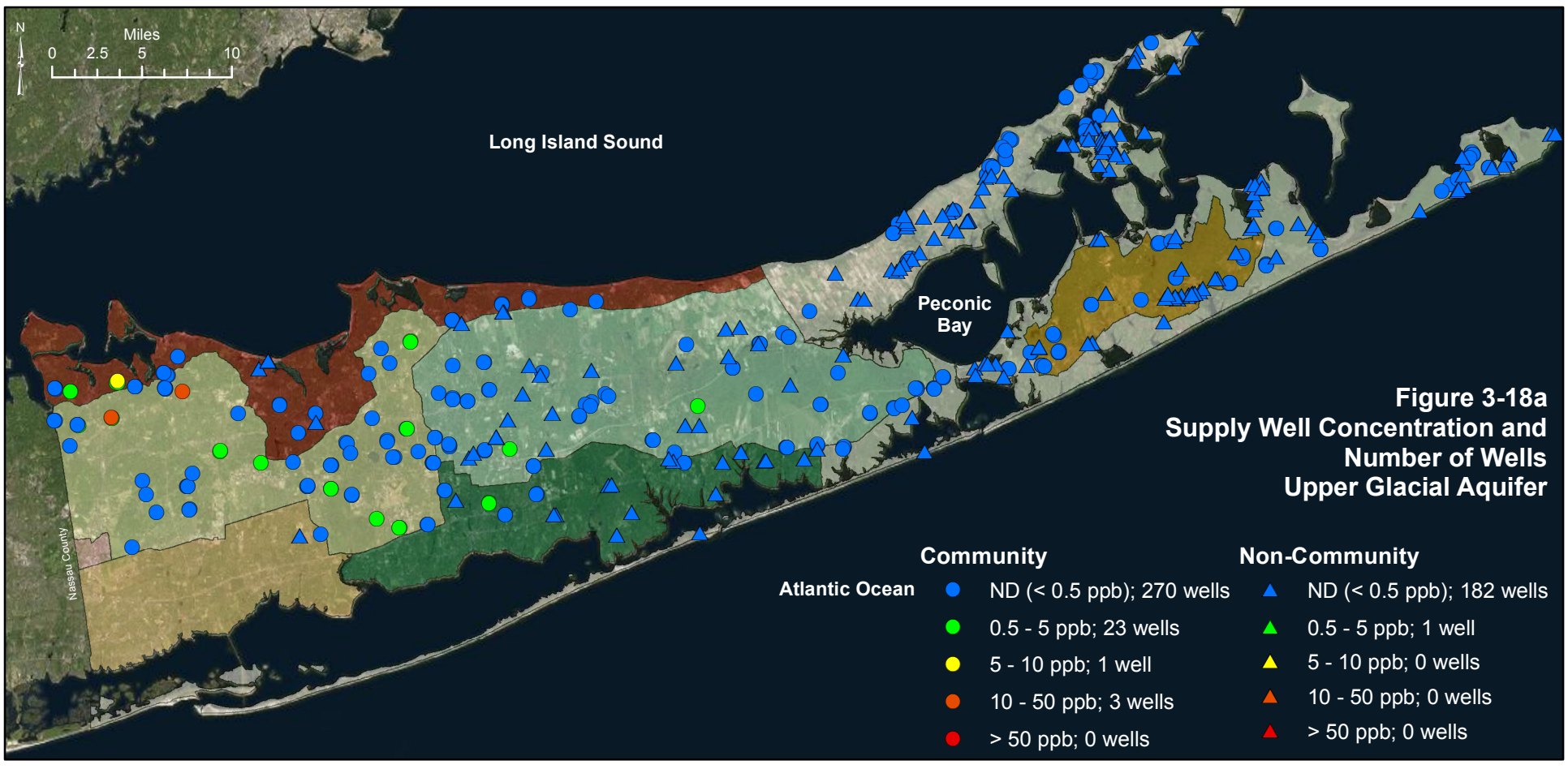
Tetrachloroethene (PCE)

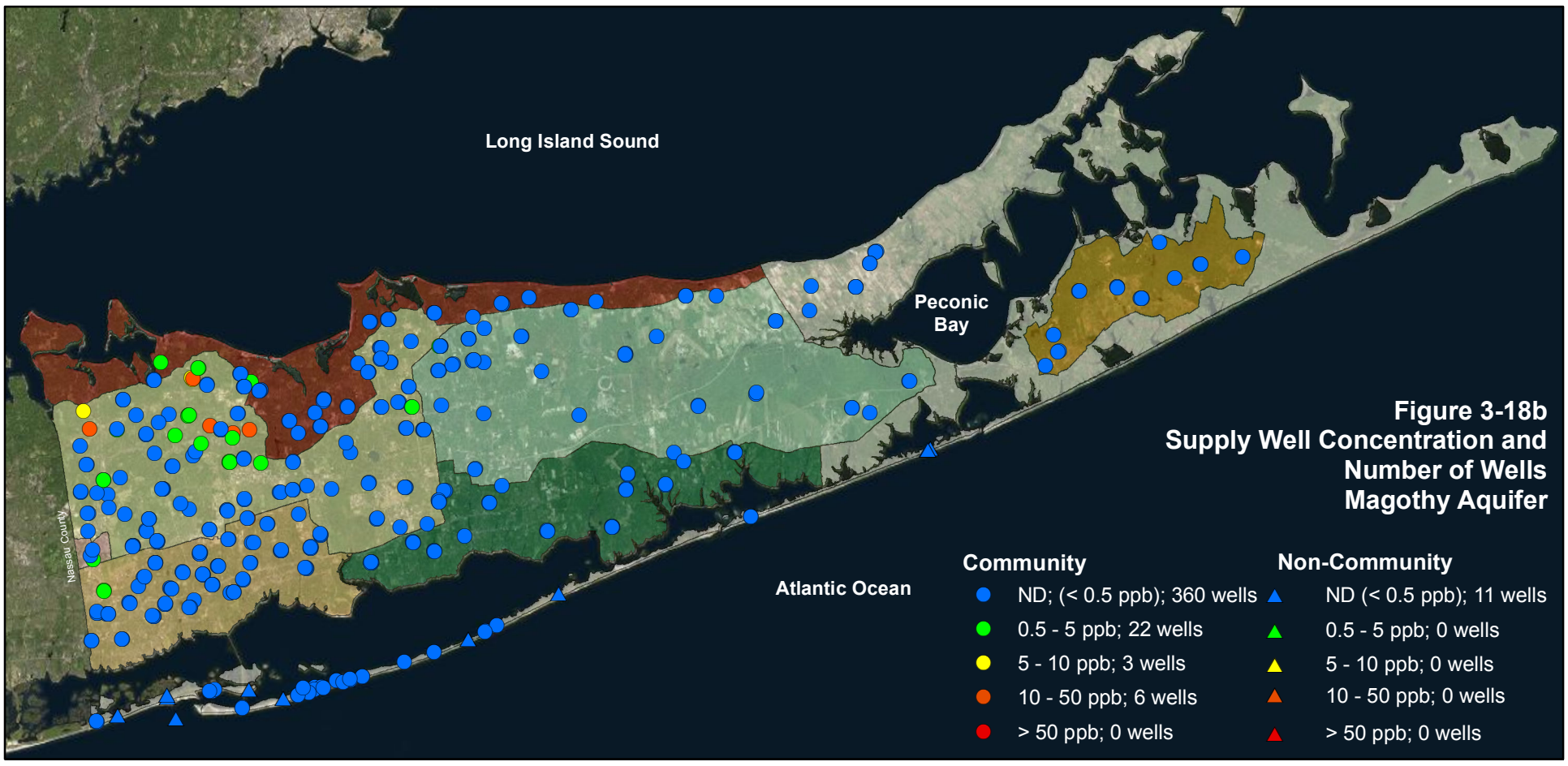
Tetrachloroethene is primarily used as a solvent and is widely used in the dry cleaning industry because it dissolves many organic materials. It is also used as a metal degreaser and in the manufacture of various other chemicals. The USEPA has established PCE as a carcinogen, and has developed an MCL of 5 µg/L. The average concentrations of PCE in raw water sampled from community and non-community supply wells in 2013 are shown on **Figures 3-18a, 3-18b** and **3-18c** for the upper glacial, Magothy, and Lloyd aquifers, respectively. Most PCE detections have been observed in wells in the western part of the County, with only a few detections at very low levels in eastern towns.

Table 3-7 summarizes average annual PCE concentrations for supply wells that were sampled in both 1987 and in 2013. The percentiles shown in **Table 3-7** are based on well averages, while reported maximum and minimum values are based on the entire sample sets. The data shows that PCE has not been detected in 92 percent of the supply wells sampled from 2009 through 2013, and PCE levels in raw water samples collected from over 98 percent of the supply wells tested remain below the drinking water standard of 5 µg/L. However, a comparison of PCE levels in wells that were sampled in both years indicates that PCE was detected in over three times as many wells in 2013 as in 1987 and that increased PCE levels have been observed in unsewered areas of the towns of Huntington and Smithtown.

Although PCE was detected in more wells in 2013 than in 1987, this is at least partially attributable to the fact that advances in analytical technology allow analysts to detect increasingly lower levels of contaminants, including PCE, in the environment. For most wells tested in Suffolk County, the reported limit of detection in 1987 was 1 µg/L, while the reported detection limit in 2013 was 0.5 µg/L. In 2013, PCE concentrations in 15 of the 63 wells with PCE detections were below 1 µg/L. However, average PCE concentrations almost doubled from 0.30 to 0.58 µg/L in the 160 upper glacial public supply wells in the same- set analysis, indicating that degraded water quality is also partially responsible for the increased detections. (For the purposes of this comparison, non-detects in 1987 were assumed to be equal to 0.25 µg/L, or ½ the detection limit in 2013. Therefore, comparisons and calculations including concentrations of "ND" were similar.) A similar trend is seen in the same-set Magothy wells where average PCE concentrations increased from 0.31 µg/L to 0.71 µg/L. Only one of the wells sampled in both 1987 and 2013 exceeded the 5 µg/L MCL in 1987, while five wells in the dataset exceeded the standard in 2013. While no PCE was detected in the Lloyd aquifer in 1987, it was detected in four Lloyd wells in 2013, at an average concentration of 3.52 µg/L. However, as shown on **Figure 3-**

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





CDM Smith

Average Tetrachloroethene Concentration in the Upper Glacial, Magothy & Lloyd Aquifers Community and Non-Community Supply Wells - 2013

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-18

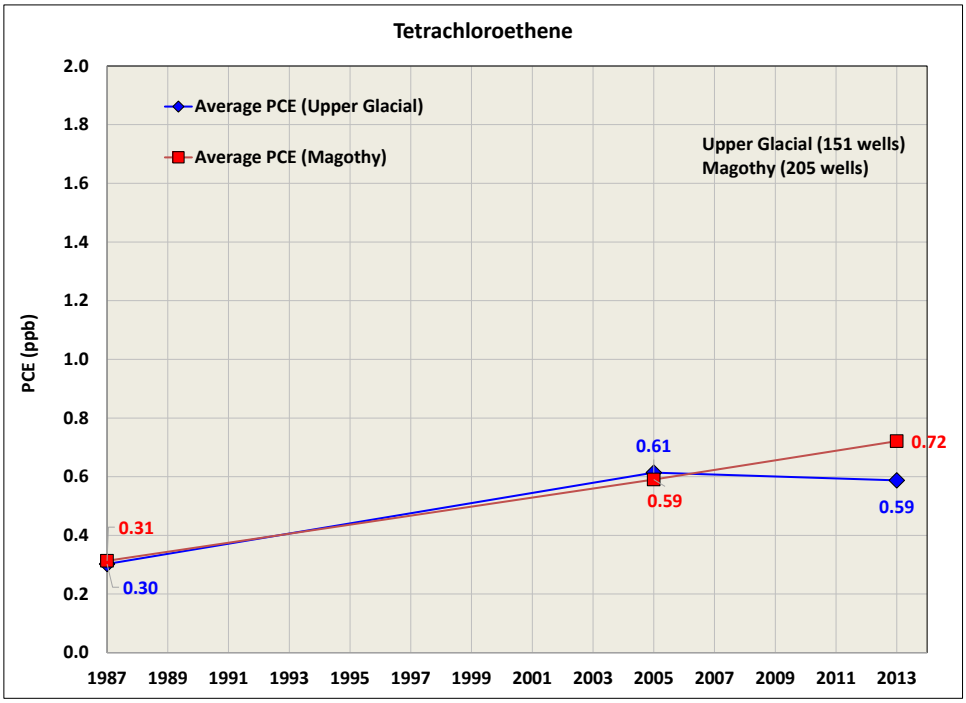
Table 3-7 Tetrachloroethene (PCE) Concentrations from Community and Non-Community Supply Wells

Aquifer	1987	2009-2013	2013	Same Set Wells 1987	Same Set Wells 2013
Upper Glacial Aquifer					
n (wells)	588	570	489	160	160
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	160	93	50	11	14
Average (µg/L)	0.60	0.43	0.48	0.30	0.58
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	ND	ND	ND	ND	0.7
No. of wells with detects	20	44	28	5	18
No. of wells with Detect > 5 µg/L	3 / 2	7 / 5	4 / 4	1 / 0	3 / 3
Magothy Aquifer					
n (wells)	279	418	402	210	210
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	8	49	39	8.00	25.00
Average (µg/L)	0.31	0.64	0.71	0.31	0.71
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	ND	ND	ND	ND	0.61
No. of wells with detects	9	38	31	7	22
No. of wells with Detect > 5 µg/L	2 / 1	11 / 10	9 / 9	1 / 1	5 / 5
Lloyd Aquifer					
n (wells)	4	5	5	1	1
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	ND	3.80	3.80	ND	ND
Average (µg/L)	ND	1.48	3.52	ND	ND
10th Percentile (µg/L)	ND	0.49	0.55	ND	ND
50th Percentile (µg/L)	ND	1.44	2.10	ND	ND
90th Percentile (µg/L)	ND	2.48	3.52	ND	ND
No. of wells with detects	0	4	4	0	0
No. of wells with Detect > 5 µg/L	0/0	0 / 0	0 / 0	0 / 0	0 / 0

Notes:
1. Data compiled from SCDHS databases.
2. Averages and percentiles calculated from annual well averages.
3. No. of wells > 5 µg/L is based on well maximum and averages, respectively (max/avg).

18c, these wells are all located in northwest Suffolk County, where the Lloyd aquifer is much closer to the surface than much of the County. Detections of VOCs are not anticipated within the Lloyd aquifer throughout most of Suffolk County.

Considering a slightly different data set (e.g. the same set of 151 supply wells screened in the upper glacial aquifer that were sampled in 1987, 2005 and 2013), the trend lines shown below shows that the average concentration of PCE in the upper glacial aquifer has remained relatively stable between 2005 and 2013, while the concentration in the same set of 205 wells screened in the Magothy aquifer has continued to increase. As shown, average concentrations remain below the MCL of 5 µg/L.



Photograph of a typical GAC unit

Although untreated groundwater from the vast majority of supply wells remains in compliance with MCLs, the data shows an increasing trend.

TCE was detected in more wells and at higher average concentrations in 2013 than in 1987. Most TCE detections were observed in unsewered areas of the western part of the County.

Trichloroethene (TCE)

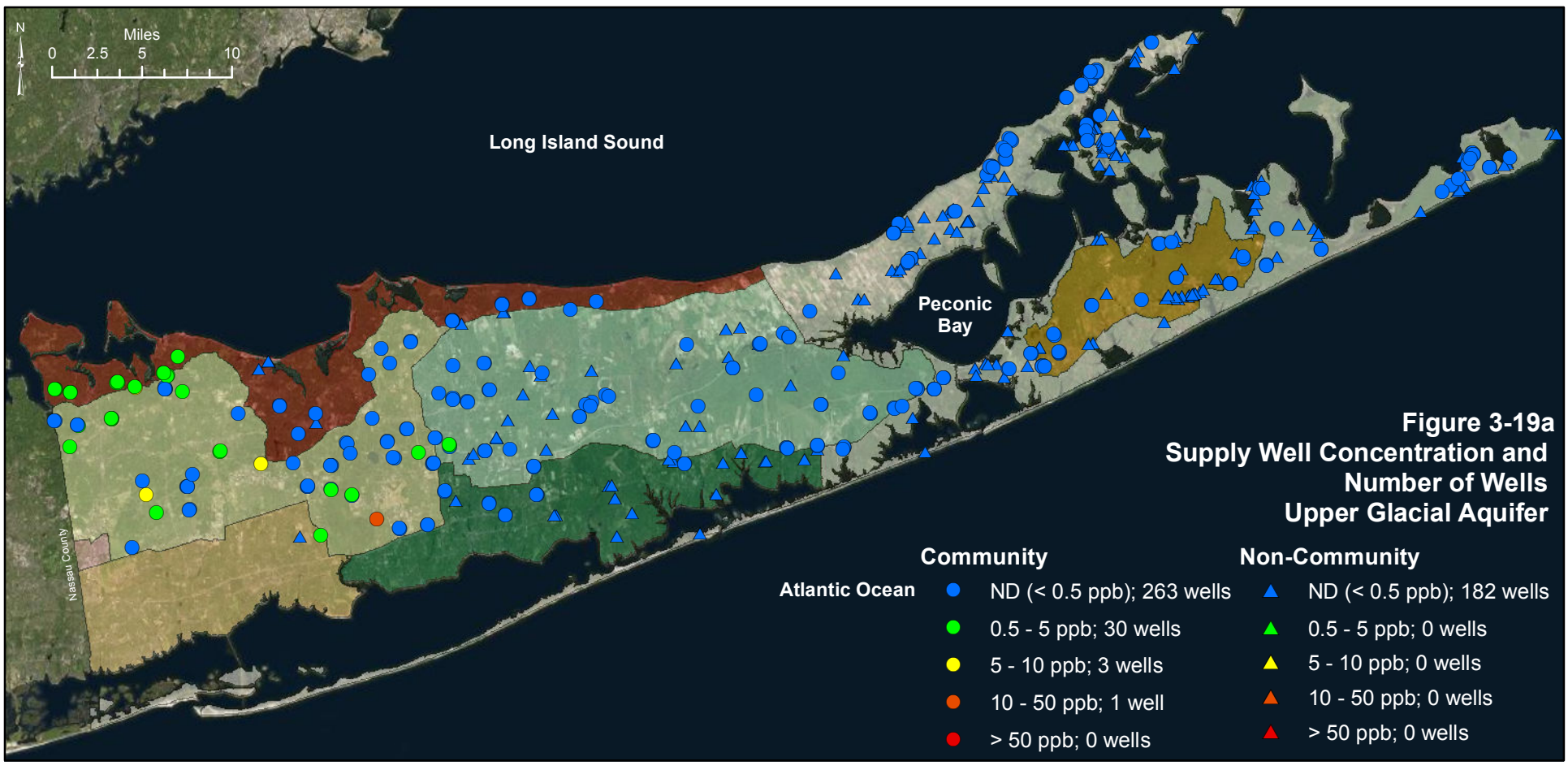
Trichloroethene has been widely used since the 1930s as a degreasing agent for cleaning fabricated metal (HSIA, 2001). It is also used in the dry cleaning industry and is a degradation product of PCE. The average concentrations of TCE in raw water sampled from community and non-community supply wells in 2013 are shown on **Figures 3-19a, 3-19b** and **3-19c** for the upper glacial, Magothy, and Lloyd aquifers, respectively. Detections were observed in the western part of the County in the towns of Islip, Huntington and Smithtown, TCE was not detected in active East End supply wells at the time.

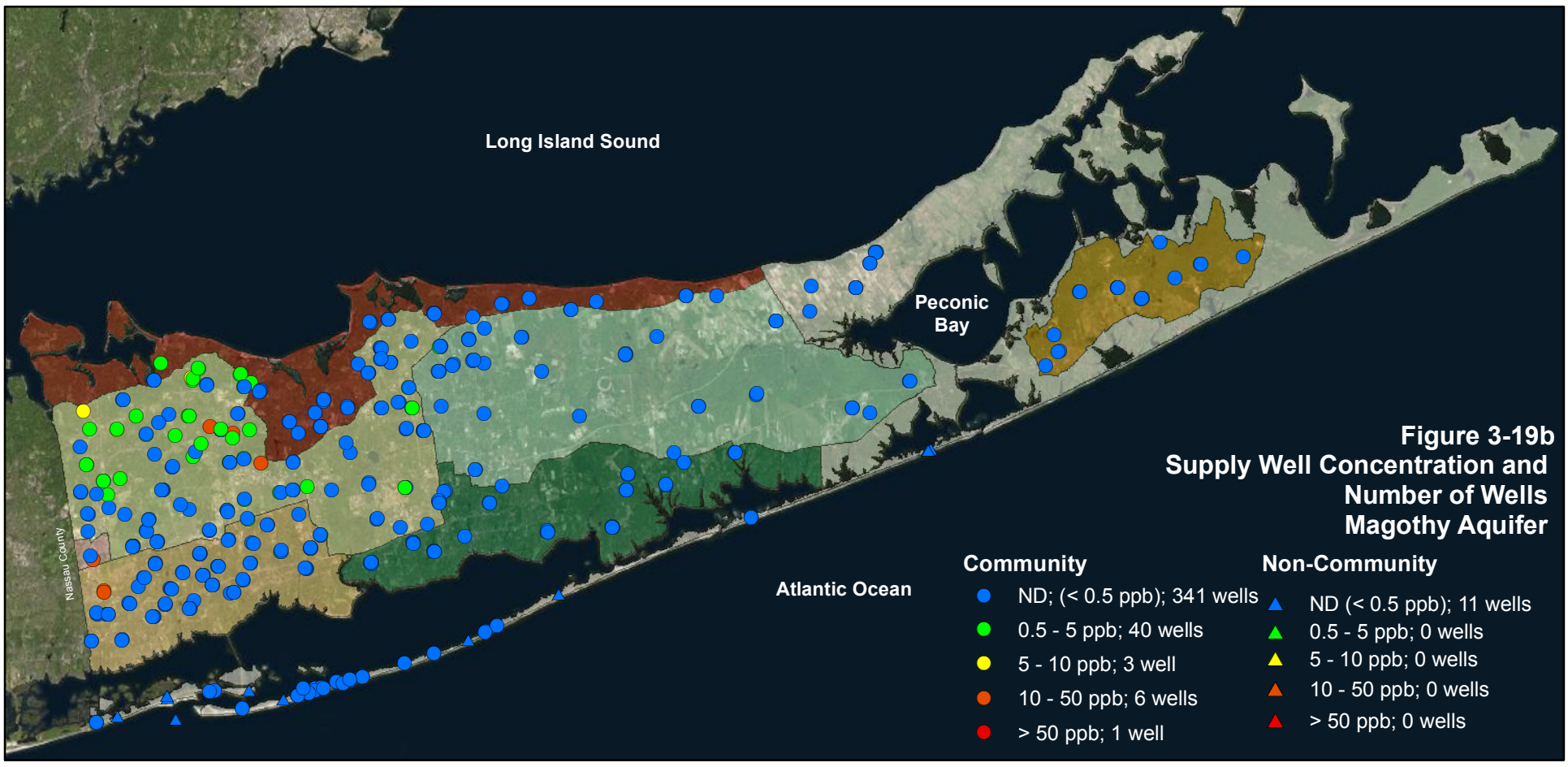
Table 3-8 summarizes average annual TCE concentrations for supply wells that were sampled in both 1987 and in 2013. Although TCE was detected in more wells in the sample set in 2013 than in 1987, it was not detected in 84 percent of the wells, and concentrations in over 98 percent of supply wells remained below the drinking water standard of 5 µg/L. TCE was not detected in the single Lloyd well sampled in either year. Increased TCE concentrations were identified in several Magothy supply wells in the western towns. As shown in **Table 3-8**, TCE was detected in more wells – and at higher average concentrations – in 2013 than in 1987. Twenty six upper glacial and 36 Magothy wells that were sampled in both 1987 and 2013 had detectable TCE concentrations in 2013. As discussed above, the increased number of detections may, in part, be attributable to the reduction in the TCE detection limit from 1 to 0.5 µg/L between 1987 and 2013, as TCE was detected in 19 of the 62 wells at concentrations less than 1 µg/L during 2013.

Average TCE concentrations in the same set of 160 upper glacial aquifer supply wells sampled in both 1987 and 2013 increased from 0.31 µg/L to 0.80 µg/L; the average TCE concentrations in the same set of 210 Magothy supply wells increased from 0.33 µg/L to 0.93 µg/L.

Average TCE concentrations nearly tripled from 0.31 µg/L to 0.80 µg/L in the 160 upper glacial public supply wells that were sampled in both 1987 and 2013. (As with PCE, for the purposes of the comparison, non-detects in 1987 were assumed to be equal to 0.25 µg/L, or ½ the detection limit in 2013. Therefore, comparisons and calculations including concentrations of "ND" were similar.) A similar trend is seen in the Magothy wells sampled in both 1987 and 2013 where average TCE concentrations increased from 0.33 µg/L to 0.93 µg/L, indicating contaminant flow to the deeper portions of the aquifer. Only one of the wells sampled during both years exceeded the 5 µg/L MCL in 1987, while eight wells exceeded the standard in 2013, indicating deteriorating water quality. Considering a slightly different data set (e.g. the same set of 151 supply wells screened in the upper glacial aquifer that were sampled in 1987, 2005 and 2013), the trend lines shown below illustrate that the upwards trends in TCE concentrations in both the upper glacial and Magothy aquifer have remained consistent throughout the period. Average concentrations remained less than 5 µg/L throughout the period.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





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Average Trichloroethene Concentration in the Upper Glacial, Magothy & Lloyd Aquifers Community and Non-Community Supply Wells - 2013

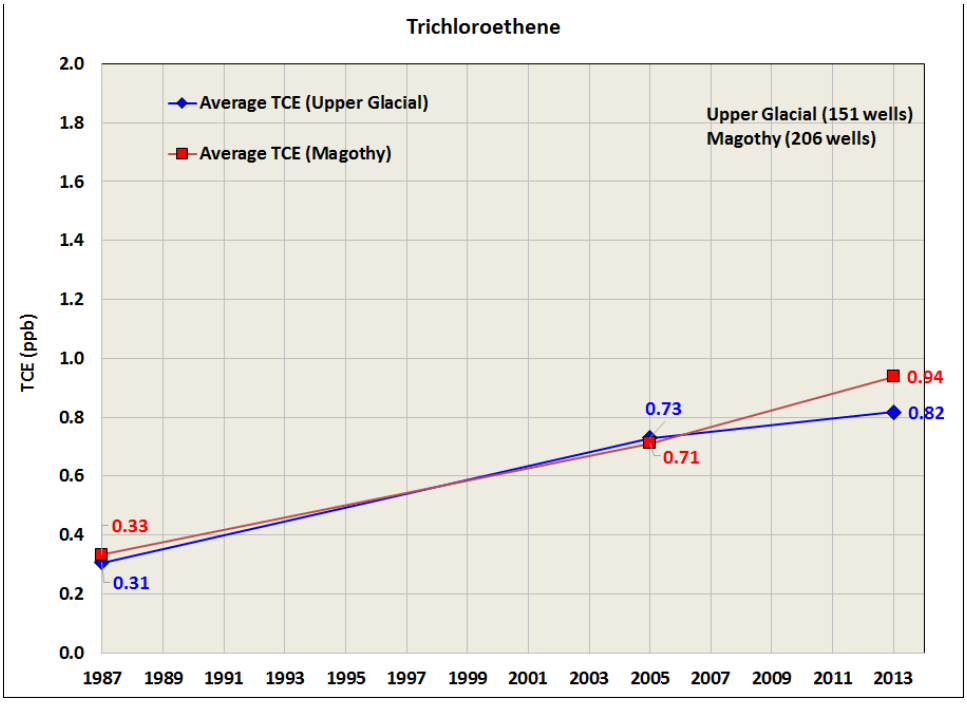
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-19

Table 3-8 Trichloroethene (TCE) Concentrations from Community and Non-Community Supply Wells

Aquifer	1987	2009-2013	2013	Same Set Wells 1987	Same Set Wells 2013
Upper Glacial Aquifer					
n (wells)	590	570	489	160	160
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	63.0	44	43	3	43
Average (µg/L)	0.44	0.41	0.45	0.31	0.8
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	ND	ND	ND	ND	1.01
No. of wells with detects	28	42	34	7	26
No. of wells with Detect > 5 µg/L	4 / 4	6 / 3	4 / 4	3 / 3	0 / 0
Magothy Aquifer					
n (wells)	279	418	402	211	211
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	15	58	58	15	27
Average (µg/L)	0.32	0.7	0.83	0.33	0.93
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	ND	0.62	0.8	ND	1.2
No. of wells with detects	6	67	50	5	36
No. of wells with Detect > 5 µg/L	1 / 1	11 / 10	10 / 10	1 / 1	8 / 8
Lloyd Aquifer					
n (wells)	3	5	5	1	1
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	ND	2.60	2.60	ND	ND
Average (µg/L)	ND	0.47	0.77	ND	ND
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	ND	0.88	1.76	ND	ND
No. of wells with detects	0	2	2	0	0
No. of wells with Detect > 5 µg/L	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

Notes:
1. Data compiled from SCDHS databases.
2. Averages and percentiles calculated from annual well averages.
3. No. of wells > 5 ppb is based on well maximum and averages, respectively (max/avg).



1,1,1 Trichloroethane (TCA)

The ban of TCA appears to be effective in reducing contamination observed in the aquifer. TCA has been detected in fewer wells and at lower average concentrations since the draft Plan was completed in 2010.

1,1,1-Trichloroethane (TCA) has been manufactured since the mid-1950s as an "all-purpose" solvent, primarily used in degreasing and cleaning fabricated metal and in aerosols (HSIA, 1994). It is also used in various other industrial/commercial processes including textiles, production of coatings, inks and for dry cleaning leather and suede. TCA was also a major component of cesspool cleaners sold to homeowners in gallon quantities until 1980, when cleaners containing TCA and other solvents were banned by Suffolk County (Local Law 12-1980).

The average concentrations of TCA in untreated water samples collected from community and non-community supply wells in 2013 are shown on **Figures 3-20a, 3-20b** and **3-20c** for the upper glacial, Magothy, and Lloyd aquifers, respectively. Very low levels of TCA were reported in all aquifers; TCA levels and the number of impacted wells have declined since the last assessment was performed in 2005. **Table 3-9** summarizes changes in average TCA concentrations in the upper glacial, Magothy and Lloyd aquifers for supply wells that were sampled in both 1987 and in 2013. TCA levels in supply wells met the 5 µg/L drinking water standard in over 99 percent of all supply wells tested in 2013.

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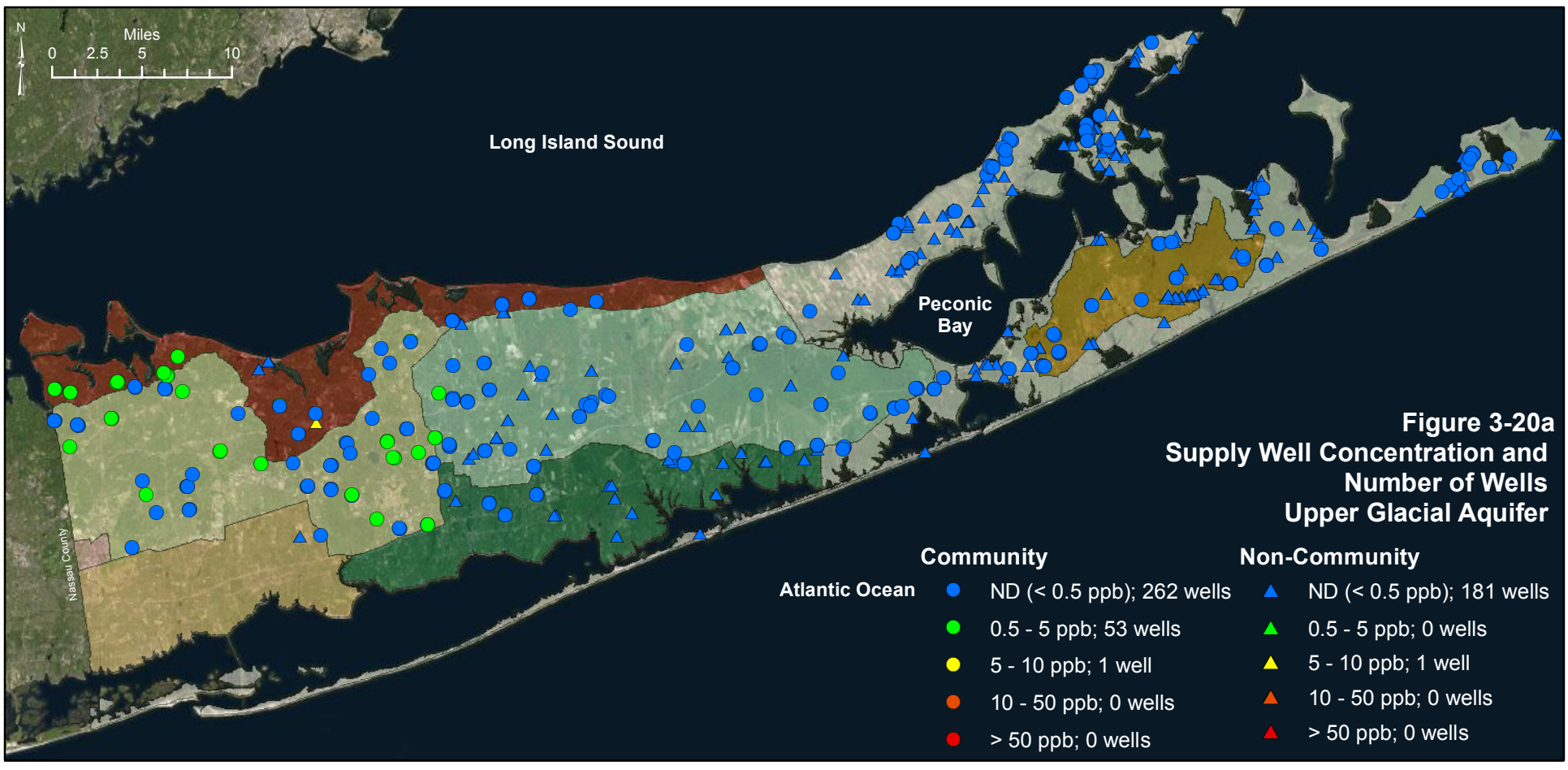

Figure 3-20a
Supply Well Concentration and Number of Wells
Upper Glacial Aquifer

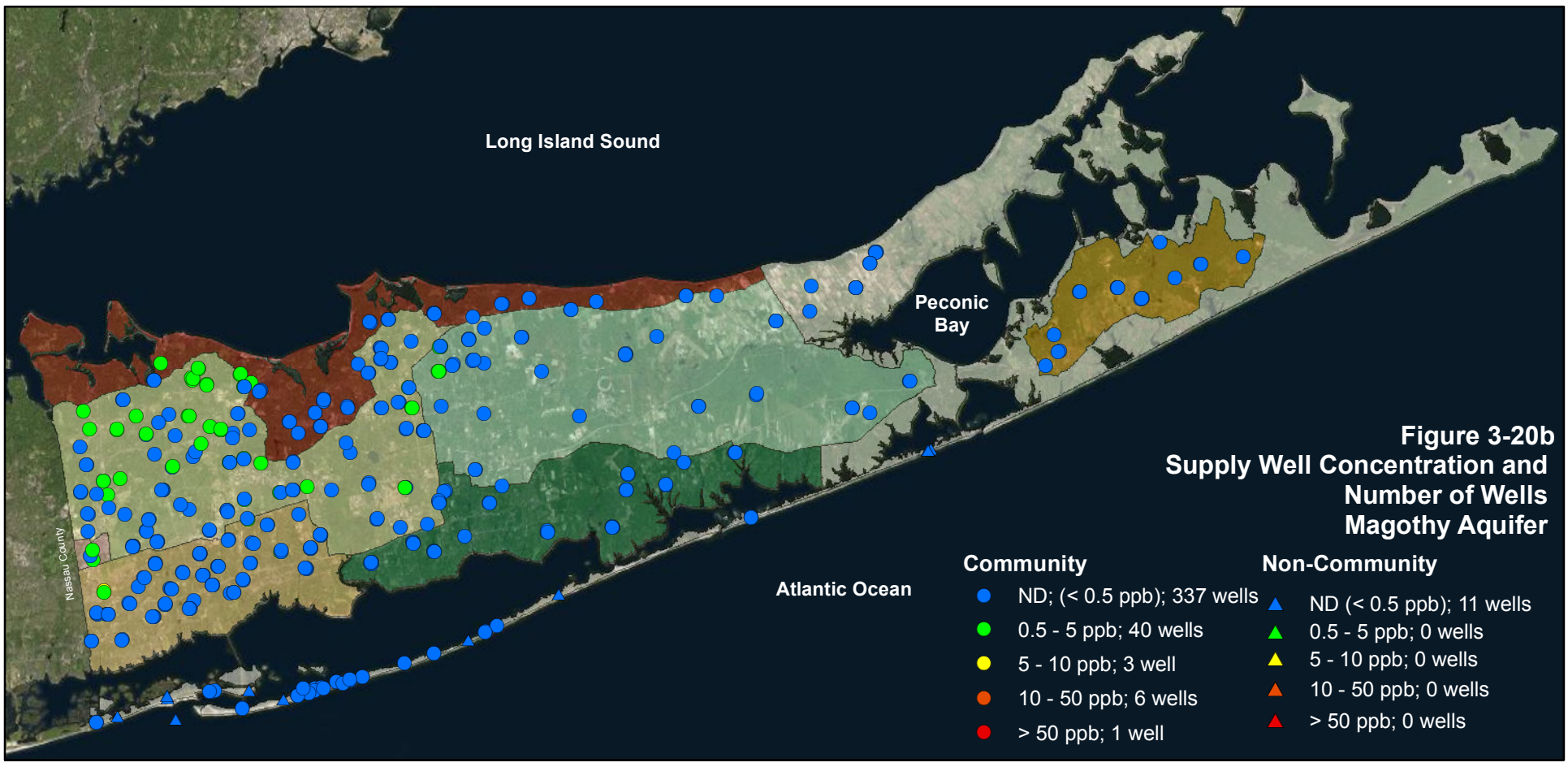

Figure 3-20b
Supply Well Concentration and Number of Wells
Magothy Aquifer

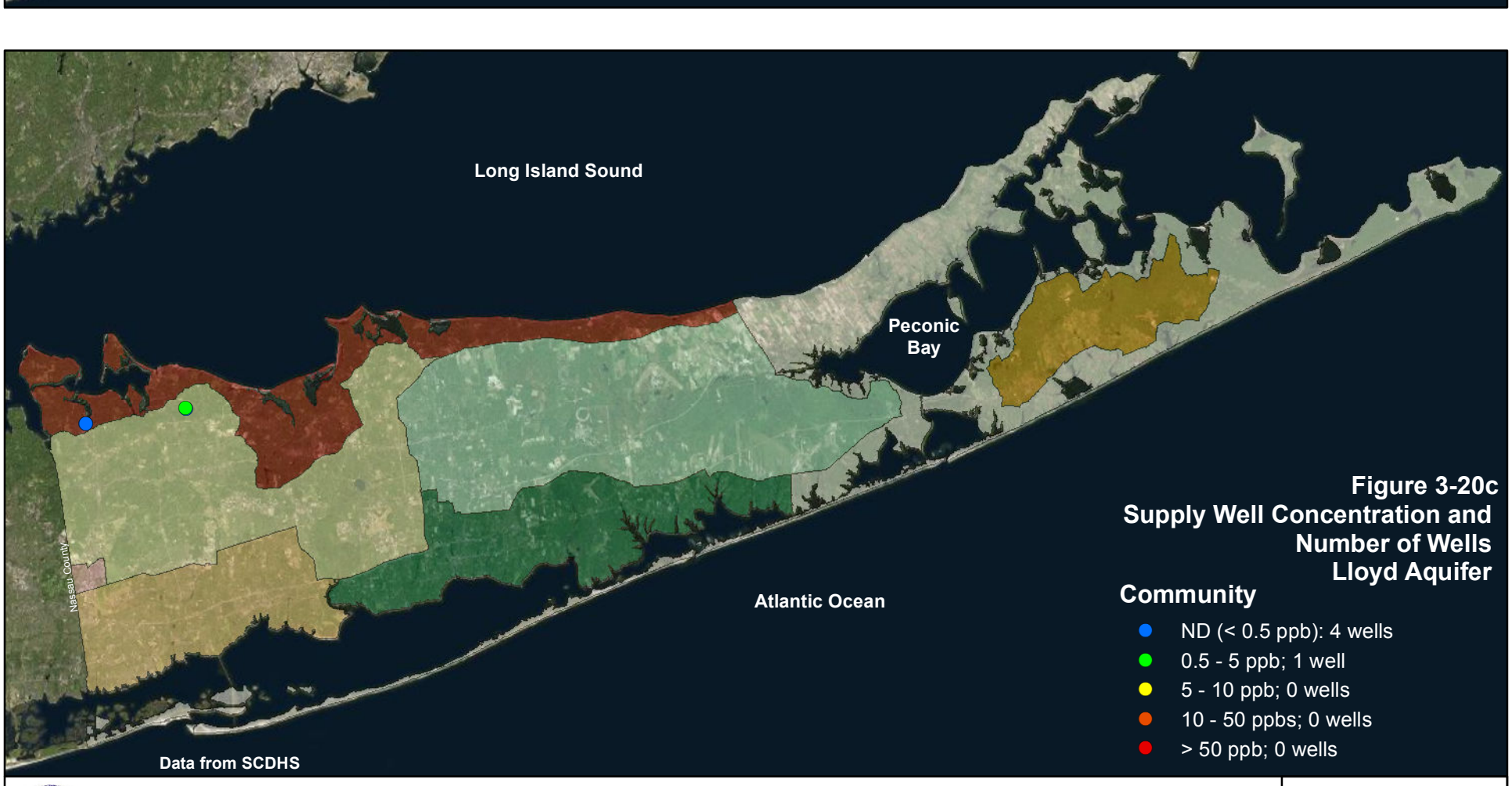

Figure 3-20c
Supply Well Concentration and Number of Wells
Lloyd Aquifer

Average 1,1,1-Trichloroethene Concentration in the Upper Glacial, Magothy & Lloyd Aquifers Community and Non-Community Supply Wells - 2013

Suffolk County Comprehensive Water Resources Management Plan

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Figure 3-20

Table 3-9 1,1,1 Trichloroethane (TCA) Concentrations from Community and Non-Community Supply Wells

Aquifer	1987	2009-2013	2013	Same Set Wells 1987	Same Set Wells 2013
Upper Glacial Aquifer					
n (wells)	584	570	489	159	159
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	760	10	6.2	760	5.4
Average (µg/L)	1.55	0.35	0.35	3.16	0.47
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	1.75	ND	ND	1.12	0.88
No. of wells with detects	103	51	37	26	25
No. of wells with Detect > 5 µg/L	23 / 18	3 / 1	2 / 2	11 / 7	1 / 1
Magothy Aquifer					
n (wells)	284	418	402	211	211
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	16.00	6.10	5.50	16.00	5.50
Average (µg/L)	0.54	0.41	0.43	0.57	0.47
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	1.09	0.65	0.79	1.00	0.94
No. of wells with detects	39	65	54	30	37
No. of wells with Detect > 5 µg/L	5 / 4	2 / 0	1 / 1	5 / 4	1 / 1
Lloyd Aquifer					
n (wells)	3	5	5	1	1
Minimum (µg/L)	ND	ND	ND	ND	ND
Maximum (µg/L)	ND	2.60	2.60	ND	ND
Average (µg/L)	ND	0.47	0.77	ND	ND
10th Percentile (µg/L)	ND	ND	ND	ND	ND
50th Percentile (µg/L)	ND	ND	ND	ND	ND
90th Percentile (µg/L)	ND	0.88	1.76	ND	ND
No. of wells with detects	0	2	2	0	0
No. of wells with Detect > 5 µg/L	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

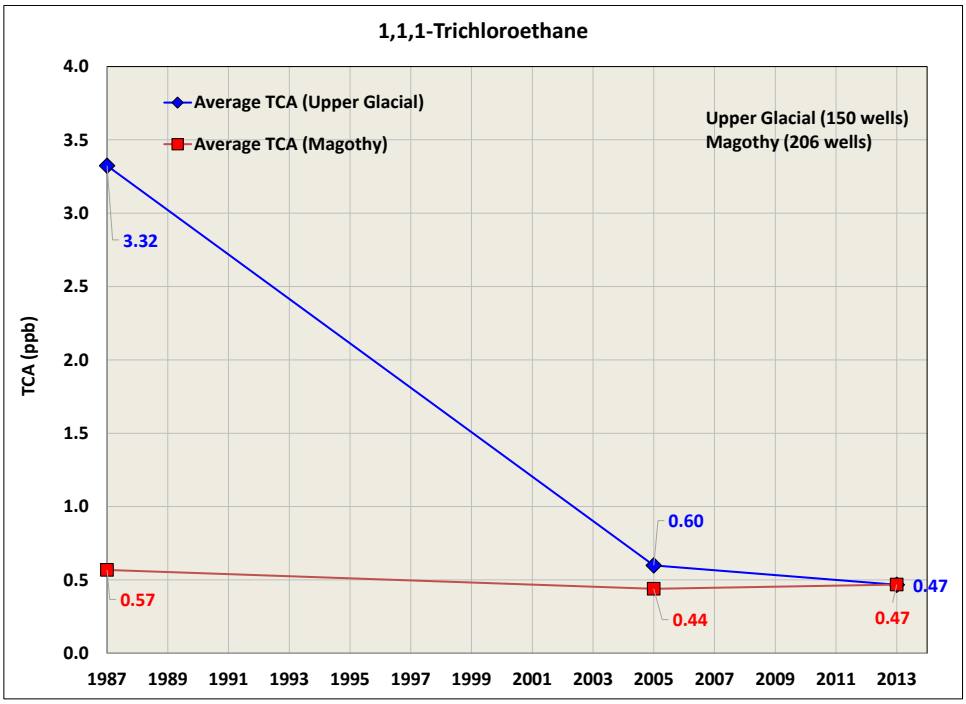
Notes:

1. Data compiled from SCDHS databases.
2. Averages and percentiles calculated from annual well averages.
3. No. of wells > 5 µg/L is based on well maximum and averages, respectively (max/avg).

Average TCA concentrations in the same set of 159 upper glacial aquifer supply wells sampled in both 1987 and 2013 decreased from 3.16 µg/L to 0.47 µg/L; the average PCE concentrations in the same set of 210 Magothy supply wells increased from 0.57 µg/L to 0.47 µg/L.

Average TCA concentrations decreased from 3.16 µg/L to 0.47 µg/L in the 159 public supply wells screened in the upper glacial aquifer that were tested in both 1987 and 2013, most likely reflecting a positive response to Suffolk's cesspool cleaner ban enacted some 25 years earlier. (As with PCE and TCE, for the purposes of the comparison, non-detects in 1987 were assumed to be equal to 0.25 µg/L, or ½ the detection limit in 2005. Therefore, comparisons and calculations including concentrations of "ND" were similar.) Average TCA concentrations in the Magothy supply wells tested from both years also decreased, although not as dramatically, from 0.57 µg/L to 0.47 µg/L. The number of detections in Magothy wells that were sampled in both 1987 and 2005 exceeding the 5 µg/L MCL also declined in the same set wells, from 5 in 1987 to only one in 2013. No detections of TCA were reported in the same set of Lloyd wells sampled in both years.

Review of a slightly smaller data set (e.g. the same set of 150 supply wells screened in the upper glacial aquifer that were sampled in 1987, 2005 and 2013), the trend lines shown below confirm the decline in average TCA concentrations in the upper glacial aquifer, and that concentrations in the Magothy aquifer have remained consistent since 2005. Average concentrations remained less than 5 µg/L throughout the period.



Methyl Tert-Butyl Ether (MTBE)

MTBE, which was used as an octane-enhancing replacement for lead from 1979 until 2004 has been detected in Suffolk County groundwater since the SCDHS began monitoring for the substance in 1991. The USEPA Clean Air Act of 1990 Reformulated Gasoline and Oxygenated Fuel requirements greatly increased MTBE use at higher concentrations to fulfill the gasoline oxygenate requirements of the program (NYSDEC website http://www.dec.ny.gov/chemical/8692.html). MTBE is highly water soluble, and persists in groundwater, biodegrading much more slowly than other gasoline-related compounds. It is often detected in the absence of other gasoline constituents, and in fact, has been more widely detected throughout Suffolk County than benzene, toluene or xylene. Spills or discharges of MTBE can move quickly through the soil, dissolve in the groundwater and migrate great distances with the same velocity as groundwater. In addition to fuel storage leaks, small amounts of gasoline from recreational and household activities associated with the use of small engines can also introduce MTBE to groundwater.

Although the USEPA did not require MTBE monitoring until the 2001-2003 monitoring cycle, SCDHS has conducted routine monitoring for MTBE since 1991, and has required community water suppliers to incorporate MTBE into their VOC monitoring of supply wells since 1994. In response to the widespread detections of MTBE, on May 24, 2000, New York State enacted legislation (Chapter 35, Laws of 2000) that prohibited gasoline containing MTBE as an additive from being imported, sold or dispensed in New York State as of January 1, 2004.

The ban on use of MTBE as a gasoline additive in New York State has been successful in reducing the detection of the contaminant in untreated groundwater samples from public supply wells.

As shown in **Table 3-10**, MTBE was detected in 129 public supply wells (community and non-community) in Suffolk County from 2009 through 2013, and in 2013, it was detected in 37 upper glacial supply wells and 12 Magothy supply wells (community and non-community wells located throughout the County). The average concentrations of MTBE in raw water sampled from community and non-community supply wells in 2013 are shown on **Figures 3-21a, 3-21b** and **3-21c** for the upper glacial, Magothy, and Lloyd aquifers, respectively. **Table 3-10** shows that MTBE was not detected above the current New York State drinking water standard for MTBE of 10 µg/L in raw water samples from public supply wells in 2013 and that most detections have been observed in the shallower upper glacial wells.

In 2005, MTBE was detected in the raw water from 16 percent of the supply wells tested. The presence of MTBE was detected in almost 10 percent of the private wells SCDHS tested from 1997 through 2007, and 1.4 percent exceeded the drinking water standard of 10 µg/L as shown on **Figure 3-22**.

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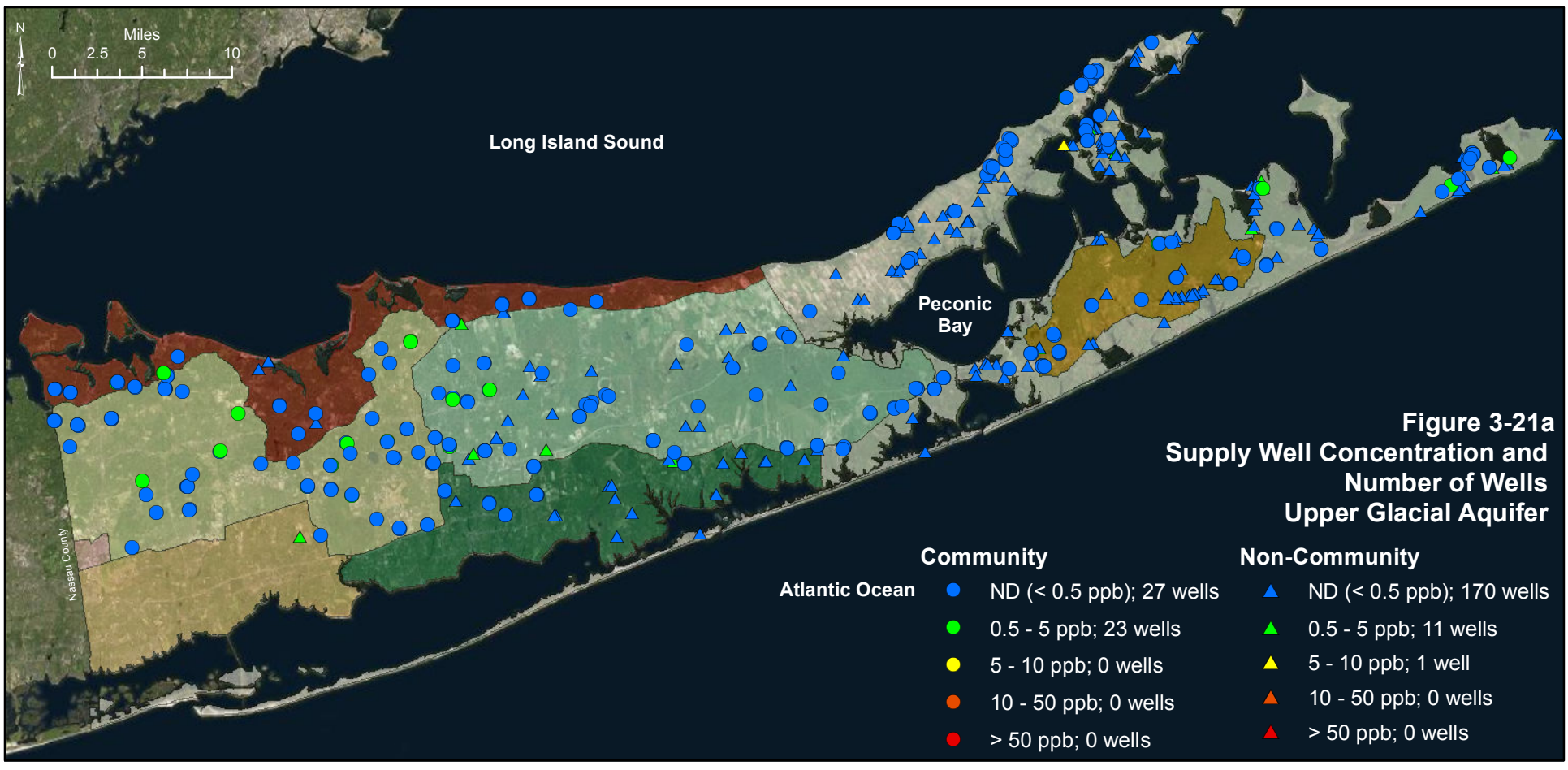

Figure 3-21a
Supply Well Concentration and Number of Wells
Upper Glacial Aquifer

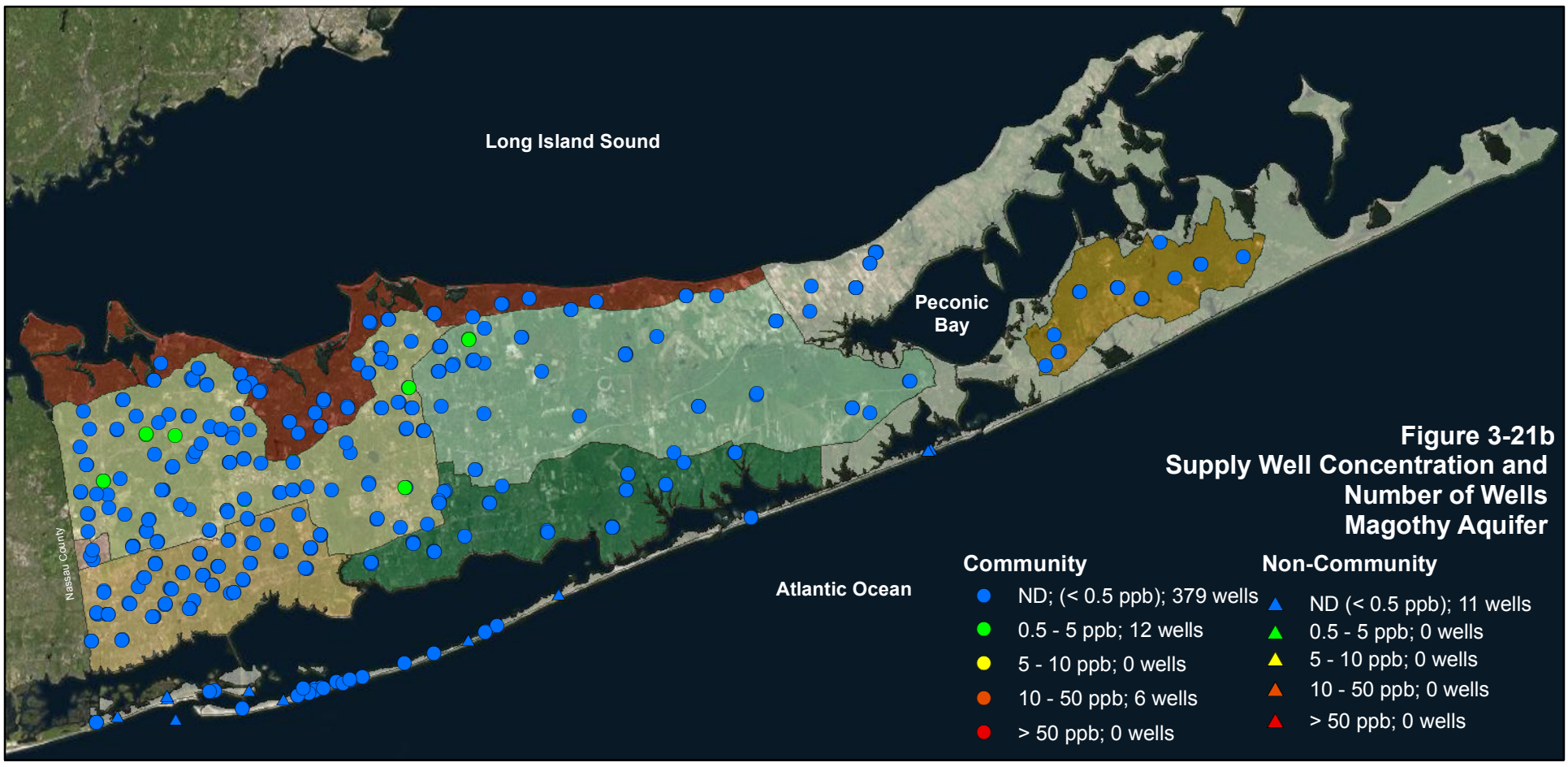

Figure 3-21b
Supply Well Concentration and Number of Wells
Magothy Aquifer

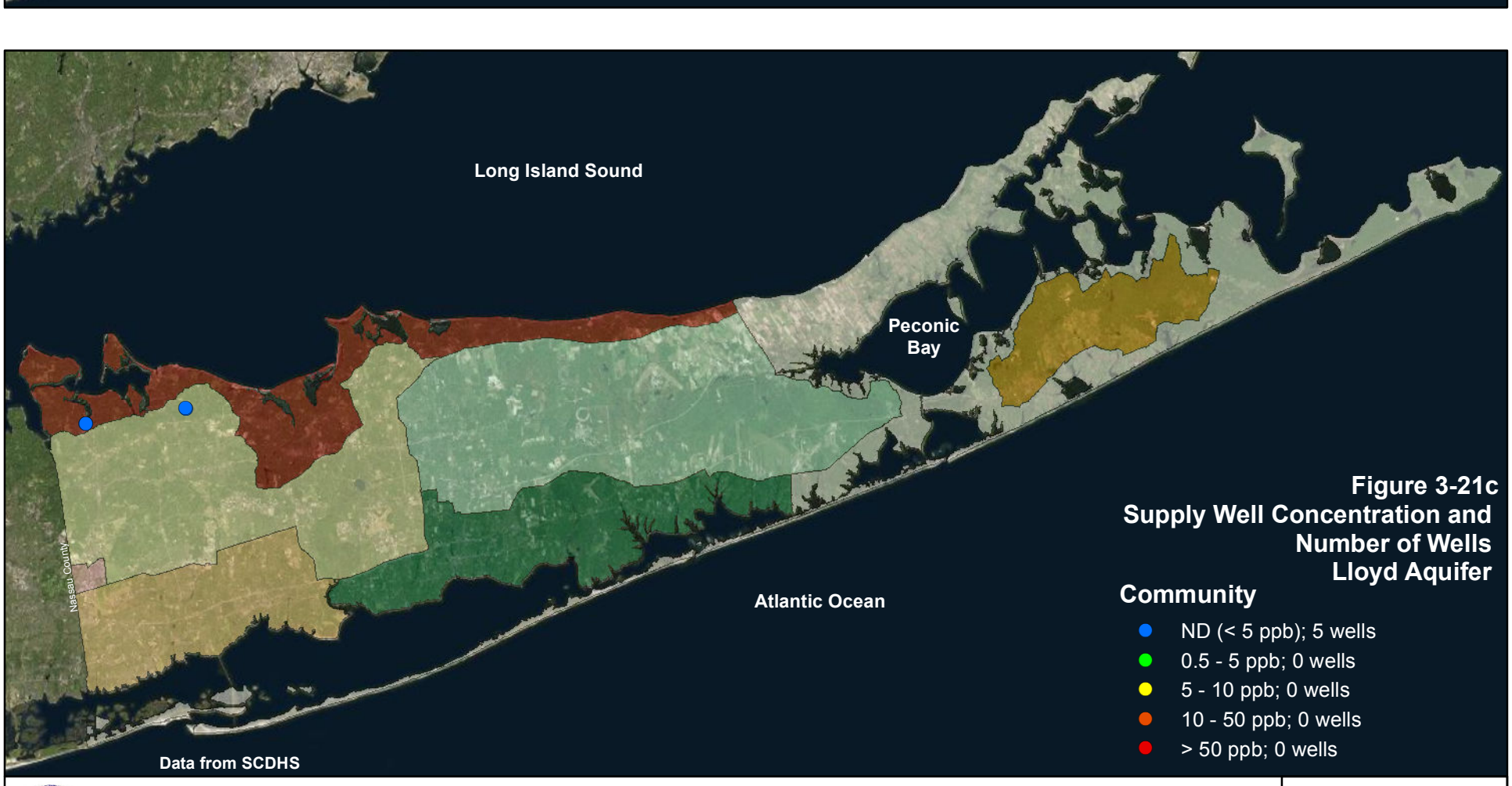

Figure 3-21c
Supply Well Concentration and Number of Wells
Lloyd Aquifer

Average MTBE Concentration in the Upper Glacial, Magothy & Lloyd Aquifers Community and Non-Community Supply Wells - 2013

Suffolk County Comprehensive Water Resources Management Plan

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Figure 3-21

Table 3-10 Methyl Tert-Butyl Ether (MTBE) Concentrations from Community and Non-Community Supply Wells

Aquifer	1987	2009-2013	2013
Upper Glacial Aquifer			
n (wells)	N/A	570	489
Minimum (µg/L)	N/A	ND	ND
Maximum (µg/L)	N/A	13	7.7
Average (µg/L)	N/A	0.37	0.3
10th Percentile (µg/L)	N/A	ND	ND
50th Percentile (µg/L)	N/A	ND	ND
90th Percentile (µg/L)	N/A	0.45	ND
No. of wells with detects	N/A	101	37
No. of wells with Detect > 5 µg/L	N/A	6 / 1	1 / 0
Magothy Aquifer			
n (wells)	N/A	418	402
Minimum (µg/L)	N/A	ND	ND
Maximum (µg/L)	N/A	12	4.7
Average (µg/L)	N/A	0.3	0.28
10th Percentile (µg/L)	N/A	ND	ND
50th Percentile (µg/L)	N/A	ND	ND
90th Percentile (µg/L)	N/A	ND	ND
No. of wells with detects	N/A	28	12
No. of wells with Detect > 5 µg/L	N/A	2 / 1	0 / 0
Lloyd Aquifer			
n (wells)	N/A	5	5
Minimum (µg/L)	N/A	ND	ND
Maximum (µg/L)	N/A	ND	ND
Average (µg/L)	N/A	ND	ND
10th Percentile (µg/L)	N/A	ND	ND
50th Percentile (µg/L)	N/A	ND	ND
90th Percentile (µg/L)	N/A	ND	ND
No. of wells with detects	N/A	0	0
No. of wells with Detect > 5 µg/L	0 / 0	0 / 0	0 / 0

1. Data compiled from SCDHS databases; SCDHS did not analyze for MTBE in 1987.
2. Averages and percentiles calculated from annual well averages.
3. No. of wells > 5 µg/L is based on well maximum and averages, respectively (max/avg).

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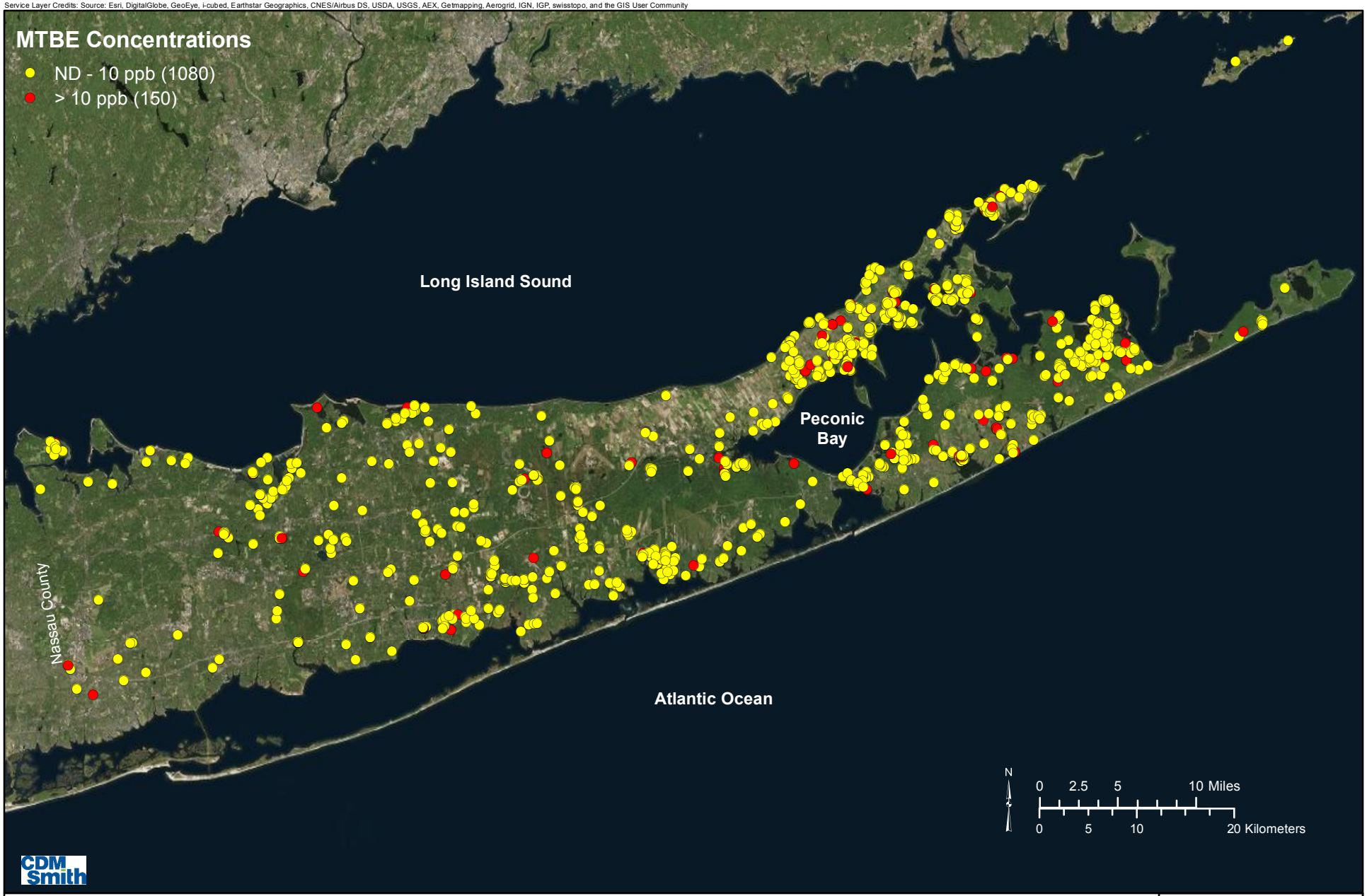


Suffolk County Department of Health Services
MTBE Detections
Private Well Database
1997 - 2013
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-22

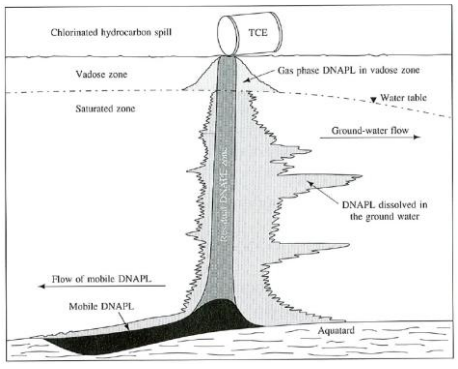
In 2013, MTBE was detected in less than five percent of raw groundwater samples collected from all supply wells, marking a significant improvement, as shown on **Figure 3-22a**.

Other VOCs

SCDHS continues to monitor the County's groundwater resources for a variety of other potential contaminants of concern. A review of SCDHS's private well data for the period from 1997 through 2007 indicated that low level VOC contamination is widespread, with VOC detections in more than one-half of the private wells tested. Approximately seven percent of the wells exceeded the 5 µg/L threshold. The data revealed that 21 percent of the private wells tested contained detectable levels of chloroform and that chloroform levels in nearly two percent of the private wells exceeded 5 µg/L. It is hypothesized that chloroform detections may result from the use of household laundry bleach interacting with organic sewage wastes and/or the discharge of chlorinated swimming pool waters. More recent private well data collected by SCDHS reveals that VOC detections in excess of the 5 µg/L threshold have been reported in 19% of the private wells sampled from 1997 through 2013, as shown on **Figure 3-23.**

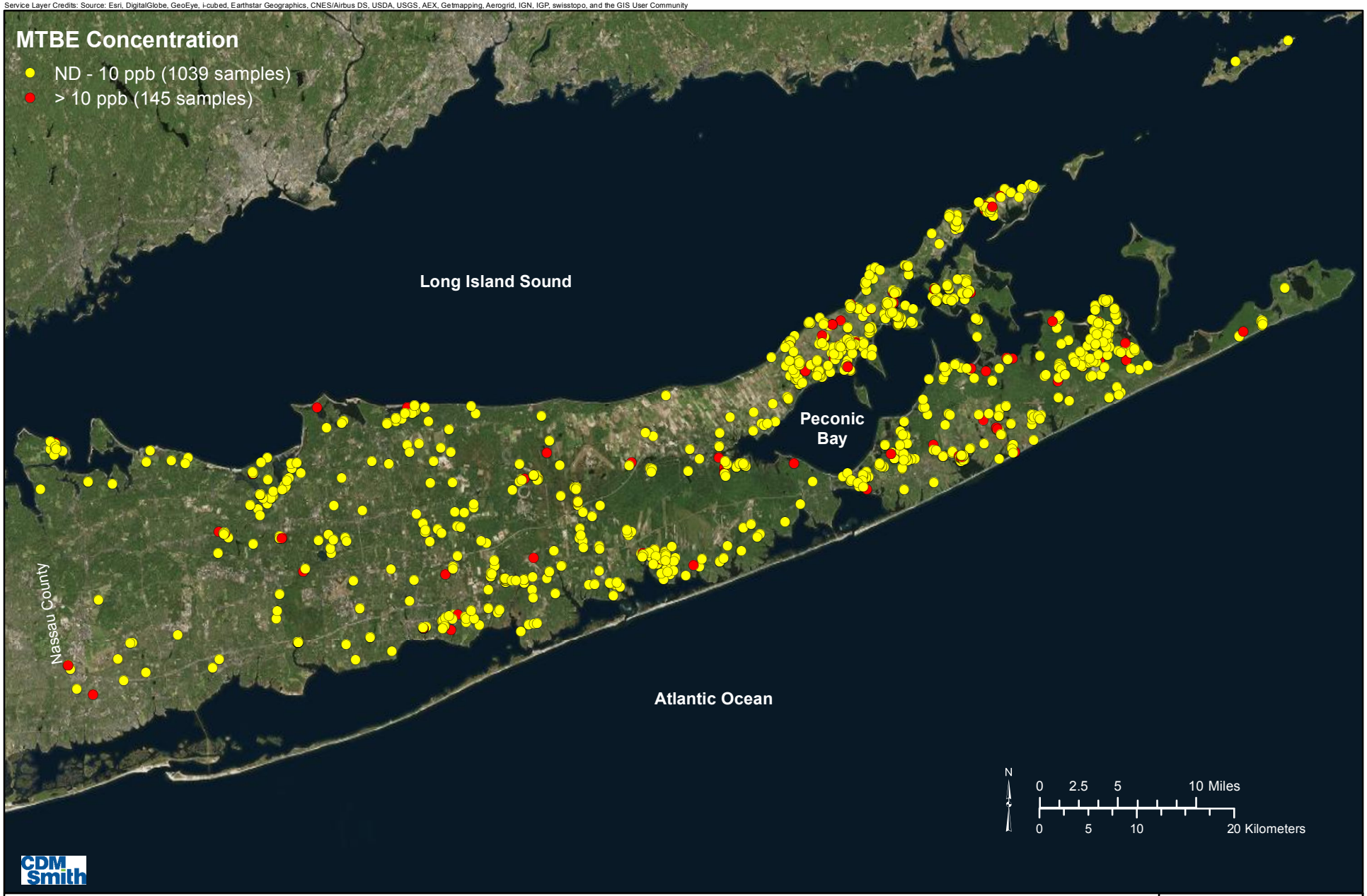
VOCs and Land Use

While non-point sources represent a significant source of nitrogen loading to groundwater, sources of VOC contamination can include both point sources, such as leaking underground storage tanks, illegal discharges and spills, and non-point sources such as septic system discharges. The impacts of land use on four of the most commonly detected VOCs in Suffolk County groundwater (PCE, TCE, TCA and MTBE) were evaluated based on the Suffolk County Department of Economic Development and Planning's analysis of historical land uses within the contributing areas of 56 community supply wells located within 29 wellfields as described below. Although the nitrate analysis indicated that land use-specific nitrate concentrations could be used to estimate nitrate levels in a supply well, predicting land use-specific concentrations for VOCs is more challenging. For example, while primary users of the targeted VOCs include dry cleaners and gasoline stations, both of which are classified as commercial land uses, most commercial establishments are neither dry cleaners nor gasoline stations and in fact use very little VOCs other than over the counter cleaning products. VOCs may also be found in a wide variety of products that are used in residential areas, including automatic transmission fluid, degreasers, hydraulic fluids, motor oils, gasoline, diesel fuel, kerosene, heating oil, car waxes and polishes, asphalt and roofing tar, paints, varnishes, stains, dyes, paint and lacquer thinners, paint and varnish removers, paintbrush cleaners, floor and furniture strippers, metal polishes, laundry soil and stain removers, spot removers and dry-cleaning fluids, refrigerants, bug



Example of DNAPL flow (from Fetter, 1999).

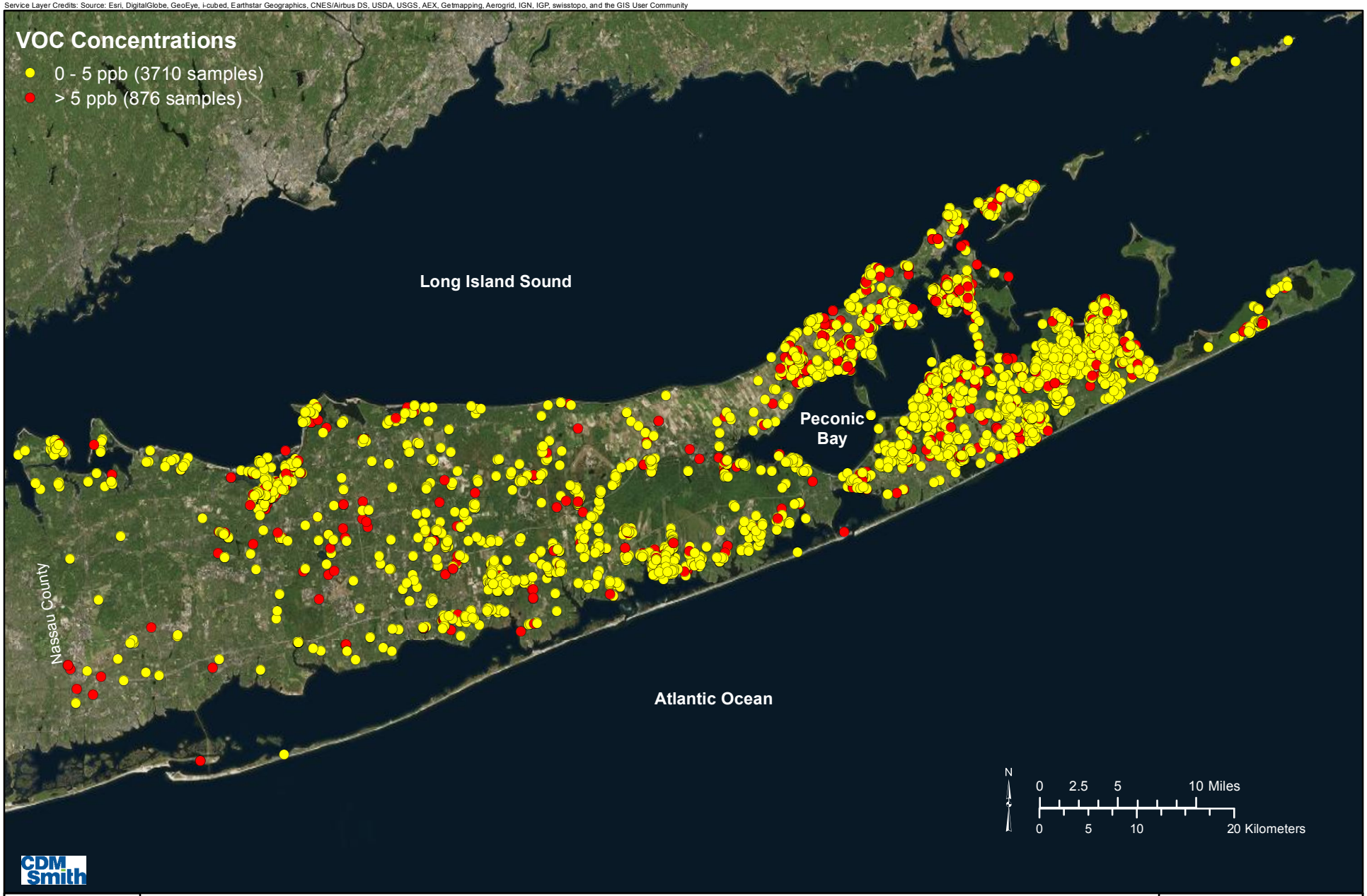
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Suffolk County Department of Health Services
MTBE Detections
Private Well Database
1997 - 2013
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-22

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Suffolk County Department of Health Services
VOC Detections
Private Well Database
1997 - 2013
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-23

and tar removers, household cleaners, oven cleaners, toilet cleaners, some cesspool cleaners and printing inks.

In fact, household wastes were estimated to be a significant source of observed VOC contamination in groundwater in Nassau County (CDM, 1994, Nassau County Department of Health, 1979). Because much of Suffolk County is not sewered, low levels of VOCs may be introduced to groundwater via septic systems. Many of the small sewage treatment plants that serve commercial and industrial areas discharge treated effluent to groundwater; it is also possible that this could be another pathway by which VOCs are introduced to the aquifer system. Unlike nitrates, organic compounds can adsorb onto sediments that will retard their movement through the aquifer; therefore, evaluation of VOC migration from the water table to a well screen is not straightforward. The adsorption or retardation of a particular contaminant is related to the amount of organic carbon in the sediments, which can vary in different zones of the aquifer. It may take VOCs much longer to reach a well screen than it would take a non-retarded contaminant such as nitrates. Although the time it takes water to travel from the water table to a well screen may be defined as 10 years, land uses from previous decades can continue to influence VOC levels. In addition, VOCs such as PCE and TCE that are denser than water (dense, non-aqueous phase liquids, or DNAPLs) can sink vertically into the aquifer until an aquitard, such as a clay layer, is reached. DNAPLs can present a much more extensive source area as the dissolved phase of the contaminants can spread vertically throughout the aquifer.

During this study, the types of land uses that are located within the contributing areas of 29 wellfields were evaluated. Historical water quality data indicate that low level VOC contamination is widespread throughout the County; in fact, VOCs have been detected in all but the following two of the 29 wellfields that were evaluated:

- North Country Road – the unsewered contributing area is now primarily medium density residential; and
- Old North Road (Greenport) – more than 67 percent of the contributing area is agricultural and includes very limited commercial land.

VOCs above the drinking water standard (5 µg/L for PCE, TCE, and 1,1,1-TCA and 10 µg/L for MTBE) were identified in untreated water samples from 11 wellfields; the contributing areas for each well included commercial, industrial, institutional or transportation uses. As an aside, it should be noted that VOC removal facilities are in operation at all of the impacted wellfields, to provide potable supply that is in compliance with applicable MCLs. The

targeted VOCs were also detected at low levels (below drinking water standards) in five wellfields that do not have any commercial, industrial or transportation land use within the contributing areas, indicating that unsewered residential areas can also introduce low level VOC contamination to the aquifer.

Widespread detections of VOCs, particularly PCE and TCE, have been observed in the wellfields included in this analysis. Relating the presence of VOCs in groundwater to overlying land use is not straightforward, given the widespread detections of low levels of VOCs in shallow groundwater, and the myriad of potential pathways by which low levels of the contaminants can be introduced to the aquifer system. However, commercial, industrial and/or transportation or institutional land uses have existed within the contributing areas of most of the wells that have shown significant (e.g., exceeding applicable drinking water standards) VOCs. If significant levels of VOCs are identified in a well, and no commercial, industrial or institutional uses are present within the well's contributing area, the possibility that an upgradient DNAPL exists should be considered.

SCDHS Office of Pollution Control (OPC) regulates facilities that store and use toxic and hazardous materials; there are currently over 20,000 industrial and commercial facilities in the OPC database. OPC has prioritized these facilities based on the contaminants used, the potential for release to the environment, and historical enforcement actions. Those facilities with a medium or low ranking are inspected less frequently than high priority sites. However, recent staffing levels have precluded the SCDHS from inspecting the regulated facilities at the frequency they have targeted for groundwater protection. For example, underground gasoline storage facilities are only inspected on a three-year interval. Because the use of a commercial property may change over time, the priority assigned to a particular property may remain out of date for years, until the facility is inspected again.

Currently, only high priority facilities, those with permitted storage (approximately 3,200 facilities) are inspected. No routine inspections of dry cleaners currently occur. OPC has estimated that between five and ten percent of the lower priority facilities are improperly storing and/or disposing of hazardous materials. As fewer facilities are inspected, the number of environmental clean-ups has also declined, from approximately 300 per year to 148 per year (from January through November 2014).

A recent initiative known as the VOC Action Plan resulted in the hiring of 5 new staff members in the Division of Environmental Quality (DEQ) to increase inspections at commercial/industrial facilities. Implementation of the VOC

Action Plan will result in annual inspections at gasoline stations and dry cleaners as long as these resources are maintained in DEQ. This plan also allows for additional sampling at these facilities and initiation of enforcement actions where violations are found. This plan does not include staff for inspections at the thousands of other non-permitted industrial and commercial facilities which have the potential to use and discharge large quantities of VOCs. In order to complete these inspections on a routine basis, several additional staff members would be required. The most effective way to address this deficiency will be studied in the next phase of the VOC Action Plan via implementation of the Reducing Toxics Study.

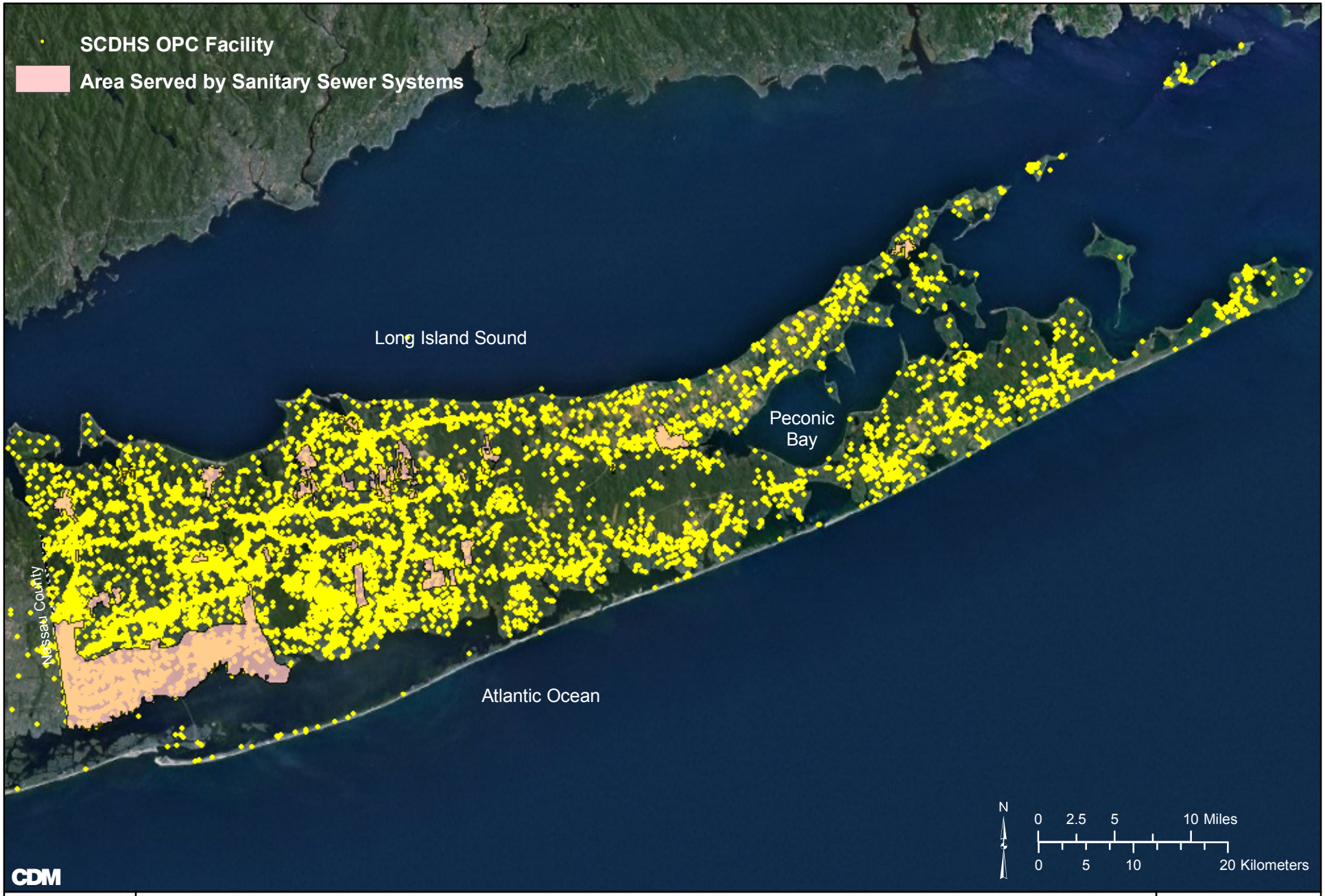
SCDHS OPC records indicate that almost 80 percent of the facilities in their database discharge to on-site septic systems; the locations of facilities in SCDHS's database is depicted along with sewer district locations on **Figure 3-24**. While many of these facilities do not use or store significant quantities of hazardous materials on-site, some facilities do have a higher potential to introduce contamination to groundwater.

While the highest levels of VOCs have been found in supply wells with industrial, commercial, transportation or industrial uses within their source water areas, low levels of VOCs were widely detected throughout the County, suggesting a widespread low-level source, such as residential septic systems.

Industrial, commercial, transportation, institutional and residential land uses all have the potential to introduce VOC contamination to the aquifer system; current VOC loads to groundwater have not been well established in the County.

Summary

Review of water quality data has shown that the highest levels of VOCs are found in wells with industrial, commercial, transportation or institutional uses within their source water areas. Nevertheless, low levels of VOCs were widely detected in groundwater throughout the County, indicating a more widespread low-level source of the observed contaminants, such as residential septic systems. Before targeted recommendations to reduce the release of VOCs to the County's groundwaters can be developed, a better understanding of the potential sources of the observed contamination is required. SCDHS OPC has developed a scope of work for a capital project to evaluate existing industrial/commercial establishments in the County using or storing hazardous materials, including the volume of materials stored, location of storage, potential for release, and assessment of contaminant fate and transport. The contaminant inventory and characterization should form the basis for a revised facility ranking system, and identification of potential new regulations, storage requirements, operator training requirements or inspection/enforcement procedures to improve the effectiveness of OPC programs, and to reduce the further release of toxic contaminants, including VOCs to the environment.



Areas Served by Sanitary Sewer Systems

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-24

Public supply wells that have a history of VOC detections, particularly those in which the MCL is exceeded, should be evaluated, considering the land uses within the well's contributing area, the well operating history and sampling results, to identify the source of the observed contamination. SCDHS should work with NYSDEC/USEPA to ensure necessary actions are taken to eliminate or reduce the threat to the aquifer.

http://www.foodsafetynews.com/2010/04/appeals-court-rules-on-pesticide-application/#.VOSravnF_Nw

SCDHS investigations have identified the presence of more than 100 pesticide-related compounds in Suffolk County groundwater in recent years.

3.1.1.5 Pesticides

Overview

Pesticides, including insecticides, herbicides and fungicides, are a group of synthetic or natural compounds used to kill or control insect pests and nuisance vegetation that affect crops, turf, residential lawns and gardens, homes (e.g., termiticides), pets, and people. They are also designed to disrupt biological functions.

Under the USEPA's Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), New York State regulates the federal registration of pesticides and is required to operate a program and track pesticide use. The authority to perform these activities is provided to the NYSDC under 6 NYCRR Parts 320-329, as well as other articles of the Environmental Conservation Law.

Most pesticides and degradation products do not have specific Federal or New York State drinking water standards, or MCLs. As a result, many of these compounds are typically regulated as Unspecified Organic Contaminants (UOCs) by the New York State Department of Health (NYSDOH) and have an assigned drinking water standard of 50 parts per billion or µg/L. In addition, there is also a total organic compound MCL of 100 µg/L in drinking water set by the NYSDOH.

Pesticide Compounds Detected in Suffolk County Groundwater (1986)
aldicarb (Temik)
carbaryl (Sevin)*
carbofuran (Furadan)
chlorothalonil
dacthal
dibrom*
1,2-dibromoethane (EDB)
1,2-dichloropropane (Telone, D-D, Vorlex)
dinoseb
methomyl (Lannate)*
oxamyl (Vydate)
paraquat*
picloram*
* detection not confirmed by repeat samples or second lab

from 1987 Comp Plan

The ***1987 Comp Plan*** reported the confirmed presence of eight pesticide compounds and unconfirmed detections of five additional compounds in Suffolk County groundwater. In recent years, more extensive investigations conducted by SCDHS, including sampling of private wells and monitoring wells, have identified the presence of more than 100 pesticide-related compounds in Suffolk's groundwater (NYSDEC, 2014).

SCDHS has been on the forefront of pesticide monitoring and has implemented several intensive pesticides monitoring programs since 1979, when aldicarb (Temik) was detected in several private wells in eastern Suffolk County. SCDHS collected and analyzed samples from more than 8,000 private wells during the initial monitoring events, focusing on additional carbamate pesticides (e.g., carbofuran, oxamyl, methomyl), soil fumigants (1,2 dichloropropane, EDB) and an herbicide (dacthal) known to be widely applied

to agricultural crops in the County. The PEHL has published methods for the determination of carbamate pesticides (e.g. aldicarb and its breakdown products), and the breakdown products of dacthal (e.g. TCPA).

Historic sampling results showed that more than 27 percent of the wells sampled contained more than 1 µg/L of aldicarb. As a follow-up, NYSDEC authorized SCDHS (in cooperation with NYSDEC, Nassau County Department of Public Works and Nassau County Health Department) to conduct a more comprehensive evaluation of pesticides contamination that included sampling and analysis of nearly 6,000 samples from approximately 600 community supply wells, and sampling and analysis of private wells and monitoring wells in areas of known or suspected high pesticide use, including agricultural areas, vineyards, lawn care businesses, and golf courses. The United States Geological Survey (USGS) has also conducted an independent pesticide investigation targeting shallow wells in the County.

SCDHS used Cornell Cooperative Extension of Suffolk County's ***Pesticide Usage Report for Agricultural Crops in Suffolk County 1975-2000*** to guide monitoring program development and implementation. The report listed 286 pesticides applied on agricultural crops over the time period and identified 54 agricultural pesticides in common or major usage. SCDHS evaluated the ability of these compounds or their breakdown products (degradates or metabolites) to leach through soils to groundwater to identify those pesticides with the greatest potential to contaminate groundwater and drinking water supplies.

Pesticide breakdown products have been detected more frequently and in higher concentrations than parent compounds

Between 1997 and 2012, SCDHS has collected over 37,000 potable well samples (public and private) that were analyzed for pesticides. Although the concentrations have generally been low, the frequency of detections is a concern. SCDHS results indicate the following:

- Public Community Supply Wells - At least one pesticide compound was detected in about 22% of the wells sampled during this period (196 of 865 wells).
- Public Non-Community Supply Wells - At least one pesticide compound was detected in about 25% of the wells sampled during this period (150 of the 589 wells).
- Private Wells - At least one pesticide compound was detected in about 23% of the private wells sampled during this period (2300 of the 9900 wells sampled).

Between 1997 and 2012, pesticide related contaminants were detected above the MCL in 17 community supply wells, 19 non-community supply wells; and

SCDHS samples for about 150 pesticide related compounds, including both active ingredients and breakdown products.

Between 1997 and 2012, at least one pesticide-related compound was detected in approximately 22 percent of the community supply wells tested by SCDHS.

Over the past several years, we have observed in increase in the frequency of other pesticides, such as metalaxyl, and imidacloprid, at concentrations generally below the respective drinking water standards.

213 private wells. The majority of these compounds include alachlor, TCPA (a dacthal breakdown product), EDB, dichloropropane, and breakdown products of atrazine.

As of 2014, SCDHS samples for about 150 pesticide related analytes, including both active ingredients and breakdown products (**Table 3-11**; italicized compounds on the table are not routinely analyzed by the PEHL due to staff reduction, so that specific analytical methods such as EPA 555, 526 and 527 are no longer supported.) The PEHL has included additional compounds that not currently regulated to their existing laboratory methods to assist in monitoring potential public health impacts from pesticides of current interest (e.g. etofenprox, and resmetherin). Of the 155 pesticide analytes listed in **Table 3-11**, 86 have been detected in groundwater by SCDHS. The detected contaminants are summarized in **Table 3-11a**. In addition to those parameters listed in **Table 3-11** and **Table 3-11a**, additional compounds that have other uses involving arsenic, cadmium, fluoride have also been detected (NYSDEC, 2014). A summary of recent pesticide sampling and detections is shown on **Table 3-11b**. Note that the higher percentage of detections and exceedances from the monitoring wells cannot be directly compared to supply wells as many of the monitoring wells were installed to target land uses that typically utilize pesticides (e.g. agricultural).

Community supply well susceptibility ratings for pesticides are summarized on **Figure 3-25**. Susceptibility to pesticides is rated as low to medium throughout most of the County, except on the North Fork, where community supply wells are highly or very highly susceptible to pesticide contamination due to the agricultural land uses present.

Community supply wells with detections of pesticide-related chemicals are illustrated on **Figure 3-26**. Pesticide-related chemicals were detected above the MCL in raw or untreated water in only 4 community supply wells from 2011 through 2013; the pesticides detected above their MCLs were Aldicarb-Sulfone, Aldicarb-Sulfoxide, DCP and TCPA. The distribution of these MCL exceedances is shown on **Figure 3-26**. Metalaxyl has been detected in more than 300 private wells throughout the County between 1997 and 2010, particularly on the north fork (**Figure 3-26a**).

The use of many of the pesticides detected in groundwater has been banned in Suffolk County for years; nevertheless, they persist in the environment due to their chemical properties. The most frequently detected pesticide chemicals were aldicarb sulfoxide and sulfone, metolachlor, the dacthal degradate, tetrachloroterephthalic acid (TCPA), 1,2-dichloropropane (DCP), 1,2,3-

Table 3-11 Pesticide Analytes Tested by SCDHS PEHL, 2014
(Italicized Analytes Currently Not Routinely Conducted)

1,2-dibromo-3-chloropropane (DBMC)	*Cyanazine*	Methomyl
1,2-Dibromomethane (EDB)	Cyfluthrin (beta-Cyfluthrin)	Methoprene
1-Naphthol	Cypermethrin	Methoxychlor
2,4,5-T	Dacthal	Methyl parathion
2,4,5-TP (SILVEX)	Deisopropylatrazine (G-28279)	Metolachlor
3,5-Dichlorobenzoic Acid	Deltamethrin	Metolachlor ESA (CGA-354743)
4-Nitrophenol	Desethylatrazine (G-30033)	Metolachlor metabolite (CGA-37735)
Acifluoren	*Diazinon*	Metolachlor metabolite (CGA-40172)
Alpha-BHC	*Dicamba*	Metolachlor metabolite (CGA-41638)
Anthracene	Dichlobenil	Metolachlor metabolite (CGA-67125)
Delta-BHC	*Dichloroprop*	Metolachlor OA (CGA-51202)
2,6-Dichlorobenzamide	Dichlorvos	Metribuzin
1,2,3-Trichloropropane	Didealkylatrazine (G-28273)	Monomethyltetrachloroterephthalate
1,2-Dichloropropane	Dieldrin	Naled (Dibrom)
1,3-Dichloropropane	*Dimethoate*	Napropamide
2,2 Dichloropropane	Dimethyldisulfide	*Nitrofen*
2,4,6-Trichlorophenol	Dinoseb	*Norflurazon*
2,4-D	Disulfoton	Oxamyl
2,4-DB	Disulfoton sulfone	*Oxychlordane*
2,4-Dichlorophenol	Diuron	Pendimethalin
2-HydroxyAtrazine (G-34048)	Endosulfan I	Pentachlorobenzene
3-Hydroxycarbofuran	Endosulfan II	Pentachloronitrobenzene
4,4-DDD	Endosulfan Sulfate	*Pentachlorophenol*
4,4-DDE	Endrin	Permethrin
4,4-DDT	Endrin aldehyde	Picaridin
Acetochlor	EPTC	*Picloram*
Alachlor	*Esbiol*	Piperonyl butoxide
Alachlor ESA (Sulfonic Acid)	*Esfenvalerate*	Prallethrin
Alachlor OA (Oxanilic Acid)	Ethofumesate	Prometon
Aldicarb	Ethyl Parathion	Prometryn
Aldicarb sulfone	Etofenprox	Prometryne
Aldicarb sulfoxide	Etofenprox alpha-CO	Propachlor
Aldrin	*Fenvalerate*	Propamocarb hydrochloride
Allethrin	*Fonofos*	Propiconazole (Tilt)
Atrazine	gamma-BHC (Lindane)	Propoxur (Baygon)
Azoxystrobin	Germanium	Resmethrin
Benfluralin	Heptachlor	Ronstar
Bentazon	Heptachlor epoxide	Siduron
beta-BHC	Hexazinone	Simazine
Bifenthrin	Imidacloprid	Sumithrin
Bloc	Imidacloprid Urea	Tebuthiuron
Bromacil	Iodofenphos	Terbacil
Bromomethane	Iprodione	*Terbufos*
Butachlor	Isofenphos	*Terbufos sulfone*
Carbaryl	Kelthane	Tetrachloroterephthalic acid
Carbofuran	Malaoxon	*Thiobencarb*
Chloramben	Malathion	Triadimefon
Chlordane	*MCPA*	*Triadimenol*
Chlorofenvinphos	*Mecoprop(MCPP)*	Trichlorfon
Chlorothalonil	Metalaxyl	Trifluralin
Chloroxylenol	Methiocarb	Vinclozolin
Chlorpyriphos	Methiocarb sulfone	

Table 3-11a Pesticides Detected by SCDHS, 1997-2014

Pesticide Analyte	Source[1]	Pesticide Analyte	Source[1]
1,2 Dichloropropane	Blacksmith/MW	Fenarimol (Bloc)	NYSDEC(2014)
1,2,3 Trichloropropane	Blacksmith/MW	gamma-BHC (Lindane)	Blacksmith
1,2-dibromo-3-chloropropane	Blacksmith	Germanium	MW
1,3 Dichloropropane	Blacksmith	Heptachlor epoxide	Blacksmith/MW
2,4-D	NYSDEC(2014)	Hexazinone	NYSDEC(2014)
2-Hydroxyatrazine (a.k.a. hydroxyatrazine)	NYSDEC(2014)	Imidacloprid	NYSDEC(2014)/MW
2,6-Dichlorobenzamide	MW	Imidacloprid Urea	NYSDEC(2014)/MW
3-Hydroxycarbofuran	NYSDEC(2014)	Iprodione	NYSDEC(2014)
4-Nitrophenol	NYSDEC(2014)	Kelthane	NYSDEC(2014)
Acetochlor	NYSDEC(2014)	Malaoxon	NYSDEC(2014)
Alachlor	Blacksmith/MW	Mecoprop (MCPP)	NYSDEC(2014)
Alachlor ESA	NYSDEC(2014)/MW	Metalaxyl	NYSDEC(2014)/MW
Alachlor OA	NYSDEC(2014)/MW	Methiocarb	NYSDEC(2014)
Aldicarb	Blacksmith/MW	Methomyl	NYSDEC(2014)/MW
Aldicarb-Sulfone	Blacksmith/MW	Methoxychlor	Blacksmith
Aldicarb-Sulfoxide	Blacksmith/MW	Metolachlor	Blacksmith/MW
Atrazine	Blacksmith/MW	Metolachlor ESA	NYSDEC(2014)/MW
Azoxystrobin	NYSDEC(2014)	Metolachlor metabolite	NYSDEC(2014)/MW
Bentazon	NYSDEC(2014)	Metolachlor OA	NYSDEC(2014)/MW
Bromacil	NYSDEC(2014)	Metribuzin	Blacksmith
Carbaryl	NYSDEC(2014)	Monomethyltetrachloroterephthalate	Blacksmith
Carbofuran	NYSDEC(2014)	Napropamide	NYSDEC(2014)
Chlordane	Blacksmith/MW	Norflurazon	NYSDEC(2014)
Chlorofenvinphos	NYSDEC(2014)	Oxamyl	NYSDEC(2014)
Chloroxylenol	NYSDEC(2014)/MW	Pentachlorobenzene	NYSDEC(2014)
Cyanazine	NYSDEC(2014)	Pentachloronitrobenzene	NYSDEC(2014)
Dacthal	Blacksmith	Pentachlorophenol	NYSDEC(2014)
Deisopropylatrazine	NYSDEC(2014)	Piperonyl butoxide	NYSDEC(2014)
Dibromomethane	Blacksmith	Prometon	NYSDEC(2014)
Dicamba	NYSDEC(2014)	Propachlor	NYSDEC(2014)
Dichlobenil	NYSDEC(2014)	Propamocarb hydrochloride	NYSDEC(2014)
Dichlorvos	NYSDEC(2014)	Propiconazole	NYSDEC(2014)/MW
Didealkylatrazine	NYSDEC(2014)	Propoxur (Baygon)	NYSDEC(2014)
Dieldrin	Blacksmith/MW	Ronstar	NYSDEC(2014)/MW
Dimethyldisulfide	Blacksmith	Siduron	NYSDEC(2014)/MW
Dinoseb	NYSDEC(2014)	Simazine	Blacksmith/MW
Disulfoton sulfone	NYSDEC(2014)	TCPA	Blacksmith
Diuron	NYSDEC(2014)	Tebuthiuron	NYSDEC(2014)/MW
Endosulfan I	Blacksmith/MW	Triadimefon	NYSDEC(2014)/MW
Endosulfan II	Blacksmith	Triaimenol	NYSDEC(2014)

Pesticide Analyte	Source[1]	Pesticide Analyte	Source[1]
Endosulfan Sulfate	NYSDEC(2014)/MW	Trichlorfon	NYSDEC(2014)/MW
Ethofumesate	NYSDEC(2014)/MW	Triedimenol	NYSDEC(2014)
Ethyl dipropylthiocarbamate (EPTC)	NYSDEC(2014)	Vinclozolin	NYSDEC(2014)

1. Blacksmith = Supply Wells (SCDHS database); MW = SCDHS monitoring well database

Table 3-11b Wells Sampled for Pesticides by SCDHS, 2011 through 2013

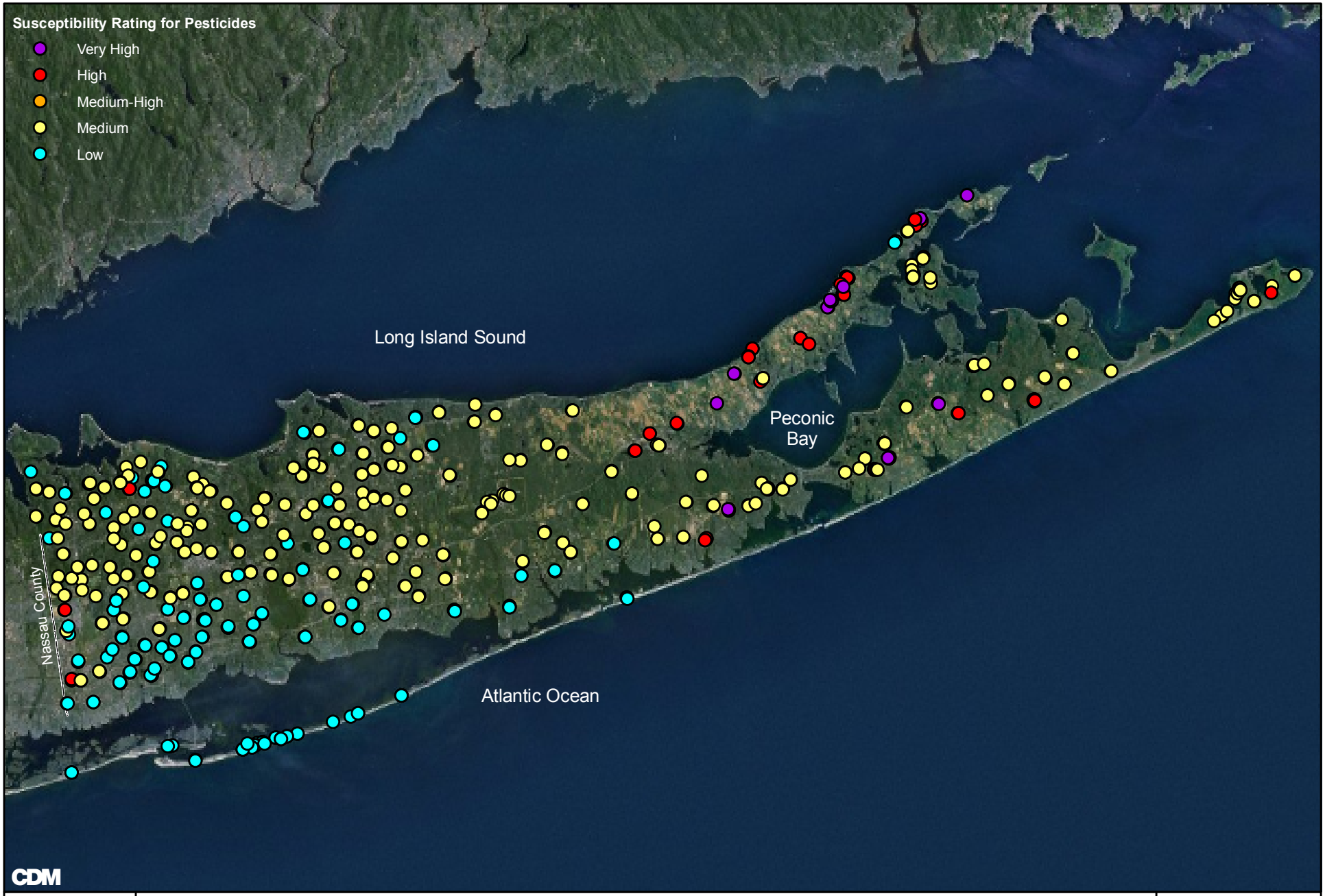
Type	# Sites Sampled	with Detects	Exceeded MCL
Community*	319	49 (15%)	4 (1%)
Non-Community*	230	22 (10%)	1 (< 1%)
Private*	966	90 (9%)	20 (2%)
Monitoring	524	192 (37%)	49 (9%)

*Based on SCDHS Blacksmith database. Some pesticides (e.g., metalaxyl, and Imidacloprid, for example) are not included in this database.

trichloropropane (TCP), alachlor, dinoseb, metalaxyl, imidacloprid, simizine and atrazine. Of the ten most frequently detected pesticide chemicals in the private wells, only simazine, metalaxyl, imidacloprid and atrazine remain registered for use on Long Island and metalaxyl has been detected in hundreds of wells (**Figure 3-26a**), albeit below the MCL of 50 µg/L.

The public and private well data compiled for selected pesticides from 1980 through 2014 demonstrates that several common agricultural pesticide chemicals can persist in groundwater for decades and that pesticide degradates are detected more frequently and in higher concentrations than some parent compounds. Levels of these older, banned pesticides have been decreasing in groundwater samples collected by SCDHS, as shown on **Figures 3-27** and **3-28**. Note that aldicarb has only been detected in three private wells since 1997 and concentrations shown on **Figures 3-27 and 3-28** are therefore almost entirely its metabolites after 1997. As shown on these figures, although these banned pesticides remain in the groundwater system, concentrations are declining and parent compounds are rarely detected supporting the effectiveness of the ban.

Crop type has a significant impact on the type and volume of pesticides that are observed in downgradient groundwater. A SCDHS report entitled **Water Quality Monitoring for Pesticides in Nassau & Suffolk County, Vineyard Monitoring Draft Report 2003-2006** describes water quality monitoring of 26 monitoring wells at seven Suffolk County vineyards. In general, low levels of pesticides or pesticide-breakdown products were widely observed, with

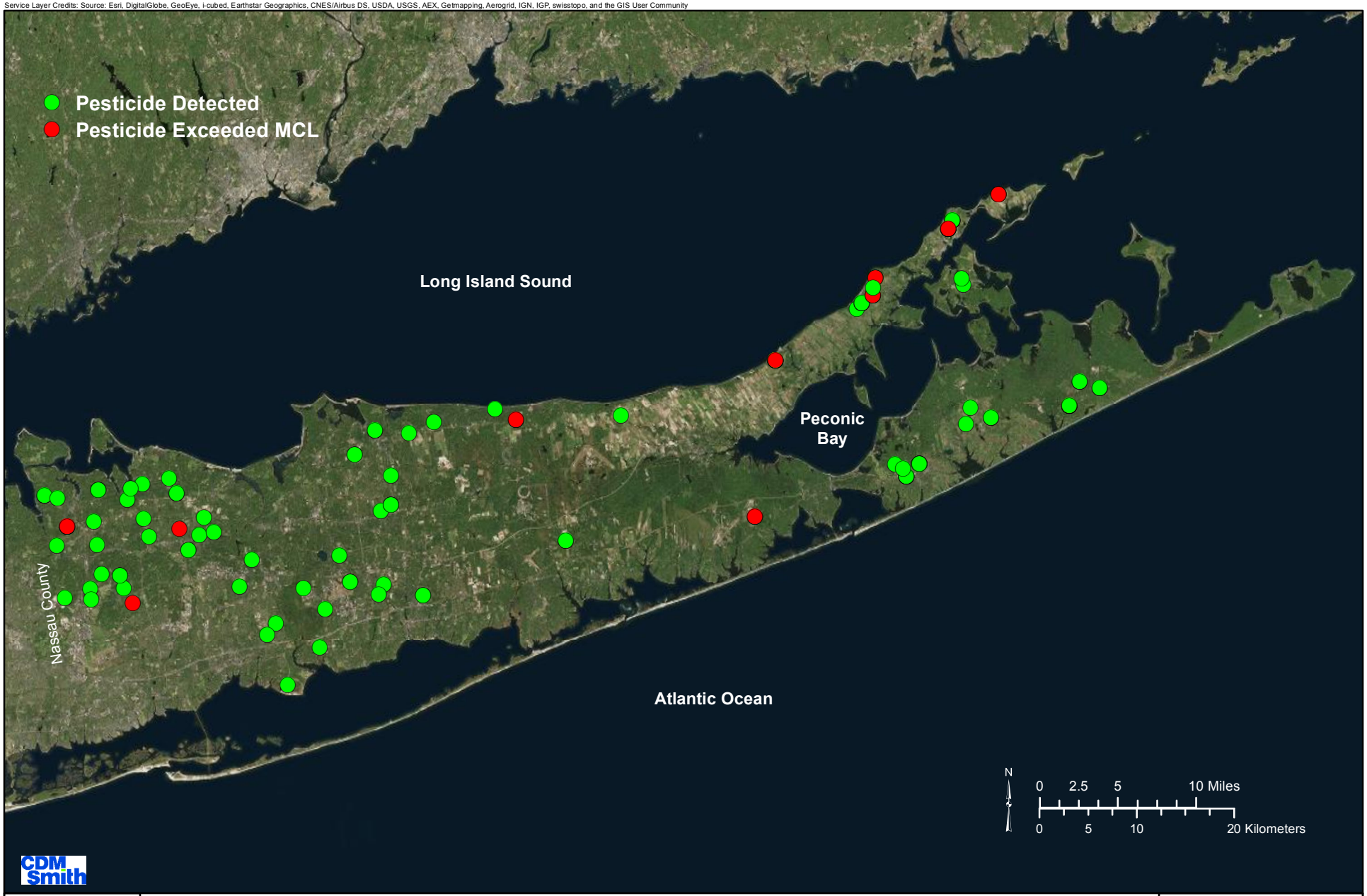


Community Supply Well Susceptibility Rating for Pesticides

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-25

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Pesticide Detections & MCL Exceedances 1997-2014
Community Public Water Supply Wells
SCDHS Blacksmith Water Quality Database

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-26

The pesticide-related chemicals found most often by the SCDHS were:

Aldicarb (Temik) breakdown products aldicarb sulfoxide and aldicarb sulfone – Despite the fact that aldicarb, a water soluble pesticide used on potatoes and other agricultural crops from 1975 through 1979 was banned from sale and use on Long Island in 1980, low levels of its two breakdown products have persisted in the aquifer in agricultural areas.

Tetrachloroterephthalic acid (TCPA) – A breakdown product of the herbicide dacthal, which was used in agricultural settings and on golf courses before being removed from use on Long Island in 1988.

1,2-dichloropropane (DCP) and 1,2,3-trichloropropane (TCP) - DCP was used extensively in the 1950s through 1970s to rid potato fields of the golden nematode and the Colorado potato beetle. Although use of DCP was banned in 1987, both DCP and TCP continue to be detected; because TCP has been reported in wells in non-agricultural areas and without DCP, it suggests that a few of these detections may have resulted from its use as an industrial solvent.

Metolachlor and its metabolites --- Although the herbicide metolachlor, used since the 1980s, has been banned from sale and use on Long Island since 2002, metolachlor and its metabolites continue to be identified in the aquifer, particularly in agricultural areas.

Simazine – A herbicide that is still registered for use in areas such as utility rights-of-way and electric company substations, simazine and its degradates have been detected in public and private supply wells.

Alachlor and its two breakdown products alachlor ESA and alachlor OA – Alachlor, a widely used agricultural herbicide until it was banned in 1999, and its two breakdown products are still detected in wells located in agricultural areas.

Atrazine – Atrazine is an herbicide that is applied to turf and crops and has been detected in wells primarily on the east end.

Metalaxyl – Low concentrations of metalaxyl, a fungicide in use since the 1980s and commonly used by vineyards and golf courses, have been reported in supply wells in the eastern part of the County. As of 2014, metalaxyl remains a registered on Long Island.

Dinoseb – Dinoseb was banned in 1986 after being widely used in agricultural areas in the 1970s and 1980s; low levels of the herbicide are still reported today.

Imidacloprid – An insecticide used to control grubs and the Asian Longhorned Beetle, imidacloprid is beginning to be detected in community supply wells.

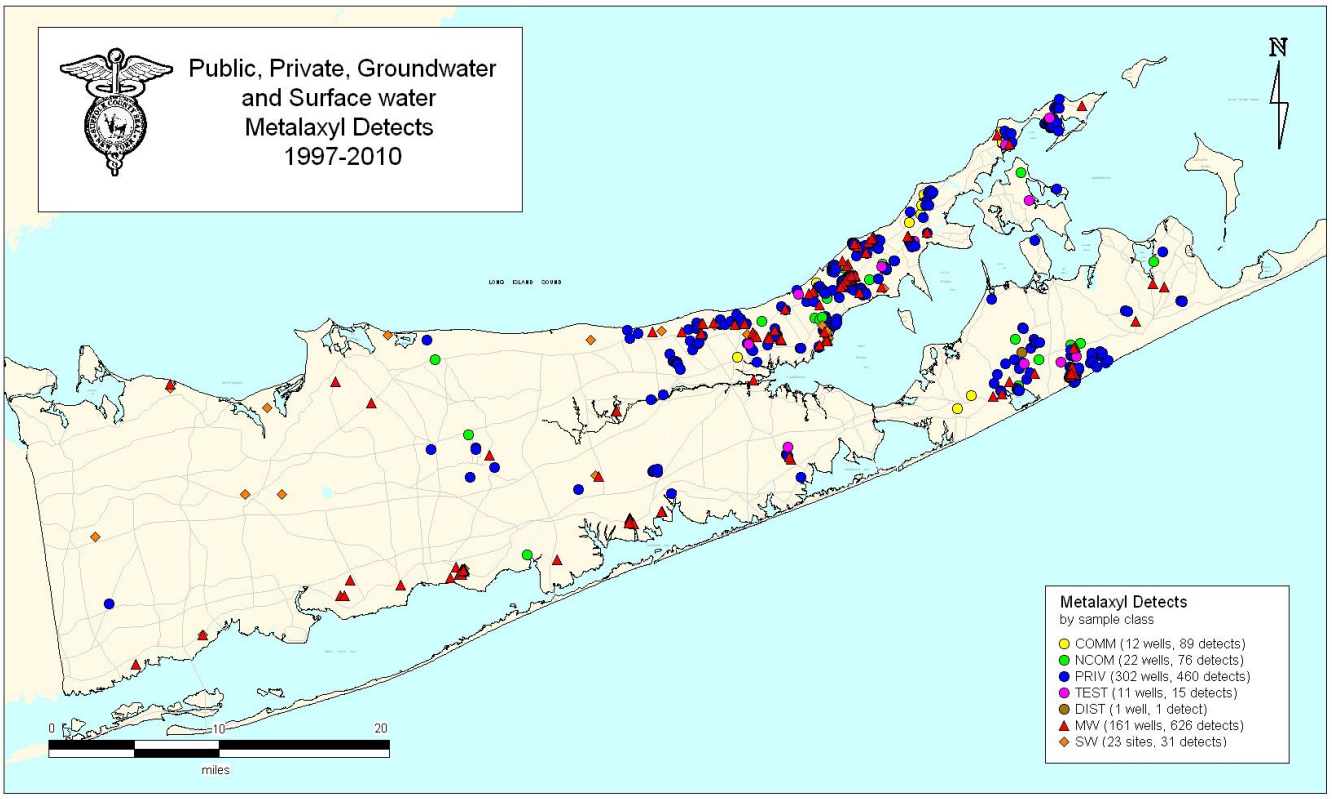


Figure 3-26a Detections of Metalaxyl between 1997 and 2010 (from SCDHS, 2011)

detections reported in 80 percent of the wells tested (21 of 26 wells) at five of the six vineyards. The fungicide metalaxyl, which is currently registered for use on grapes, was the most frequently detected compound, occurring at low levels in 15 of the wells sampled. In addition to the low levels of registered pesticides that were detected, low levels of historically applied pesticides and breakdown products not associated with vineyard applications were also widely reported, including metolachlor, alachlor and aldicarb. These compounds are likely artifacts from pesticide applications to agricultural crops that were previously grown in areas now planted in grapes. The detected pesticides were reported at concentrations an order of magnitude lower than applicable drinking water standards, except for simazine. Simazine was detected in four monitoring wells at concentrations ranging from 0.17 µg/L to 1 µg/L, all below the MCL of 4 µg/L.

Table 3-12 summarizes metalaxyl and atrazine detections in Suffolk County groundwater in 1997, 2005 and 2013 and imidacloprid detections in 2000, 2005 and 2013. The most recent data shows low levels off metalaxy detections in community, non-community and private wells. The data shows that atrazine

SCDHS records show there have been fewer detections of the oldest long withdrawn pesticides; however, these compounds are persistent and in some cases, still exceed drinking water standards. Examples include aldicarb and TCPA.

Figure 3-27 Trends in Maximum Aldicarb, Metolachlor and TCPA Concentrations Detected by SCDHS

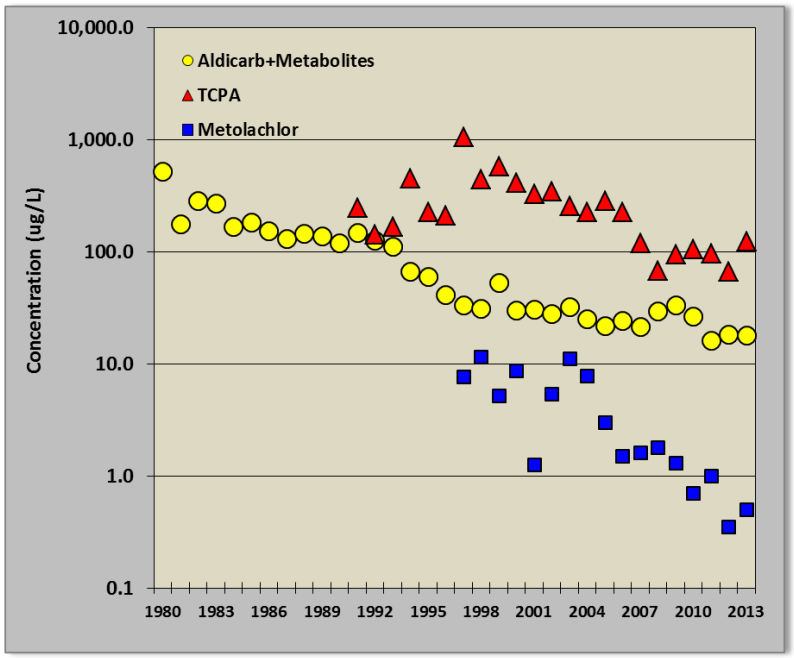


Figure 3-28 Trends in Median Aldicarb, Metolachlor and TCPA Concentrations Detected by SCDHS

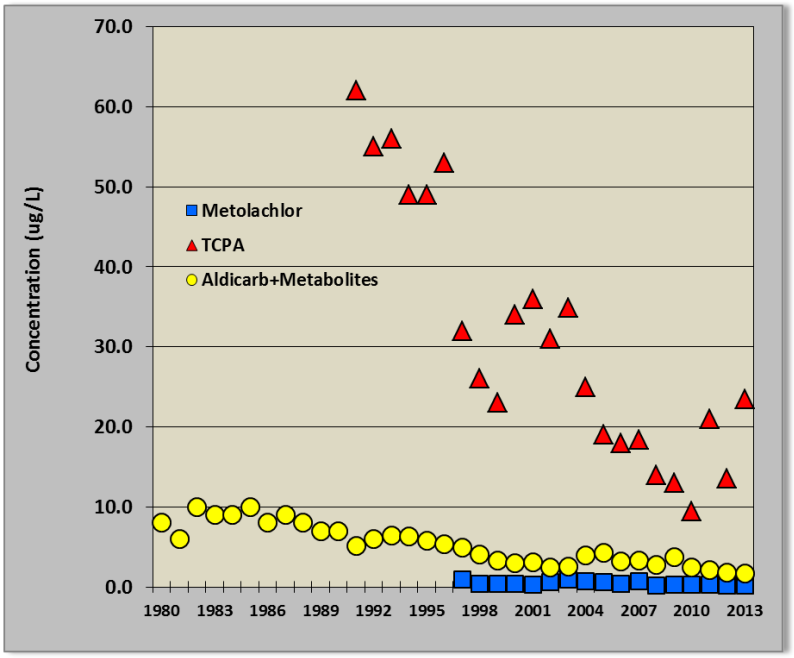


Table 3-12 Metalaxyl, Atrazine and Imidicloprid Data Trends in Community, Non-community and Private Wells

SCDHS Metalaxyl Data	1997			2005			2013		
	Com.	NC	Private	Com.	NC	Private	Com.	NC	Private
No. Wells Sampled	-	13	156	218	311	456	973	370	672
No. Wells with Detections	-	1	5	5	1	72	14	6	21
% Wells with Detections	-	8%	3%	2%	0%	16%	1%	2%	3%
Minimum Detection (µg/L)	-	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20
Maximum Detection (µg/L)	-	1.20	0.38	3.40	0.50	4.30	2.20	1.60	2.80
Median (µg/L)	-	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20
90% Percentile (µg/L)	-	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20
Detection Limit (µg/L)	-	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20
SCDHS Atrazine Data	**1997**			**2005**			**2013**		
	Com.	NC	Private	Com.	NC	Private	Com.	NC	Private
No. Wells Sampled	1	19	306	137	264	420	178	75	311
No. Wells with Detections	0	8	158	0	0	2	1	1	1
% Wells with Detections	0	42%	52%	0%	0%	0.5%	1%	1%	0%
Minimum Detection (µg/L)	0.20	0.10	0.10	0.20	0.20	0.20	0.10	0.10	0.10
Maximum Detection (µg/L)	0.20	0.20	0.65	0.20	0.20	0.80	1.00	0.20	0.20
Median (µg/L)	0.20	0.10	0.20	0.20	0.20	0.20	0.10	0.10	0.10
90% Percentile (µg/L)	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.10	0.10
Detection Limit (µg/L)	-	0.10	0.10	0.20	0.20	0.20	0.10	0.10	0.10
SCDHS Imidacloprid Data	**2000**			**2005**			**2013**		
	Com.	NC	Private	Com.	NC	Private	Com.	NC	Private
No. Wells Sampled	179	66	708	296	204	449	314	203	321
No. Wells with Detections	0	0	1	2	1	13	3	4	12
% Wells with Detections	0%	0%	0%	1%	0%	3%	1%	2%	4%
Minimum Detection (µg/L)	0.20	0.20	0.20	0.20	0.20	0.11*	0.20	0.20	0.20
Maximum Detection (µg/L)	0.20	0.20	0.42	0.27	0.40	8.44	0.30	0.70	2.80
Median (µg/L)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
90% Percentile (µg/L)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Detection Limit (µg/L)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Notes:

1. Data compiled from SCDHS Blacksmith database.
2. Com. Is community wells, NC is non community wells.
3. Detection limits are not consistent from year to year; * sample appears to be a spurious value.

Over 100 pesticides and pesticide-related chemicals have been detected in groundwater; concentrations are typically less than 5 µg/L.

Multiple pesticide and pesticide degradate compounds often co-occur in wells downgradient of agricultural areas; pesticide degradates are often detected in higher concentrations than the parent pesticide.

The highest pesticide concentrations are found in areas downgradient of agricultural areas.

Groundwater from over 98 percent of the supply wells sampled complied with the drinking water quality criteria for these contaminants.

Many of the pesticides and pesticide-breakdown products detected have been banned from use in Suffolk County for decades, but are still present in the aquifer system due both to their solubility and persistence in the environment. The continued presence of pesticide-related chemicals in both monitoring and supply wells demonstrates that pesticides continue to be of concern.

levels have declined through the years, and imidacloprid levels have increased. Imidacloprid is used throughout the County, in fact it is an ingredient in pet flea-control products.

The USGS has independently conducted pesticide investigations in Suffolk County and their findings are consistent with those of the SCDHS. As part of the National Water Quality Assessment Program, the USGS published ***Water Quality in the Long Island-New Jersey Coastal Drainages, New York and New Jersey, 1996-1998*** in 2000, and also documented their work investigating pesticides and their metabolites in shallow wells in Suffolk County. The five pesticides that were most frequently detected by the USGS were atrazine and metolachlor (agricultural herbicides), deethylatrazine (a metabolite), and prometon and simazine (herbicides available for purchase and use by homeowners). Reported concentrations of each in groundwater were well below the MCL or drinking water health advisory, except for deethylatrazine, for which no standard or guideline has been established to date.

The USGS study found that the most commonly used pesticides were not the same compounds that were most frequently detected in shallow groundwater in the study area. Pesticides that are characterized as having low persistence and/or low mobility were detected in less than five percent of the groundwater samples, even when high quantities of use had been reported. Pesticides that were reportedly applied in much lower quantities were detected more frequently when they were characterized with higher persistence and/or mobility. Due to their persistence and widespread application, organochlorine insecticides that have been banned were detected in groundwater in the study area. In addition, the USGS reports that the metabolites, or break down products of these pesticides were also widely detected throughout the study area. In fifty wells sampled on Long Island, 36 percent of the pesticide compounds detected were in fact metabolites; and the highest pesticide concentrations were associated with pesticide metabolites (Phillips et al, 1999).

Assessment of the significance of the pesticide detections is complicated by the fact that contaminant-specific MCLs have only been established for a small number of pesticides and only seven of the most frequently detected compounds in the County (alachlor, aldicarb (and metabolites), dinoseb, atrazine, simazine, DCP, TCP). The UOC MCL of 50 ppb is applied to all other pesticides. When multiple pesticide residues co-occur in wells located in agricultural areas, the total Principal Organic Contaminant (POC) and UOC MCL of 100 ppb was applied.

NYSDOH MCL	µg/L
1,2 Dichloropropane	5
1,2,3-Trichloropropane	5
1,3-Dichloropropane	5
2,2-Dichloropropane	5
2,3,7,8-TCDD (dioxin)	0.00003
2,4,5-TP (Silvex)	10
2,4-D	50
Alachlor	2
Aldicarb	3
Aldicarb sulfone	2
Aldicarb sulfoxide	4
Atrazine	3
Bromomethane	5
Carbofuran	40
Chlordane	2
Dibromochloropropane(DBCP)	0.2
Dinoseb	7
Diquat	20
Endrin	2
Ethylene dibromide(EDB)	0.05
Heptachlor	0.4
Heptachlor epoxide	0.2
Hexachlorobenzene	1
Lindane	0.2
Methoxychlor	40
Pentachlorophenol	1
Simazine	4
Toxaphene	3

Pesticide contamination in Suffolk County is primarily associated with agricultural land use, although additional sources are associated with residential, commercial and institutional lawn care.

The pesticide-related chemicals without contaminant-specific MCLs that were found most often by the SCDHS were:

- The herbicide Metolachlor (trade name Dual) and its two primary degradation products, metolachlor ethane sulfonic acid (ESA) and metolachlor oxanilic acid (OA);
- Tetrachloroterephthalic acid (TCPA) a dacthal herbicide metabolite;
- Metalaxyl, a fungicide; and
- Imidacloprid, an insecticide.
- Germanium
- Endosulfan sulfate

Pesticides and Land Use

The results of the initial SCDHS investigations led to expanded pesticides monitoring in Suffolk County and throughout the nation, to the ban of some pesticides found to leach to groundwater, and eventually prompted changes in the federal and state pesticide registration processes to prevent future similar contamination from occurring. Pesticide contamination in Suffolk County is primarily associated with agricultural land use, although additional sources are associated with residential, commercial or institutional lawn care. Pesticides were detected in 9 of the 29 wellfields whose historical land uses were evaluated in detail during this study; they are listed in **Table 3-13**.

Based on detailed evaluation of pesticide detections in a limited set of community supply wells, historical land uses, and aquifer travel times, the primary source of the pesticides detected in community supply wells appears to be agricultural activities. Agricultural land was present within the contributing area at some point in time. The USGS study also concluded that land use in the source water area is the primary factor differentiating water quality variability across the Long Island – New Jersey study area. Groundwater samples obtained from agricultural areas were most likely to show pesticide contamination.

However, it is also important to note that pesticides were not detected in water quality samples collected from fifteen of the wellfields evaluated as part of this study that included agricultural land within the contributing area. While the presence of historical agricultural use in the contributing area was related to the observation of low levels of pesticide contamination in downgradient supply wells, it seems that agriculture does not always introduce

pesticide contamination to groundwater. It is also important to understand that SCDHS tests for only a small percentage of pesticides that are registered, and it is possible that these pesticides and/or their degradates may be present.

Table 3-13 Pesticide Detections in Community Supply Wells (2011 through 2013)*

Wellfield	Agricultural Land	Pesticide Detected
Ackerly Pond Lane	Current and historical	Aldicarb metabolites
Bridgehampton Road	Current and historical	Aldicarb metabolites
Dare Road	Historical	1,2,3-Trichloropropane
Mt. Sinai-Coram Road	Historical	DCP
Old North Road (Greenport)	Current and historical	Metabolites of aldicarb, metolachlor
Ryder Avenue	Historical	DCP
Schuyler Drive	Current and historical	Simazine
Vanderbilt Parkway	Historical	DCP, TCP
Woodchuck Hollow Road	Historical	DCP, TCP, Aldicarb metabolites

*based on SCDHS Blacksmith database; Not all pesticides included.

SCDHS also investigated pesticides associated with golf course maintenance from 1999 through 2014. During the study, SCDHS collected 531 samples from 43 shallow monitoring wells installed at 27 golf courses. Over that time frame, low levels of pesticide-related chemicals were detected at nearly 93 percent (25 of 27) of the golf courses monitored.

The twenty-eight pesticides detected at the golf course wells are summarized on **Table 3-14**. Approximately 1/3 of the pesticides detected are no longer registered for application on Long Island, but persist from historical applications. The detected pesticides included herbicides, insecticides, and fungicides. The most frequently detected pesticides were metalaxyl, a fungicide, and DEET, which was detected at eight golf courses, and probably resulted from personal use rather than direct golf course application. In general, the pesticides were detected at low levels, an order of magnitude or more below applicable drinking water standards. Imidacloprid, an insecticide, and TCPA, a break-down product of dacthal, were also frequently detected. The SCDHS and USGS pesticide monitoring programs, as well as data that has been reviewed during this study, have identified agricultural use of pesticides as a major source of groundwater contaminants.

Summary

Pesticides continue to be detected in the groundwater within Suffolk County, particularly due to agricultural land use activities on the east end. Pesticides that have been banned or voluntarily restricted, have shown a decreasing trend

in concentrations indicating that the ban is effective. Although pesticides are frequently detected, currently registered pesticides have not been detected at concentrations exceeding MCLs in recent years (SCDHS, 2014).

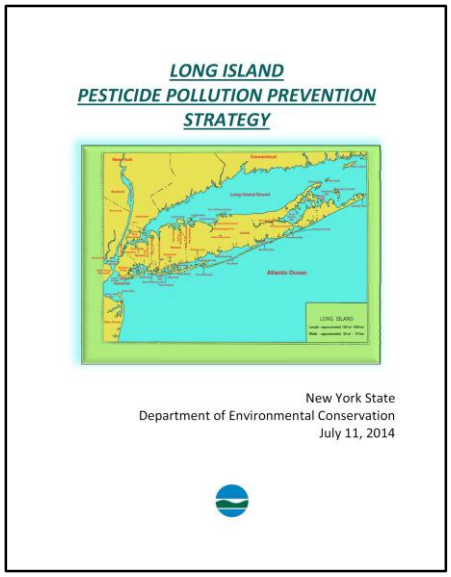
Table 3-14 Pesticide Detections in Golf Course Monitoring Wells since 1999 (SCDHS, 2014)

Compound Detected	L.I. Registration	Min (µg/L)	Max (µg/L)	No. of Wells	No. of Golf Courses	% of Courses Tested	MCL (µg/L)
Alachlor	Withdrawn	0.13	0.13	1	1	4%	2
Alachlor ESA	Withdrawn	0.1	0.4	1	1	4%	50
Alachlor OA	Withdrawn	0.16	0.81	2	2	7%	50
Aldicarb sulfone	Withdrawn	0.7	0.7	1	1	4%	2
Bentazon	Active	4.1	4.1	1	1	4%	50
Bromacil	Active	0.11	0.5	3	3	11%	50
Chloroxylenol	Active	0.16	0.34	1	1	4%	50
DEET	Active	0.1	1.4	12	8	30%	50
3,5-Dichloroaniline	Active	0.07	0.6	4	4	15%	50
2,6-Dichlorobenzamide	Active	0.1	0.1	1	1	4%	50
Dieldrin	Withdrawn	0.11	0.5	2	2	7%	5
Endosulfan Sulfate	Active	0.2	0.8	2	2	7%	50
Ethofumesate	Active	0.2	2.6	2	2	7%	50
Imidacloprid	Restricted	0.07	9.9	14	12	44%	50
Iprodione	Active	0.11	0.6	3	3	11%	50
Metalaxyl	Active	0.1	2.74	15	15	56%	50
Methomyl	Active	0.5	0.5	1	1	4%	50
Metolachlor	Withdrawn	0.1	0.4	3	3	11%	50
Metolachlor ESA	Withdrawn	0.06	2.58	10	8	30%	50
Metolachlor OA	Withdrawn	0.08	1.95	5	5	19%	50
Pentachlorobenzene	Withdrawn	0.14	0.41	4	4	15%	50
Pentachloronitrobenzene	Active	0.2	1.3	2	2	7%	50
Propiconazole	Active	0.2	3.4	2	2	7%	50
Siduron	Active	0.6	7.1	2	2	7%	50
TCPA (ppb)	Withdrawn	0	272	15	12	44%	50
Triadimefon	Active	0.15	3	2	2	7%	50
Triaimenol	Active	0.23	21	4	4	15%	50
Trichlorfon	Active	0.6	0.9	1	1	4%	50

Although concentrations are generally low for most pesticides, well below the drinking water MCL, the frequency of detection, particularly on the east end, is concerning. As long as pesticides are registered on Long Island, they will continue to be used until a proven alternative is introduced. SCDHS is committed to monitoring pesticides and their impact on the aquifer. SCDHS has pledged to:

- Continue our sampling and monitoring activities as part of our NYSDEC Pesticide Monitoring Program.

- Continue to monitor for pesticides at regulated public water systems as part of our programmatic activities, and continue to sample and test for pesticides at individual water supplies.
- Continue to explore the expansion of existing analytical capabilities at our PEHL to increase the number of pesticide compounds and degradation products that can be included in an analysis.
- Continue to work with stakeholders and the agricultural communities to implement the use of Best Management Practices (BMP) at various agricultural settings, particularly at farms where row crops are grown.



NYSDEC has released the ***Long Island Pesticide Pollution Prevention Strategy*** in July 2014. The goal of this strategy is to enhance water quality regarding pesticides through a "pollution prevention blueprint" which will focus on management methods, water quality monitoring and extensive research and outreach. As mentioned above, registered pesticides will continue to be utilized until a practical alternative is introduced. This new NYSDEC strategy coupled with extensive stakeholder input and cooperation will potentially identify alternatives and framework for implementation.

3.1.1.6 Other Contaminants of Potential Concern

Perchlorate

Perchlorate was first identified as a potential threat to groundwater and surface water supplies in 1997 when the California Department of Health Services (CADHS) developed a sensitive analytical method that was able to detect contaminant levels as low as 4 µg/L. Perchlorate (ClO_4-) originates as a contaminant in ground and surface waters from the dissolution of perchloric acid and salts of perchlorate, including ammonium, potassium, magnesium or sodium. With the exception of potassium perchlorate, these compounds have a solubility similar to table salt. The perchlorate anion is non-volatile, highly mobile in groundwater and can persist in the aquifer for very long periods of time.

Perchlorate is both naturally occurring and manufactured. Natural sources of perchlorate include atmospheric creation, evaporate deposits, and Chilean caliche deposits that have been mined and used extensively to produce fertilizer and gunpowder saltpeter since the 1830s. SCDHS has identified reports dating back to 1896 noting the presence of perchlorate in Chilean fertilizer, varying from trace concentrations to 2.7 percent (SCDHS, 2001) and has been advised that Chilean fertilizer was at one time the product of choice for many farms throughout Suffolk County, until replaced by less costly

ammonia-derived products in the late 1960s. A recent survey of existing fertilizers by EPA concluded that perchlorate should not be present in most fertilizers used today, except for products derived from Chilean caliche.

Perchlorate has been manufactured in the United States since 1910 and has been widely used; since World War II, ammonium perchlorate has been used as the oxidizer and primary ingredient in solid propellant for rocket motors, including the space shuttle rocket boosters. Other uses of perchlorate salts include flares, and fireworks (potassium salt); explosives, chemical processes and fireworks (ammonium salt); and military batteries (magnesium; Rogers, 1998), as a component of air bag inflators and in nuclear reactors (perchlorate acid), electronic tubes, lubricating oil additives, tanning and finishing leathers, color fixers in fabric and dyes, electroplating, aluminum refining, rubber manufacturing, and in the production of paints and enamels.

Routine monitoring of perchlorate by SCDHS and the SCWA began in 1998. Perchlorate is currently not regulated by the EPA. In December 1998, in response to finding perchlorate in Suffolk County groundwater, NYSDOH adopted a two-tiered Action Level requiring Public Notification at 18 µg/L and a planning-step trigger at 5 µg/L based upon the EPA reference dose.

The average concentrations of perchlorate in raw water sampled from community and non-community supply wells in 2005 are shown on **Figures 3-29a, 29b** and **29c** for the upper glacial, Magothy, and Lloyd aquifers, respectively. Low levels of perchlorate were detected throughout the County in both the upper glacial and Magothy aquifers, although no detections were reported in supply wells located in Babylon. Perchlorate detections in the upper glacial aquifer were observed in both the western part of the County in formerly agricultural areas, as well as in east end agricultural areas. Perchlorate was detected in fewer Magothy wells, and in general, at lower concentrations.

In 2011, perchlorate was detected in 365 wells, close to 60 percent of all supply wells sampled. Fourteen wells had raw water concentrations exceeding 4 µg/L, and the New York State action level of 18 µg/L was exceeded in a single well (see **Table 3-15**). During past monitoring however, perchlorate was found in excess of 18 µg/L in two community wells that were voluntarily removed from service by the SCWA, in one non-community well, and in private wells.

Perchlorate and Land Use

Perchlorate could be introduced to groundwater from overlying agricultural, commercial or industrial land uses, or from locations where fireworks disposal occurred. Based on the SCDEDP analysis of contributing area land uses and

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

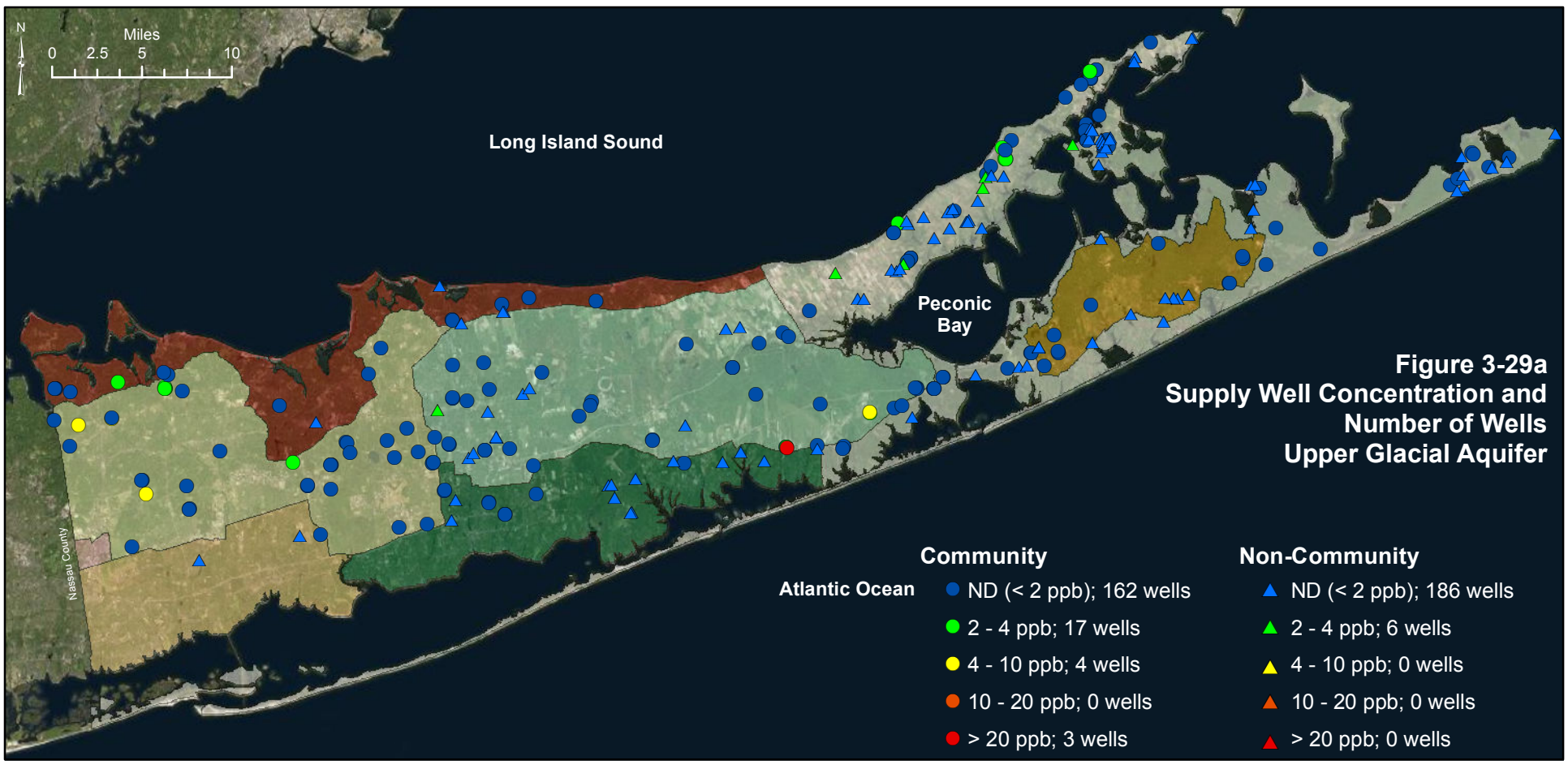


Figure 3-29a
Supply Well Concentration and Number of Wells
Upper Glacial Aquifer

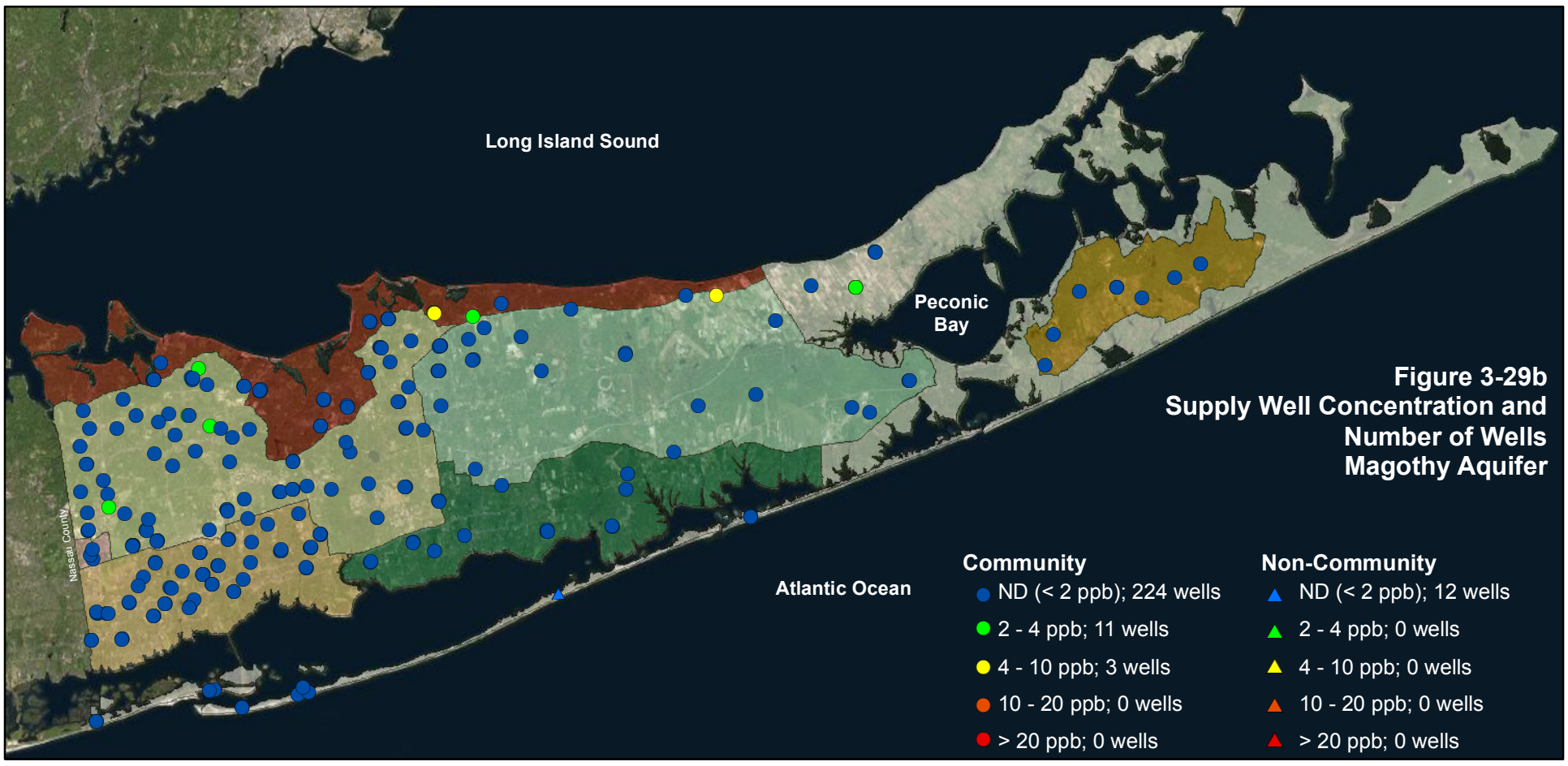


Figure 3-29b
Supply Well Concentration and Number of Wells
Magothy Aquifer

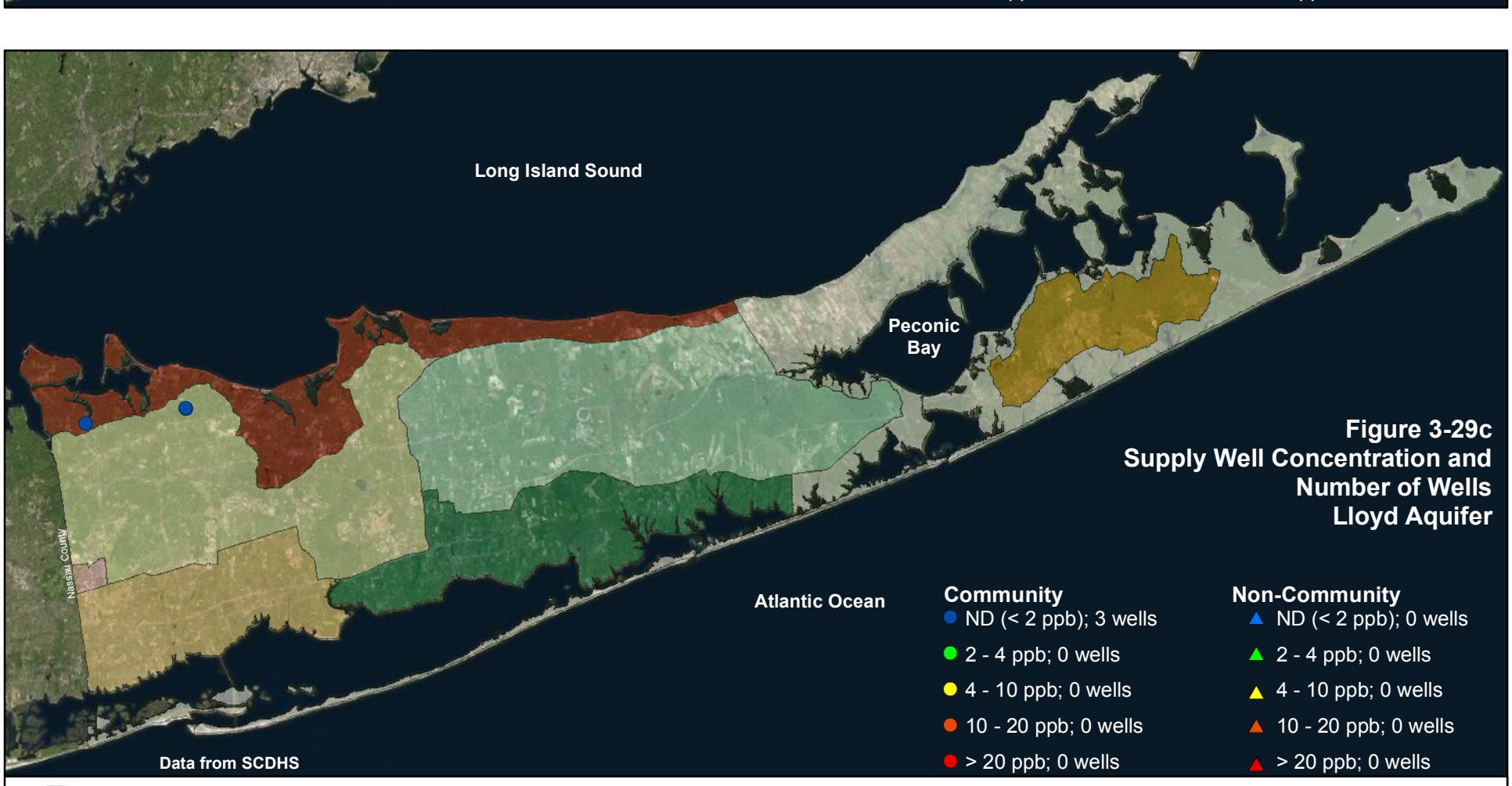


Figure 3-29c
Supply Well Concentration and Number of Wells
Lloyd Aquifer

Average Perchlorate Concentration in the Upper Glacial, Magothy & Lloyd Aquifers Community and Non-community Supply Wells - 2011

Suffolk County Comprehensive Water Resources Management Plan

CDM Smith

Figure 3-29

Table 3-15 Perchlorate Concentrations from Community and Non-Community Supply Wells

Aquifer	1987	2007-2011	2011
Upper Glacial Aquifer			
n (wells)	N/A	598	380
Minimum µg/L	N/A	ND	ND
Maximum µg/L	N/A	44.7	38.7
Average µg/L	N/A	0.39	0.73
10th Percentile µg/L	N/A	ND	ND
50th Percentile µg/L	N/A	0.12	0.33
90th Percentile µg/L	N/A	0.79	0.70
No. of wells with detects	N/A	303	263
No. of wells with Detect > 4 µg/L	N/A	21 / 4	8 / 5
No. of wells with Detect > 18 µg/L	N/A	1 / 0	1 / 1
Magothy Aquifer			
n (wells)	N/A	412	250
Minimum µg/L	N/A	ND	ND
Maximum µg/L	N/A	11.8	9.9
Average µg/L	N/A	0.27	0.49
10th Percentile µg/L	N/A	ND	ND
50th Percentile µg/L	N/A	ND	ND
90th Percentile µg/L	N/A	0.40	1.20
No. of wells with detects	N/A	105	99
No. of wells with Detect > 4 µg/L	N/A	10 / 2	6 / 3
No. of wells with Detect > 18 µg/L	N/A	0 / 0	0 / 0
Lloyd Aquifer			
n (wells)	N/A	5	3
Minimum µg/L	N/A	ND	0.8
Maximum µg/L	N/A	1.50	1.5
Average µg/L	N/A	0.44	1.2
10th Percentile µg/L	N/A	0.19	0.9
50th Percentile µg/L	N/A	0.40	1.3
90th Percentile µg/L	N/A	0.71	1.46
No. of wells with detects	N/A	4	3
No. of wells with Detect > 4 µg/L	N/A	0 / 0	0 / 0
No. of wells with Detect > 18 µg/L	N/A	0 / 0	0 / 0

Notes:

1. Data compiled from SCDHS databases.

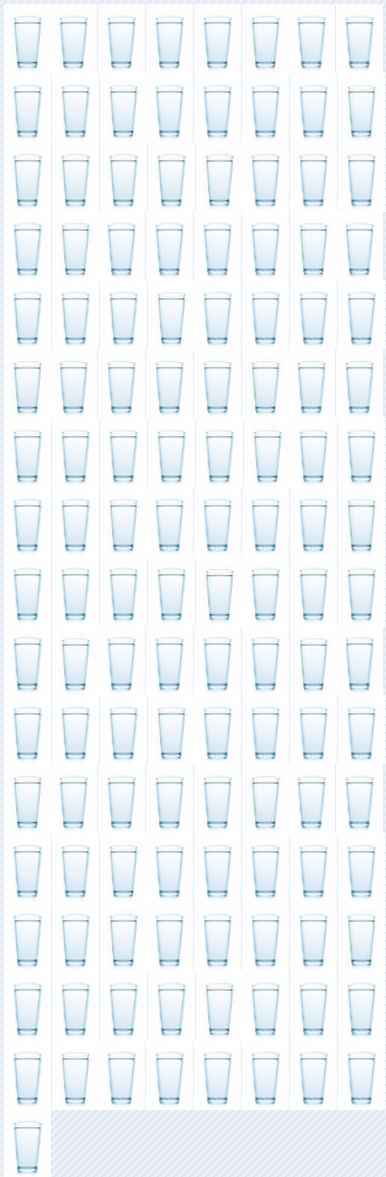
2. Averages and percentiles calculated from annual well averages.

3. No. of wells > 4 and 18 µg/L is based on well maximum and averages, respectively (max/avg).

4. 2011 data was used as it represents the most robust set of data (data in 2012 and 2013 is sparse) SCDHS did not analyze samples for perchlorate in 1987.

A person would have to drink almost 1,300 8 ounce glasses of water each day to exceed the lowest therapeutic dose (lowest dose that produces a desired clinical effect) of gemfibrozil, based on the highest concentration detected by SCDHS in groundwater to date.

Note: Each glass shown represents 10 glasses of water.



well water quality for a set of 56 community supply wells, agricultural land was either present or existed historically within the contributing areas for all 11 of the wellfields where perchlorate has been detected. Commercial and/or industrial land uses are also present in several of the contributing areas; facilities located within these areas could also have caused the perchlorate detections. Further site-specific evaluation would be required to determine if the sites are either currently or previously have been associated with perchlorate use.

Pharmaceutical and Personal Care Products (PPCPs)

Since the **1987 Comp Plan** was published, more advanced and sensitive analytical techniques have been developed that allow the detection of increasingly lower concentrations of contaminants in the environment. In recent years, very low levels of pharmaceuticals and personal care products (PPCPs), also sometimes referred to as pharmaceutically-active compounds (PhACs) or organic wastewater contaminants (OWC) have been detected in the environment. PPCPs include a broad range of products such as prescription and over the counter drugs, including antibiotics, veterinary and illicit drugs, fragrances, sun-screen products, cosmetics, some detergents, some food and drink additives, trace plasticizers that contaminate the consumer products and all of their respective metabolites and transformation products. Many are used and released to the environment in large enough quantities such that low levels are detected in wastewaters and receiving waters.

As most pharmaceuticals are designed to be water soluble, and to be persistent long enough to serve their designated therapeutic purposes, they can be present in dissolved form in receiving ground and surface waters. Aspirin was one of the first PPCPs to be identified in the environment; ibuprofen has also been detected in Suffolk County groundwater.

PPCPs are continuously introduced into the environment by sewage treatment plants and by on-site wastewater disposal systems (e.g., septic tanks and leach fields) in unsewered areas. Based upon estimated release rates to the environment and the field surveys that have been completed, the presence of PPCPs is expected to be at about the nanograms per liter (ng/l) or part per trillion (ppt) level in the environment. Many of these contaminants (e.g., nonylphenol, which mimics estrogen and is found in detergents, paints and cosmetics) are stable and persistent in the environment. Very little information on the fate of PPCPs in the environment is available.

Most PPCPs are not currently monitored – and in fact, cannot be monitored at this time. There are potentially hundreds, if not thousands of PPCPs and their

PPCPs include a broad range of products such as prescription and over the counter medications, fragrances, sun-screen products, cosmetics, some detergents, food and drink additives, trace plasticizer contaminants in consumer products, and all of their respective metabolites and transformation products.

PPCPs are continuously released to the environment by sewage treatment plants and on-site wastewater disposal systems.

Hundreds of PPCPs and their metabolites and breakdown products may potentially be released to the environment. Not all can be monitored, because analytical methods to detect the part per billion or part per trillion levels of PPCPs and their metabolites that may exist in the environment are not yet available.

metabolites and breakdown products that may be released to the environment. Although not all are PPCPs, Chemical Abstracts Services reports that more than 88 million organic and inorganic chemicals have been registered, more than 65 million chemical products are available commercially, and approximately 15,000 new chemicals are added per day (www.cas.org).

It should not be necessary to monitor for all of these parameters, however the subset of compounds with potential human-health impacts that ultimately should be monitored has not yet been identified. In addition, analytical methods to detect the extremely low levels of some PPCPs and their metabolites that may exist in the environment are not yet available. While analytical protocols to detect some PPCPs have been developed, cost effective methods to rapidly detect the presence of many of the other compounds that may be present have not. More information on potential monitoring approaches is described in Section 3.3.5 below.

Impacts on human health resulting from exposure to PPCPs are, for the most part, hypothesized and studies that both support and refute these hypotheses exist. Many of the compounds of concern are biologically active at low concentrations. Studies of the impacts of low levels of PPCPs in the environment are complicated by the fact that drugs designed with a specific purpose can also have other non-targeted effects or unknown mechanisms of action, and specific compounds can co-occur with multiple other contaminants. Assessments of human health impacts are further complicated due to unanticipated actions of the parent compound's metabolites. Consequently, most PPCPs currently do not have contaminant-specific drinking water standards or health advisories; instead they are regulated in New York State by the unspecified organic contaminant standard of 50 µg/L established by the NYSDOH in 1989.

This level is much higher than the concentrations that have been observed to occur in the environment, since the low concentrations detected in wastewater effluents are reduced even further by dilution in the receiving ground or surface water. It is currently believed that because the extremely low levels of pharmaceuticals that have been detected in drinking water are far below the daily prescribed dosage they do not pose an appreciable health risk (NYCDEP, 2011), although research continues. Lifetime consumption of pharmaceuticals from drinking water has been compared to a maximum consumption of only 5 percent of one daily therapeutic dose (GWRC, 2004).

A subset of PPCPs, endocrine disrupting compounds (EDCs), is of particular concern. USEPA has established an Endocrine Disruptor Screening Program (EDSP) to develop an approach to identify chemicals as EDCs. The EDSP uses

Endocrine Disrupting Compounds (EDCs) are of particular concern. USEPA has developed a screening program to develop an approach to identify EDCs. USEPA will evaluate the need to regulate a potential EDC after they conduct an exposure assessment, and a risk assessment integrating the potential exposure and the hazard.

a tiered approach to assess whether a contaminant may have an effect in humans that is similar to an effect caused by estrogen, androgen or thyroid hormones. The EDSP includes establishment of priorities for chemicals to be screened and tested, Tier 1 (Screening), Tier 2 (Testing) and hazard assessment. The chemicals selected for Tier 1 screening were active ingredients and inerts in pesticides, selected based primarily on human exposure factors rather than factors related to exposure. Tier 1 screening includes assays to identify substances with the potential to interact with estrogen, androgen, or thyroid hormone systems.

Tier 2 assays are performed to determine whether a substance may cause endocrine-mediated effects involving estrogen, androgen, or thyroid hormone systems, determining consequences to the organism, and establishing the relationship between doses and observed responses. Tier 1 Screening and Tier 2 Testing data identify and characterize the hazard associated with each potential EDC. EPA will then conduct an exposure assessment based on the amount of chemical to which wildlife or humans are likely to be exposed, followed by a risk assessment, integrating the potential exposure and the hazard. Based upon the risk assessment results, the need for regulation can be determined.

The presence of PPCPs in the environment is of potential significance to Suffolk County's groundwater supplies, and is being followed with great interest at federal, state and County levels. Sources of PPCPs in Suffolk County include treated and untreated sanitary wastewater, where disposal of uncompleted courses of medications such as antibiotics has occurred. PPCPs are continuously introduced into the environment by sewage treatment plants and by on-site wastewater disposal systems in unsewered areas. Recent SCDHS data indicates that PPCPs are also discharged to the groundwater by laundromats and health care facilities.

In response to the potential impacts of PPCPs on the County's groundwater, the SCDHS initiated a monitoring program incorporating analytical methodology development by the PEHL. The SCDHS PEHL utilizes EPA methodologies designed for analysis of regulated semi-volatile organic chemicals and a liquid chromatograph/mass spectrometer (LC/MS) Solid Phase Extraction method developed by the SCDHS PEHL to detect very low levels of a variety of PPCPs. SCDHS currently analyzes for 30 PPCPs. Since 1997, SCDHS has analyzed over 21,000 samples from community, non-community and private wells for the presence of PPCPs as summarized below:

The SCDHS's response to the potential impact of PPCPs on Suffolk County's water resources dates back to 2001, and includes:

- Implementation of a monitoring program incorporating analytical methodology development by the Suffolk County Public and Environmental Health Laboratory
- A continuing literature review; and
- Discussions with other environmental and public health agencies.

SCDHS has detected PPCPs in between 5.5 to 10 percent of private wells in any given year.

- **Community water supply wells** – Low levels of PPCPs were detected in an average of approximately 2.5 percent of community supply wells in each year;
- **Non-community water supply wells** – PPCPs were detected in samples collected from between 6 and 8 percent of non-community supply wells in any given year;
- **Private wells** – PPCPs were detected in between 5.5 to ten percent of private wells in each year.

Trace levels of the following PPCPs have been detected by SCDHS in the sub- to low part per billion range:

- Ibuprofen – an anti-inflammatory and analgesic medicine available without prescription with trade names such as Advil, Motrin and Nuprin;
- Gemfibrozil – a prescription medication used to lower the levels of triglyceride in the blood with a trade name Lopid;
- Carbamazepine - an anticonvulsant drug used in the treatment of certain forms of epilepsy;
- Carisprodol – used as a muscle relaxant:
- Caffeine - a stimulant commonly found in coffee, tea, soft drinks;
- BHT and BHA - food preservatives;
- Benzophenone - a fragrance;
- DEET - one of the most common insect repellants;
- Several phthalates (chemical compounds added to plastics to increase their flexibility) that are believed to be present in shampoos and other consumer products, including diethylhexyl phthalate (DEHP);
- Bisphenol-A (BPA) – a plastic strengthener, and a suspected endocrine system disrupter; and
- Dilantin - used as an anticonvulsant to treat epilepsy and
- Triclosan – An anti-bacterial chemical used in soaps.

SCDHS has also installed shallow monitoring wells to investigate the impacts of laundromats on groundwater in unsewered areas, and detected PPCPs associated with detergent use (diethyl phthalate, benzophenone) or clothing contamination (DEET). Several detections of diethyl phthalate and DEET near laundromats have exceeded the New York State UOC MCL of 50 ppb.

Diethylhexyl phthalate (DEHP) exceeded the drinking water standard of 6 µg/L in five public wells and 10 private wells sampled between 1997 and 2013. The affected public supply wells were either removed from service or provided with treatment.

A recent SCDHS study revealed low concentrations of the insecticide DEET in 10 of 37 monitoring wells installed at 27 golf courses throughout Suffolk County. The low concentrations, ranging between 0.10 and 0.62 µg/L, are believed to reflect use by golfers and staff.

While most PPCP detections (with the noteworthy exception of wells downgradient of laundromats) have been at concentrations of less than 1 µg/L, maximum concentrations found in Suffolk County groundwater are cause for concern as summarized on **Table 3-16**. Sampling conducted by the SCDHS between 1997 and 2013 indicates that detections of PPCPs at public water systems were below the drinking water standards established by the NYSDOH, with the exception of DEHP.

As part of a Science to Achieve Results (STAR) grant from the USEPA, SUNY at Stony Brook researched the "Occurrence and Fate of Pharmaceuticals and Personal Care Products in Groundwater Environments", to characterize the occurrence and fate of PPCPs in groundwater. The study includes sampling and analysis of effluent from on-site wastewater treatment plants and adjacent monitoring wells at 18 sites (including hospitals, nursing facilities and retirement communities) to estimate loadings of selected PPCPs to groundwater, as well as fate and transport characteristics. Groundwater samples were collected and analyzed by both the USGS and SUNY Stony Brook. The USGS sampled 52 deep wells within Suffolk County and Stony Brook analyzed samples from 20 shallow wells and the effluent from five sewage treatment plants (STPs), primarily within western and central Suffolk County. Preliminary project results presented at an USEPA Workshop (Benotti and Brownawell, 2005) are summarized on **Table 3-17**.

A site-specific study sampling effluent and groundwater at a nursing home was also completed, to begin to assess contaminant mobility in the environment. Preliminary conclusions from the study indicate the following (Benotti and Brownawell, 2005):

Table 3-16 PPCPs currently Analyzed by the Suffolk County PEHL and Maximum Concentrations Detected

Contaminant	Use	Detected by PEHL
Pharmaceuticals		
Acetaminophen	Pain Reliever	X
4-Androstene-3,17-dione	hormone	
Carbamazepine	anticonvulsant	X @ 17.8 µg/L
Carisoprodol	skeletal muscle relaxant	X @ 13.0 µg/L
Diethylstilbestrol	hormone	X
Dilantin (Phenytoin)	antiepileptic	X
4-Hydroxyphenytoin	metabolite of dilantin	X
Estrone	hormone	X
17 b Estradiol	hormone	
17 a Ethynylestradiol	hormone	
Gemfibrozil	lipid regulator	X @ 4.6 µg/L
Ibuprofen	anti-inflammatory	X @ 7.6 µg/L
Personal Care Products		
Benzophenone	fragrance	X
Chloroxylenol	antimicrobial	X
Dibutyl phthalate	plasticizer in nail polish	X
1,4-Dichlorobenzene	disinfectant	X
Diethyl phthalate	binds cosmetics & fragrances	X @ 59.8 µg/L
Dimethyl phthalate	used in insecticide repellents	X
Dimethyltoluamide (DEET)	insecticide repellent	X @ 69 µg/L
D-Limonene	deodorant	X
Picaridin	insect repellent	
Triclosan	antimicrobial	X
Other		
Benzyl butyl phthalate	plasticizer	X
bis-(2-ethylhexyl) adipate	plasticizer	X
bis-(2-ethylhexyl) phthalate	plasticizer	X
Bisphenol A	plasticizer	X
Bisphenol B	plasticizer	
Butylated Hydroxyanisole (BHA)	antioxidant; food additive	X @ 2.2 µg/L
Butylated Hydroxytoluene (BHT)	antioxidant; food additive	X
Caffeine	stimulant	X

Table 3-17 Preliminary Sample Results for PhAcs from Groundwater Collected in Suffolk County (from Benotti and Brownawell, 2005)

Compound	*USGS Nat'l Recon. median concentration for SW (ng/L)*	Shallow-well median concentration (ng/L)	Frequency of detect (n=20)	Deep-well median concentration (ng/L)	Frequency of detect (n=52)
Acetaminophen	*110*	14.2	65	18.5	11.5
Caffeine	*100*	18.8	85	5.5	32.7
Carbamazepine		57.9	50	3.8	55.8
Cimetidine	*74*	36.7	5	6.5	1.9
Codeine	*12*	7.0	35	9.4	7.7
Cotinine	*240*	5.2	50	3.5	19.2
Diltiazem	*21*	0.5	25	2.0	7.7
Erythromycin		47.4	10	6.3	1.9
Fluoxetine	*12*	33.1	25	174	5.8
Metformin	*110*	14.5	50	4.5	1.9
Paraxanthine	*110*	21.8	70	40.1	5.8
Ranitidine		3.9	25	nd	0
Salbutamol		7.3	10	0.7	3.8
Sulfamethoxazole	*66*	35.0	50	4.9	51.9
Trimethoprim	*103*	1.3	20	2.9	9.6

- PhACs are present in Long Island groundwater, although at concentrations that are typically lower than those found in impacted streams and rivers in the United States;
- Concentrations of PhACs are higher in shallow wells, particularly those near point source discharges;
- Transport and mobility of PhACs are limited by sorption and biological degradation.

The USGS has analyzed for, and detected additional PPCPs in groundwater in Suffolk County, including:

- Alprazolam (used to treat anxiety disorders)
- Cis-Andosterone (hormone)
- Carbazole (thryoid medication)

Suffolk County has passed two resolutions to strengthen public awareness of and encourage proper disposal of pharmaceuticals. Resolution No. 762-2008 established Operation Medicine Cabinet allowing residents to deposit unused medications in secure receptacles located in Suffolk County Police Precincts 24 hours/day, seven days/week. Resolution No. 181-2011 requires medical facilities to file a written plan for the disposal of unused or expired medications in an environmentally safe manner annually with the SCDHS.

- Cotinine (metabolite of nicotine)
- Cis-Diltiazem (used to treat hypertension/angina)
- 1,7-Demethylxanthine (stimulant)
- Diphenylhydramine (used to treat cold, cough, allergy)
- Fluconazole (antifungal)
- Galaxolide (HHCB, musk fragrance)
- Lidocane (topical analgesic)
- Loperimide (antidiarrheal)
- Methyl Salicylate (personal care)
- 4-Nonylphenol (surfactant/estrogen disruptor)
- 4-tert-octyl-phenol (detergent metabolite/EDC)
- Piperonylbutoxide (pharmaceutical/pesticide synergist)
- Thiabendazole (pharmaceutical)
- Tonalide (AHTN, musk fragrance)
- Tramadol (analgesic)
- Tributyl phosphate (TBP, plasticizer and solvent)
- Triethyl citrate (ethyl citrate, personal care)
- Triphenyl phosphate (TPP, plasticizer)
- Tris-(2-butoxy-ethyl) phosphate (TBEB, plasticizer)
- Tris-(2-chloro-ethyl) phosphate (TCEB, flame retardant and plasticizer)
- Tris-(2-dichloriso-propyl) phosphate (TDCP, plasticizer, suspected EDC)

PPCPs and Land Use - In Suffolk County, PPCPs in groundwater are of most concern in densely developed unsewered areas where sanitary wastewater is discharged directly to the ground via on-site septic systems or cesspools.

Recognizing the importance of preventing pharmaceuticals from entering ground and surface waters, in recent years, Suffolk County has passed two resolutions that both strengthen public awareness and encourage proper disposal of pharmaceuticals. Resolution No. 762-2008 established a program called Operation Medicine Cabinet, which allows residents to deposit unused medications in secure receptacles in Suffolk County Police Precincts 24 hours/day and 7 days each week. A companion program to support unused medication turn-in for the five East End Towns has been funded by the Suffolk County Water Quality Protection and Restoration Program (1/4% Sales Tax Program). Resolution No. 181-2011 requires hospitals, nursing homes, hospice facilities and long-term care facilities to file a written plan with the SCDHS annually for the disposal of unused or expired medications in an environmentally safe manner.

Concentrations of 1,4-dioxane in untreated water at SCWA supply wells in 2013 and 2014 ranged from non-detect at 0.07 µg/L to 15.2 µg/L.

1, 4 Dioxane

1,4-Dioxane ($C_4H_8O_2$) is an organic solvent with numerous industrial and synthetic uses. 1,4-dioxane is an ether that is classified by the USEPA as a probable human carcinogen. Its primary industrial use was as a stabilizer for the solvent TCA to protect the TCA from reactions with aluminum containers. Although TCA was banned worldwide starting in 1996 to protect the ozone layer, 1,4-dioxane is still directly used as a solvent in inks and adhesives, and is a manufacturing contaminant found in personal care products such as deodorants, shampoos, toothpastes, mouthwashes, bubble bath formulas, and moisturizers. It is also found as a contaminant in cleansing agents containing sodium lauryl sulfate (SLS), a surfactant used to make many cleaning and hygiene products less abrasive and better foaming. Like other ethers (such as MTBE) it does not readily bind to soils, and readily leaches to groundwater and is highly soluble. It is resistant to naturally occurring biodegradation processes in groundwater, but can be biodegraded by a number of pathways in surface waters, and has a low toxicity to aquatic life. 1, 4-dioxane is difficult and expensive to remove from drinking water (i.e., it is not effectively removed by granular activated carbon (GAC) and air-stripping).

When found in water, it is at µg/L levels. There is currently no federal drinking water standard for 1,4-dioxane; however NYSDOH regulates this compound at 50 ppb as an unspecified organic contaminant (UOC). The current USEPA 10^{-6} lifetime risk value for 1,4-dioxane is 0.35 µg/L and the noncancer lifetime Health Advisory (HA) is 200 µg/L based upon non-cancer effects (USEPA, 2012). 1,4-dioxane is currently being evaluated under the USEPA's Unregulated Contaminant Monitoring Rule (UCMR3) and is likely to be regulated due to its characterization as a probable human carcinogen. California and Illinois have reduced their drinking water guidance level to 1 µg/L, while Massachusetts set its guidance level at 0.3 µg/L. California Department of Public Health has

posted a notification level of 1 µg/L based upon an evaluation of new evidence of dioxane's carcinogenic activity in animals, and the limits of the current standard analytical detection.

SCWA has been analyzing well samples for 1,4-dioxane since 2003. Testing performed by the SCWA in 2013 and 2014 identified the presence of 1,4-dioxane at low levels in approximately 45 percent of the wells tested in 2013 and 2014 as illustrated by **Figure 3-30**. The contaminant was detected in wells screened in both the Upper Glacial and the Magothy aquifers. 1,4-dioxane was found in 53% of the Upper Glacial supply wells tested at concentrations ranging from the detection limit of 0.07 µg/L up to 3.02 µg/L and in 39% of Magothy wells at concentrations ranging from the detection limit of 0.07 µg/L up to 15.2 µg/L.

Chlorate may be introduced to the environment as a byproduct of hypochlorite used for disinfection or as an herbicide.

Chlorate

Chlorate may be introduced to the environment as a byproduct of hypochlorite used for disinfection, or as an herbicide. Chlorate is used as a decoloring or bleaching agent in food (e.g., flour) production, and may be introduced indirectly from food packaging. When used as a pesticide, sodium chlorate targets broadleaf weeds. It is highly soluble, with a high runoff and leaching potential (The Potential Regulatory Implications of Chlorate, AWWA, 2014). USEPA has established a health reference level (HRL) of 210 µg/L.

USEPA has established a health reference level of 210 µg/L for chlorate. Chlorate levels in untreated water samples collected from SCWA supply wells in 2013 and 2014 ranged from non-detect at the detection limit of 20 µg/L to 989 µg/L. The average concentration in upper glacial supply wells was 223 µg/L.

Samples collected from untreated water at SCWA community supply wells in 2013 and 2014 revealed an average concentration in Upper Glacial wells of 223 µg/L. Chlorate levels in individual raw water samples from Upper Glacial wells ranged from ND at the detection limit of 20 µg/L to a maximum concentration of 989 µg/L.

Hexavalent Chromium

Chromium is a naturally occurring metal that can occur as trivalent chromium (Cr-3) and hexavalent chromium (Cr-6). The presence of low levels of Cr-6 in groundwater can be naturally occurring, or can result from industrial processes. While there is no specific MCL for Cr-6, USEPA has established an MCL of 100 µg/L for total chromium. Between January 2013 and October 2014, the results of SCWA public supply well monitoring for Cr-6 ranged from non-detect at < 0.030 µg/L to 11.7 µg/L with an average concentration of 0.48 µg/L. Cr-6 has a high mobility in groundwater due to its anionic nature. The average Cr-6 level in untreated samples collected from the SCWA distribution system during the same time period was 0.36 µg/L.

Contaminants of Concern from Composting Facilities

After SCDHS identified contaminants above drinking water standards in samples collected from a private drinking water supply well, SCDHS, NYSDEC

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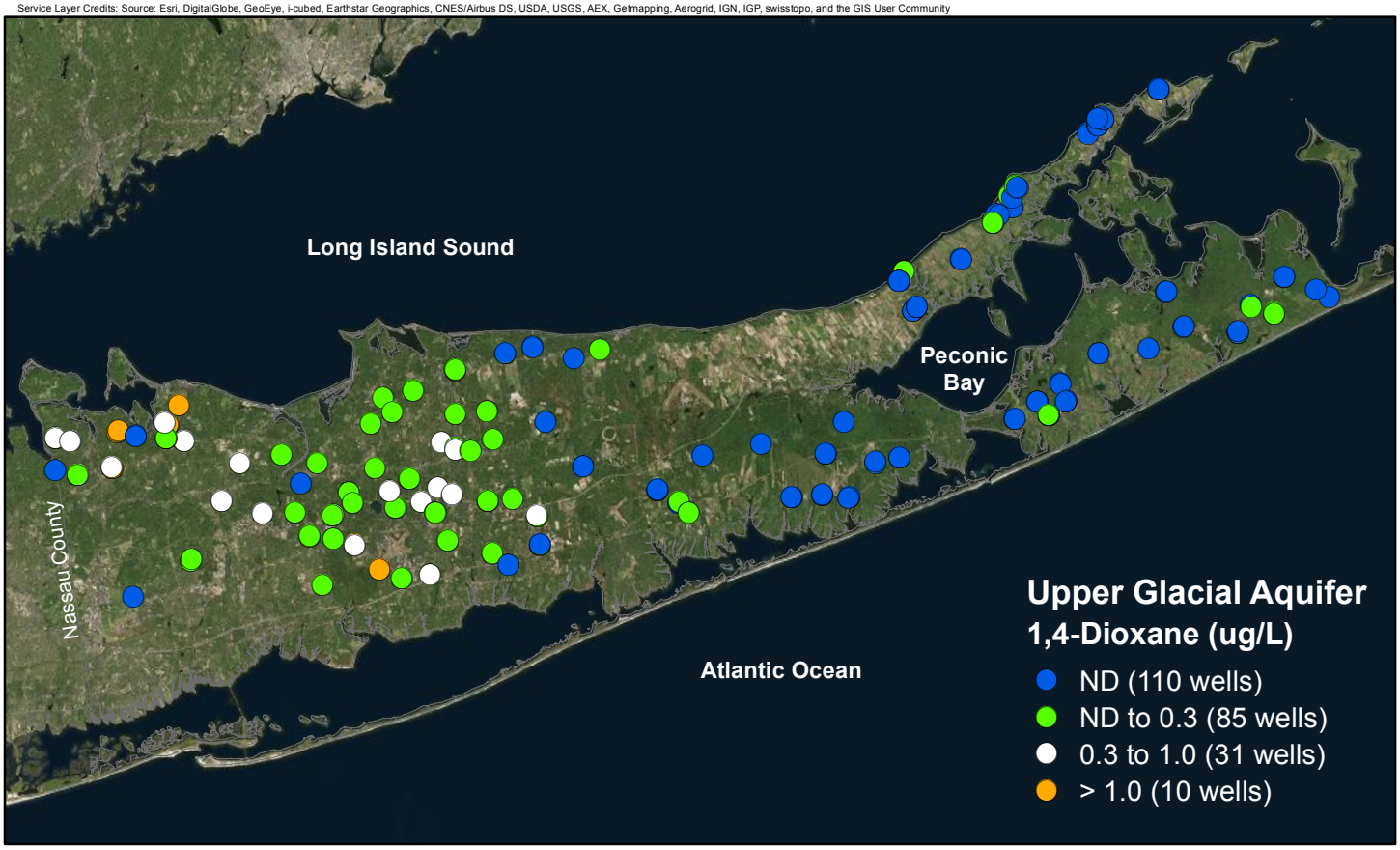
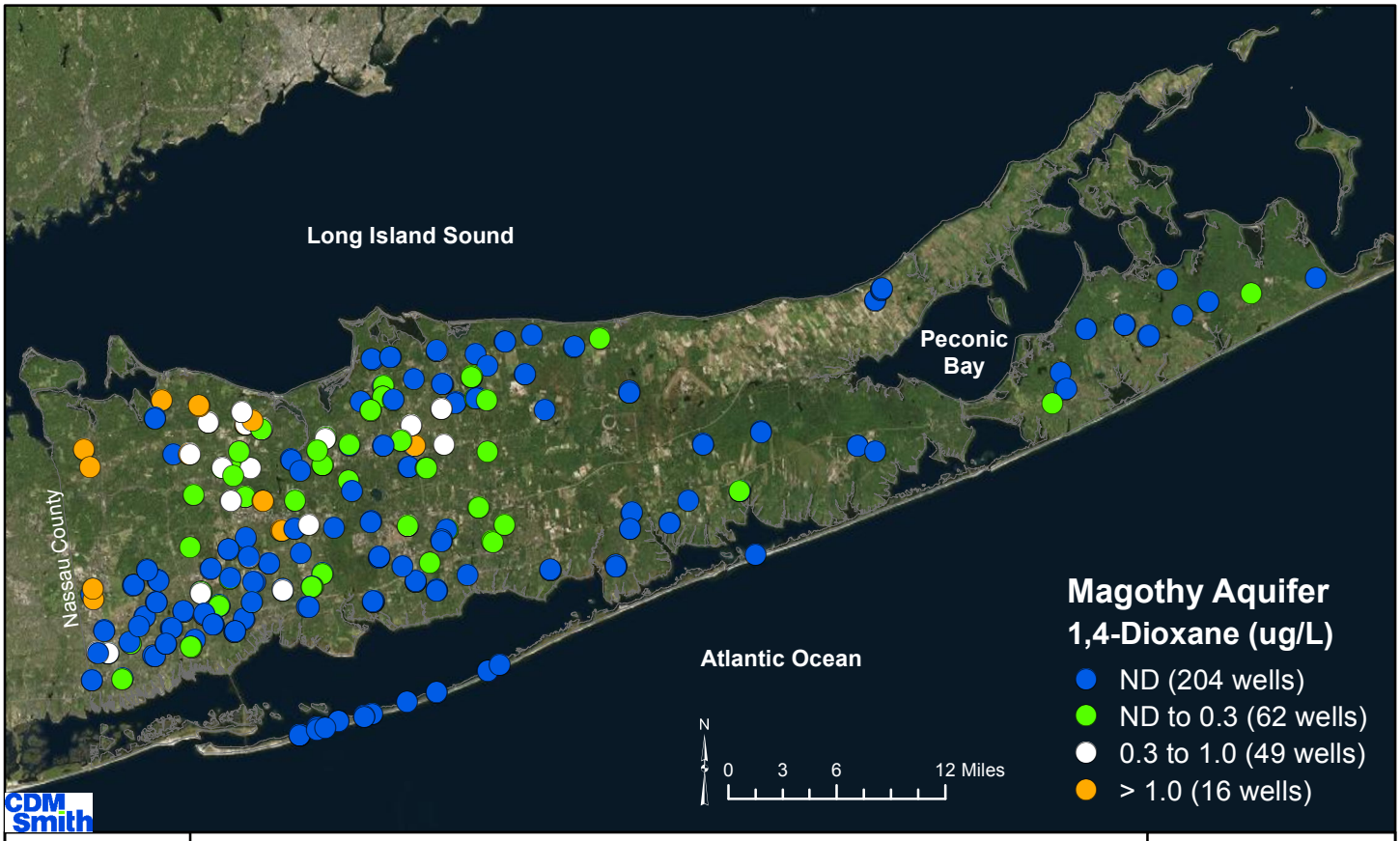




CDM Smith

Average Concentrations of 1,4-Dioxane in the Upper Glacial & Magothy Aquifers Suffolk County Water Authority Wells (2013-2014)

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-30

and NYSDOH collaborated on a series of investigations in the vicinity of the adjacent Vegetative Organic Waste Management (compost) facility. The groundwater investigations concluded that concentrations of a variety of contaminants were significantly greater in samples collected from wells downgradient of the facility than in samples collected from upgradient wells. Manganese, gross alpha, gross beta, thallium and ammonia were all detected above the drinking water standard in samples collected downgradient of the compost facility. These results prompted evaluation of groundwater quality at a second compost facility and investigation of surface water run-off at composting facilities without monitoring wells, which yielded similar results. Investigations identified the presence of other contaminants of concern including contaminants typically associated with wastewater (e.g., ammonia, pharmaceuticals and personal care products, and methylene blue activated substances) and other metals.

Analyses of compost and soil at these facilities did not identify the presence of these contaminants at levels of concern, however the investigation prompted the SCDHS to identify the need for operational changes at these facilities. Residences with private wells in the area were connected to public water supply and NYSDEC and the facility agreed that operational changes would be implemented at the facility. NYSDEC is considering potential revisions to regulations regarding vegetative organic waste management facilities to protect against impacts to groundwater and surface water, and SCDHS is continuing to investigate other similar locations to assess potential groundwater quality impacts.

3.1.1.7 Summary

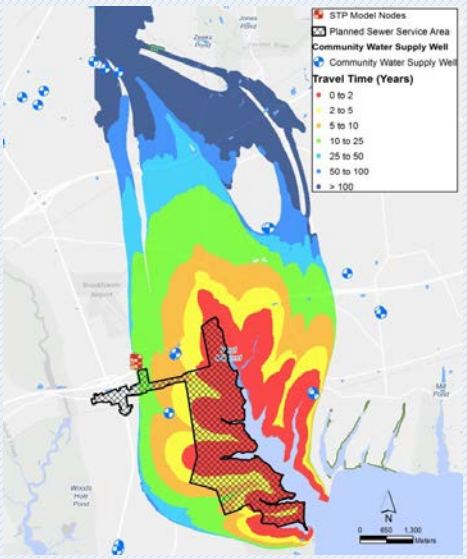
Considering the 1.5 million Suffolk County residents who live, work and play above our sole-source aquifer, the quality of the County's groundwater remains remarkably good. However, while implementation of regulations and management activities protecting groundwater quality have been effective in reducing the impacts of human development, the continued effects of overlying land uses on groundwater quality are evident.

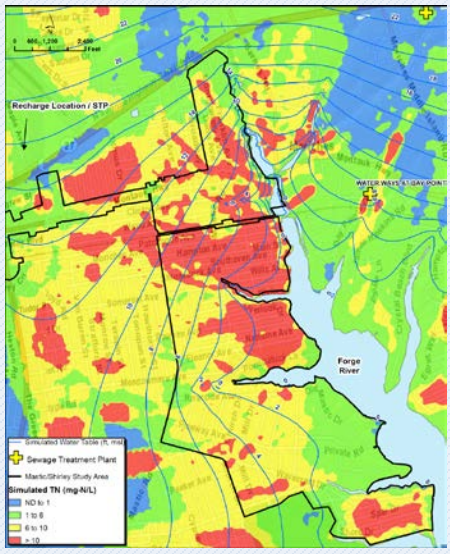
Concentrations of nitrate continue to slowly increase in all three aquifers, as a result of sanitary wastewater management and fertilization practices. Increased detections of low levels of volatile organic compounds throughout the County indicate widespread use and release to the environment, while higher levels of VOC contamination are associated with industrial, commercial, transportation or institutional land uses. Pesticides continue to be detected in groundwater downgradient of agricultural areas and more sophisticated analytical techniques have enabled detection of very low levels of

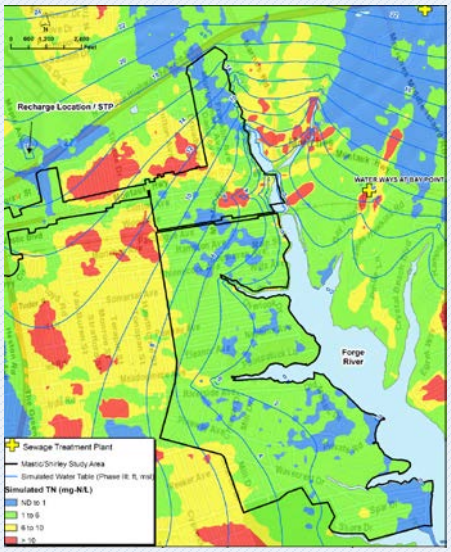
EVALUATION OF WASTEWATER TREATMENT PLANT SITING
Draft Mastic Shirley Case Study

While wastewater treatment is implemented to protect ground and surface water quality from the impacts of the contaminants associated with untreated sanitary sewage, Suffolk County is mindful that the environmental impacts of construction and operation of a wastewater treatment plant must also be identified, and mitigated to the extent possible. SCDHS has developed guidance on the siting of wastewater treatment plants to avoid unnecessary water quality impacts to sensitive water resource features such as water supply wells and surface waters. Facilities that are sited within these areas are also required to achieve more stringent effluent limits.

The impacts of the recharge of treated sanitary effluent on downgradient water quality are evaluated to provide an estimate of the anticipated water quality improvements; this may be required as part of the State Environmental Quality Review Act (SEQRA) process. One of the priority areas that the County is considering sewering is the densely developed area within the contributing area of the Forge River. The County considered the stream contributing area while defining the sewer service area, and evaluated the potential improvements to nitrogen levels as well as the potential for groundwater mounding at the recharge area.







The first figure illustrates how the red area, contributing groundwater baseflow to the Forge River within two years, guided identification of the area to be sewered. Simulated nitrogen levels in groundwater prior to sewering (second figure) and after sewering and treatment using best available technology (figure 3) were also evaluated. The water table contours identify predicted changes to the local flow field.

Given that the County's fresh surface water features derive much of their baseflow from groundwater, the County also carefully considers the impact of sanitary sewering on the water table elevation (which impacts wetlands) and on stream flows. When groundwater is removed from the aquifer for water supply, and sanitary wastewater is treated at a regional wastewater treatment plant and discharged off-shore, as is the case in the County's southwest sewer district (SWSD), the groundwater table can be lowered, and groundwater baseflow to streams, ponds and wetland areas may be reduced. The County evaluates these potential impacts on a case-by-case basis as the magnitude of the impacts is dependent on the size of the wastewater treatment facility, the locations of the groundwater withdrawals and local hydrogeology, and the proximity of downgradient streams, ponds and wetlands.

Given concerns that wetlands within the SWSD would be impacted by sewering, the County consulted with USEPA and NYSDEC and monitored vegetation at wetlands sites within and to the east of the SWSD for over a decade to assess any changes in wetlands ecology (e.g., progression from obligate wetland to facultative to upland vegetation) that might require mitigation. Stream headwaters locations, stream baseflows and depth to groundwater, identified as the most important indicator, were also monitored.

new contaminants such as PPCPs throughout our aquifer, which demonstrate the continued effects of human activity in the watershed. Based on the increasing levels of these contaminants that have been observed over the past two decades, the County's continued commitment to implementation of groundwater quality protection programs will be essential to ensure that the resource remains available to future generations.

3.1.2 Groundwater Quantity

Previous studies have documented that Suffolk County's aquifer system is capable of providing an adequate quantity of water to supply the County's residents; re-evaluation of the permissive yield defined in the ***1987 Comp Plan***, or development of permissive sustained yield values were not included in this project scope. Instead, the calibrated Main Body, North Fork, South Fork and Shelter Island groundwater models were used to develop water balances that provided additional insight into the groundwater system. In addition, the models were used to begin to consider the magnitude of the impacts that could result from predicted increases in sea level.

Construction and operation of sanitary sewer systems discharging to surface waters results in a net loss of groundwater from the aquifer system, potential reduction in the local water table elevation and potential reduction in stream baseflow. Consideration of these potential impacts requires site-specific evaluation.

Construction and operation of sanitary sewering systems that discharge to surface waters result in a net loss of groundwater from the aquifer system, and a potential reduction in the local water table elevation. Because groundwater provides the baseflow for the County's fresh surface water features, sanitary sewering with surface water discharge can also result in a loss of stream baseflow. Consideration of these impacts requires site-specific evaluation. The impacts of sanitary sewering in the County's largest sewer district, Sewer District No. 3, Southwest (SWSD) on groundwater elevations and stream baseflow have been previously documented (CDM, 1995, 2002). The localized impacts of sewer system extension in the Kings Park area, and implementation of a new sewer system in the Mastic/Shirley area were also considered as part of this study; the results of these site-specific evaluations may be found in Task Memoranda 5-2 and 15 respectively. Suffolk County considers the potential impacts of sanitary sewering on groundwater levels – whether it be an increase in the water table resulting from recharge of treated effluent, or a decline in the water table that results when treated effluent is discharged to a surface water body – as part of their evaluation of sewering feasibility.

3.1.2.1 Water Balances

The calibrated Main Body, North Fork, South Fork, and Shelter Island groundwater models were used to develop water balances to characterize aquifer conditions that would have existed at the turn of the century, prior to extensive development, and to characterize current conditions, which are defined by recent levels of public water supply pumping and the presence of

existing stormwater and wastewater collection and management facilities. Recent levels of public water supply pumping assigned in the model simulations were based on those used for the Long Island Source Water Assessment Program evaluations (SWAP, 2003). Pumping from wells categorized as non-community water supply, industrial, commercial, private, or agricultural was not included in the water balance simulations because their combined contribution to the total County-wide groundwater withdrawals is estimated to be much less than the approximately 200 million gallons per day (mgd) currently withdrawn from community water supply wells, and because a significant portion of withdrawals from these types of wells is believed to be returned to the aquifer system (with the exception of agricultural supply well pumping during the growing season).

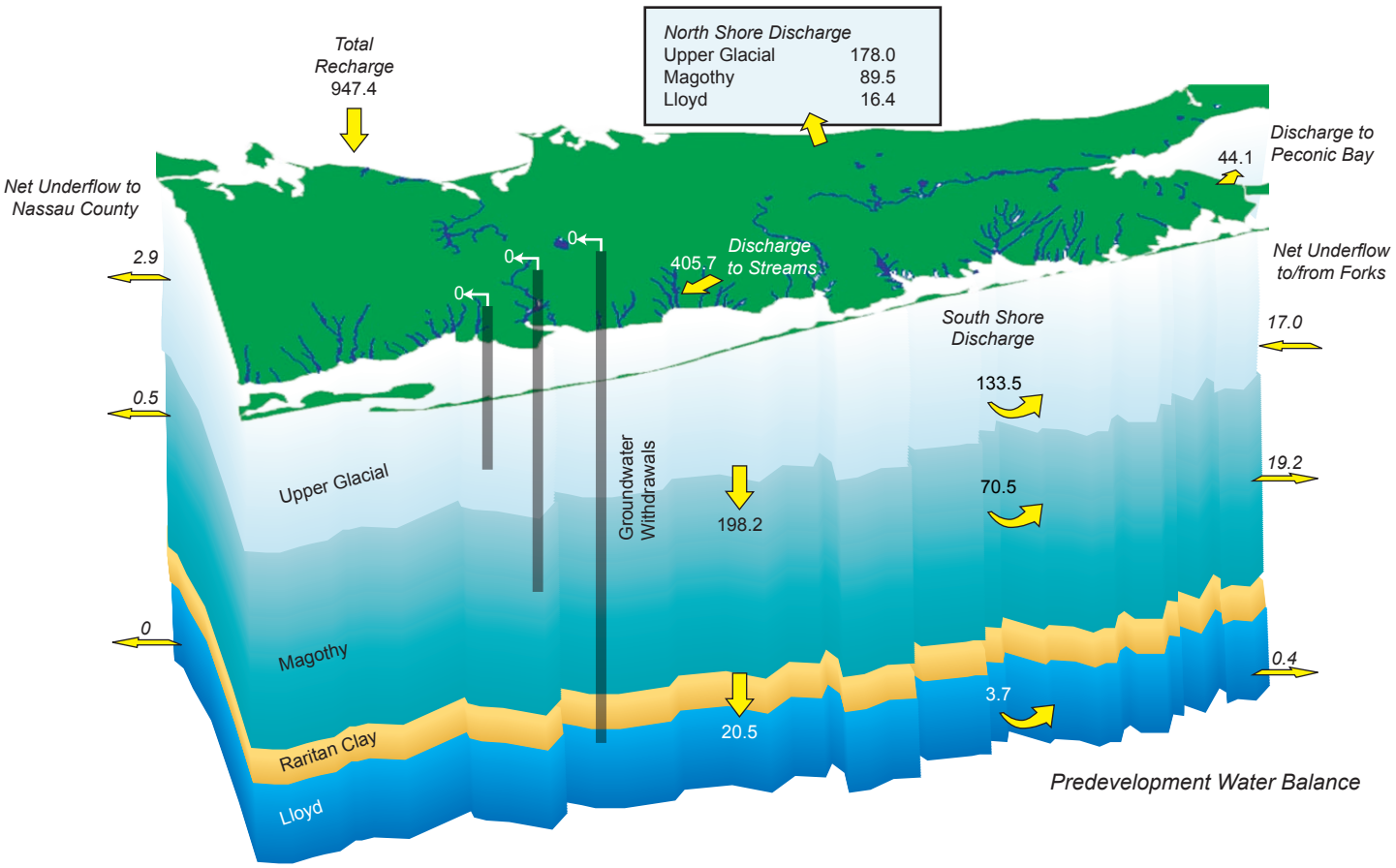
Geographically, four water balances were developed. The Main Body flow model was used to develop a water balance for the main part of Suffolk County, from the Nassau-Suffolk border on the west, to Shinnecock Inlet (on the South Fork) and Mattituck Creek (on the North Fork) on the east. The North Fork, South Fork, and Shelter Island freshwater/saltwater interface models were used as the basis for development of separate water balances for the North Fork east of Mattituck Creek, the South Fork east of Shinnecock Inlet and for all of Shelter Island.

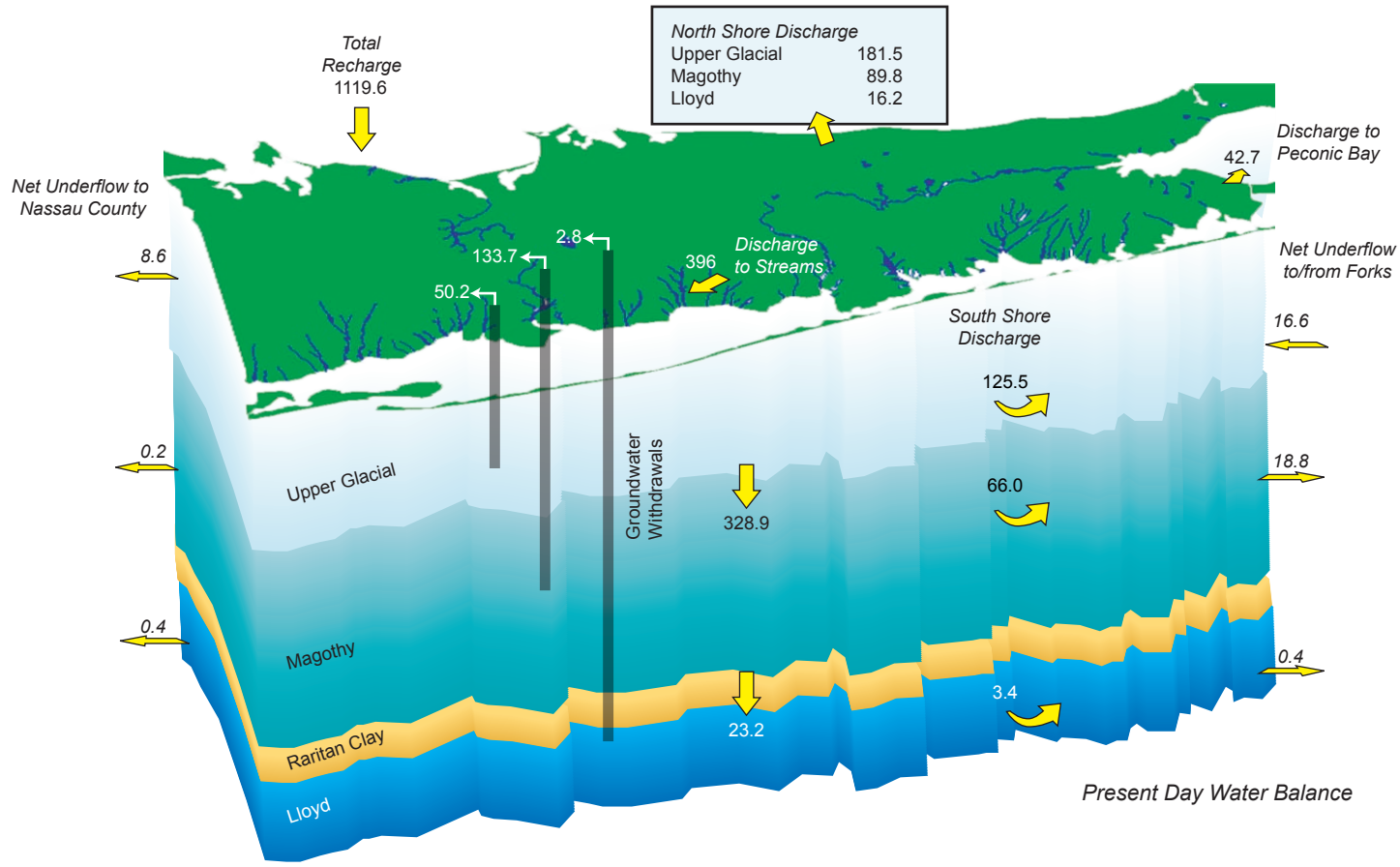
Long term average recharge rates were based on precipitation records obtained from one of four climate weather stations, each of which has over 50 years' worth of precipitation records that are readily available from the National Climatic Data Center. Data from the Mineola and Brookhaven National Laboratory (BNL) stations were used for the Main Body water balance, data from the Riverhead station was used for the Shelter Island and North Fork water balances; and data from the Bridgehampton station was used for the South Fork water balance. The Mineola station was used to assign recharge for the Nassau portion of the Main Body flow model and was not a significant factor in the development of the water budget for the Suffolk County portion of the Main Body model.

Details of the model development and application may be found in the Task 4 memoranda.

3.1.2.2 Main Body Water Balance

The Main Body flow model was used to develop predevelopment and present day water balances for Suffolk County west of Mattituck Creek and Shinnecock Inlet. The predevelopment and present day water balances are depicted graphically by **Figure 3-31** and are summarized in **Tables 3-18** and **3-19.** Under predevelopment conditions, precipitation, the only source of recharge to the





NOTE: The stratigraphic depictions do not represent actual thicknesses or depths

Figure 3-31
Main Body Flow Model
All Values in Million Gallons per Day

CDM

Table 3-18 Main Body Flow Model – Predevelopment Water Balance (All Flows in MGD)

Upper Glacial		
Flow	**Inflow**	**Outflow**
Total Recharge	945.4	
Water Supply Withdrawals		0.0
Streams		405.7
North Shore		178.0
South Shore		133.5
Magothy		198.2
Peconic Bay Shore		44.1
East End	17.0	
Nassau County		2.9
Total:	**962.4**	**962.4**

Magothy		
Flow	**Inflow**	**Outflow**
Total Recharge	2.0	
Water Supply Withdrawals		0.0
Streams		0.0
North		89.5
South		70.5
Upper Glacial	198.2	
Lloyd		20.5
East End		19.2
Nassau County		0.5
Total:	**200.2**	**200.2**

Lloyd		
Flow	**Inflow**	**Outflow**
Total Recharge	0.0	
Water Supply Withdrawals		0.0
Streams		0.0
North Shore		16.4
South Shore		3.7
Magothy	20.5	
East End		0.4
Nassau County		0.0
Total:	**20.5**	**20.5**

All Aquifers		
Flow	**Inflow**	**Outflow**
Total Recharge	947.4	
Water Supply Withdrawals		0.0
Streams		405.7
North Shore		283.9
South Shore		207.7
East End	17.0	63.7
Nassau County		3.4
Total:	**964.4**	**964.4**

Table 3-19 Main Body Flow Model Present Day Water Balance

Upper Glacial		
Flow	**Inflow (MGD)**	**Outflow (MGD)**
Total Recharge	1116.8	
Water Supply Withdrawals		50.2
Streams		396.0
North Shore		181.5
South Shore		125.5
Magothy		328.9
Peconic Bay Shore		42.7
East End	16.6	
Nassau County		8.6
Total:	**1133.4**	**1133.4**

Magothy		
Flow	**Inflow (MGD)**	**Outflow (MGD)**
Total Recharge	2.8	
Water Supply Withdrawals		133.7
Streams		0.0
North		89.8
South		66.0
Upper Glacial	328.9	
Lloyd		23.2
East End		18.8
Nassau County		0.2
Total:	**331.7**	**331.7**

Lloyd		
Flow	**Inflow**	**Outflow**
Total Recharge	0.0	
Water Supply Withdrawals		2.8
Streams		0.0
North		16.2
South		3.4
Magothy	23.2	
East End		0.4
Nassau County		0.4
Total:	**23.2**	**23.2**

All Aquifers		
Flow	**Inflow**	**Outflow**
Total Recharge	1119.6	
Water Supply Withdrawals		186.7
Streams		396.0
North Shore		287.5
South Shore		194.9
East End	16.6	61.9
Nassau County		9.2
Total:	**1136.2**	**1136.2**

groundwater system, traveled down through the aquifer system, until it was ultimately discharged to surrounding coastal waters, either as stream baseflow or as underflow. Groundwater could also leave the Suffolk County water budget area as underflow to neighboring Nassau County on the west or to the forks on the east.

Under predevelopment conditions, total recharge to the Main Body of Suffolk County was estimated to be about 947 mgd, of which nearly 43 percent (406 mgd) discharged directly to streams as baseflow. Fifty-two percent of recharge was estimated to eventually discharge to Long Island Sound or Great South Bay. The remaining five percent of recharge left the aquifer system beneath the Main Body of the County as underflow to the east or west, or as discharge to Peconic Bay. Flow from the upper glacial aquifer down to the Magothy aquifer was estimated to be 198 mgd, or nearly 21 percent of total recharge from precipitation. Flow from the Magothy to the Lloyd aquifer was estimated to be just over 20 mgd.

The present day water balance reflects the impacts of development, most notably groundwater withdrawals of 187 mgd, which account for 17 percent of total recharge. Although the installation of sanitary sewers in portions of the County has reduced the amount of water returned directly to the groundwater system, total recharge to the system — estimated to be 1,120 mgd — is calculated to be greater than total predevelopment recharge. This is a result of the construction of a network of storm sewers and recharge basins. During the growing season, the storm sewers capture stormwater runoff that would have been lost to evapotranspiration, and convey it to recharge basins, where it recharges the aquifer system. The model estimate of average present day discharge to stream baseflow is 396 mgd, a reduction of only 2 percent compared to predevelopment conditions. However, discharge to streams presently accounts for 35 percent of recharge, compared to 43 percent prior to development. Currently, 43 percent of recharge eventually discharges to Long Island Sound or Great South Bay. The remaining five percent of recharge leaves as underflow to the east or west, or as discharge to Peconic Bay. The greater downward gradient resulting from 134 mgd of groundwater withdrawals for public supply in the Magothy aquifer has increased the flow from the upper glacial aquifer down to the Magothy from 198 mgd to 329 mgd. Likewise, flow from the Magothy to the Lloyd aquifer is estimated to have increased from just over 20 mgd to 23 mgd.

The flow of groundwater from Suffolk to Nassau County (underflow) is relatively small under both predevelopment and present day conditions, when compared to the magnitude of the other flows. This is to be expected, considering that groundwater flow at the Nassau-Suffolk border is primarily

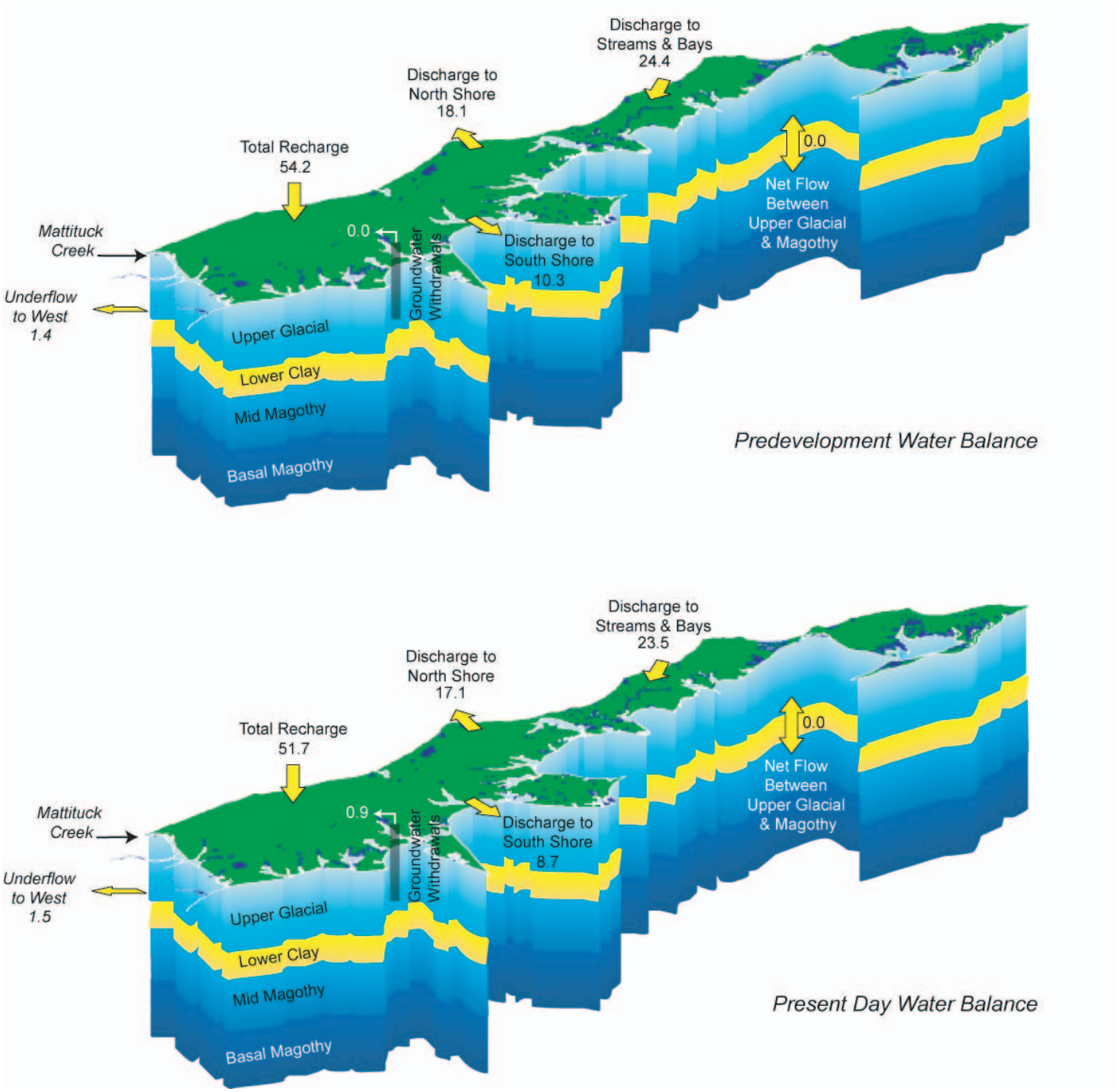
parallel to the border, with groundwater north of the groundwater divide flowing towards the north towards surface water discharge, and groundwater south of the divide flowing to the south towards surface water discharge. However, water supply pumping in Nassau County has modified groundwater flow patterns, resulting in an increase in underflow to Nassau County from 3.4 mgd prior to development, to an estimated present day amount of 9.0 mgd.

3.1.2.3 North Fork Water Balance

The North Fork freshwater/saltwater interface model was used as the basis for development of predevelopment and present day water balances for Suffolk County's North Fork, east of Mattituck Creek. The predevelopment and present day water balances are depicted by **Figure 3-32** and **Tables 3-20** and **3-21**. Under predevelopment conditions, total recharge to the North Fork east of Mattituck Creek was estimated to be about 54.2 mgd, of which 45 percent (24.4 mgd) discharged directly to streams and bays. Fifty-two percent of recharge is simulated to eventually discharge to Long Island Sound or Peconic Bay. The remaining three percent of recharge left the North Fork as underflow to the Main Body of Suffolk County to the west.

Table 3-20 North Fork Flow Model Predevelopment Water Balance (All Flows in MGD)

	Upper Glacial		Magothy		All Aquifers	
Flow	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**	**Outflow**
Total Recharge	54.2		0.0		54.2	
Water Supply Withdrawals		0.0		0.0		0.0
Streams and Bays		24.4		0.0		24.4
North Shore		18.1		0.0		18.1
South Shore		10.3		0.0		10.3
Magothy <->Upper Glacial (Net)		0.0	0.0		0.0	0.0
Main Body		1.4		0.0		1.4
Total:	**54.2**	**54.2**	**0.0**	**0.0**	**54.2**	**54.2**



NOTE: The stratigraphic depictions do not represent actual thicknesses or depths

Figure 3-32
North Fork Flow Model
All Values in Million Gallons per Day

CDM

Table 3-21 North Fork Flow Model Present Day Water Balance (All Flows in MGD)

	Upper Glacial		Magothy		All Aquifers	
Flow	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**	**Outflow**
Total Recharge	51.7		0.0		51.7	
Water Supply Withdrawals		0.9		0.0		0.9
Streams and Bays		23.5		0.0		23.5
North Shore		17.1		0.0		17.1
South Shore		8.7		0.0		8.7
Magothy <->Upper Glacial (Net)		0.0	0.0		0.0	0.0
Main Body		1.5		0.0		1.5
Total:	**51.7**	**51.7**	**0.0**	**0.0**	**51.7**	**51.7**

The inflows and outflows characterizing the present day water balance are quite similar to those prior to development. Under current conditions, total recharge is estimated to have been reduced by 2.5 mgd, to 51.7 mgd, as a result of the installation of storm sewers along the south shore of the North Fork that collect stormwater runoff that would have recharged the aquifer, and discharge it directly to Peconic Bay and its tributaries. Two percent of the groundwater recharged on an annual basis is withdrawn for water supply, and it is estimated that 50 percent discharges to Long Island Sound or Peconic Bay, and the remaining three percent leaves as underflow to the west.

Under both predevelopment and present day conditions, some freshwater in the center of the fork flows from the upper glacial aquifer down to the Magothy aquifer. The same amount of water flows back up through the upper glacial aquifer near the coast, prior to discharge along the north or south shore of the fork.

3.1.2.4 South Fork Water Balance

The South Fork freshwater/saltwater interface model was used as the basis for the development of predevelopment and present day water balances for Suffolk County's South Fork, east of Shinnecock Inlet as depicted by **Figure 3-33**, and **Tables 3-22** and **3-23**.

Under predevelopment conditions, total recharge to the South Fork east of Shinnecock Inlet is estimated to have been about 183.4 mgd, of which 47 percent (86.6 mgd) discharged directly to streams and bays. Fifty-three percent of the groundwater recharged on an annual average basis eventually discharged to Peconic Bay or marine waters to the south. Less than 1 percent of recharge was estimated to have left the South Fork aquifer system as underflow to the west. The inflows and outflows characterizing the present day water balance are quite similar to those prior to development. Under current conditions, total recharge is estimated to have been reduced by 5 mgd, to 178.4 mgd, as a result of the installation of storm drains along the north shore of the South Fork. The storm sewers in this area collect stormwater runoff that would have recharged the aquifer system, and convey it directly to discharge to Peconic Bay and its tributaries. Five percent of the groundwater recharged is withdrawn by water supply wells, 48 percent is estimated to discharge to south shore bays or the Peconic Bay, and less than one percent leaves as underflow to the west.

As on the North Fork, some precipitation recharging the center of the South Fork flows from the upper glacial aquifer down to the Magothy aquifer. Under present day conditions, some of the flow into the Magothy (0.8 mgd) is withdrawn by water supply wells. The water recharging the Magothy that is not withdrawn from water supply wells flows back up through the upper glacial aquifer near the coast, as it travels to discharge along the north or south shore of the fork. Therefore, the net flow in the Magothy is zero.

3.1.2.5 Shelter Island Water Balance

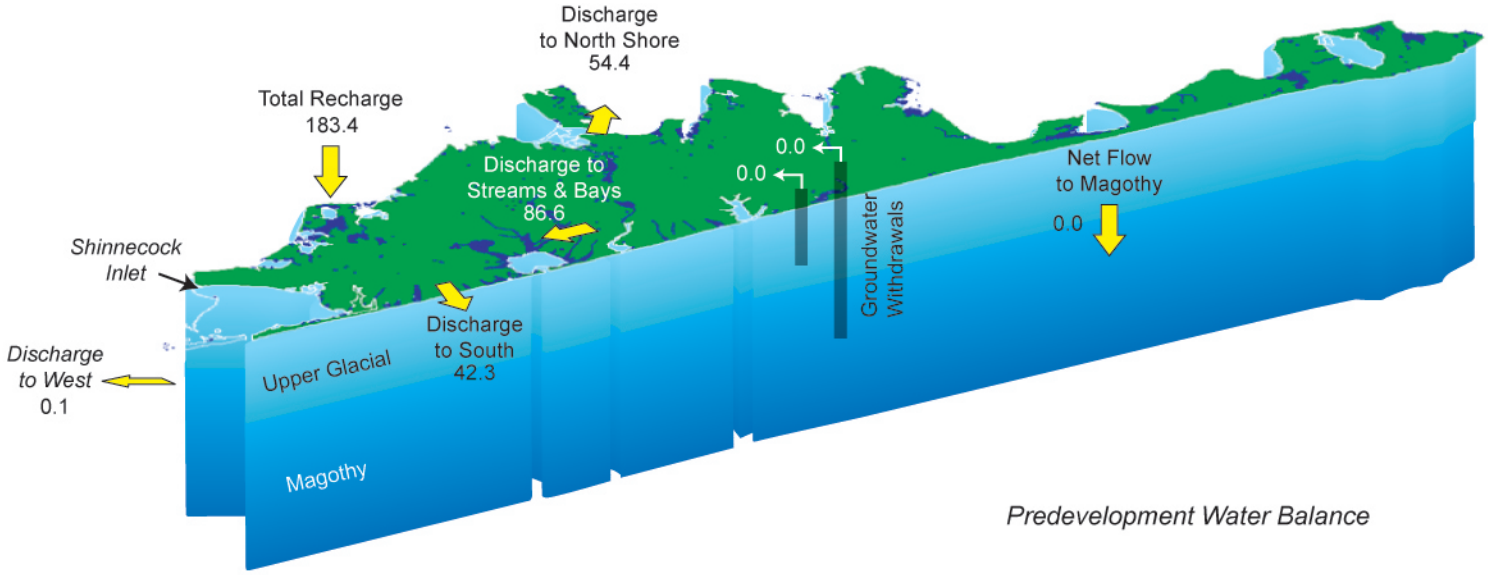
The Shelter Island freshwater/saltwater interface model was used as the basis for creation of predevelopment and present day water balances for Shelter Island. Freshwater is only expected to be present in significant amounts within the upper glacial aquifer, therefore the model was used to simulate conditions to the top of the underlying marine clay. As such, the water balance accounts for freshwater flow in the upper glacial aquifer only. The amount of freshwater discharge to the island's coast was calculated within each of four separate areas – the north and west shores; Coecles Harbor; the south and east shores; and West Neck Bay. The predevelopment and present day water balances are depicted graphically on **Figure 3-34** and on **Tables 3-24** and **3-25**.

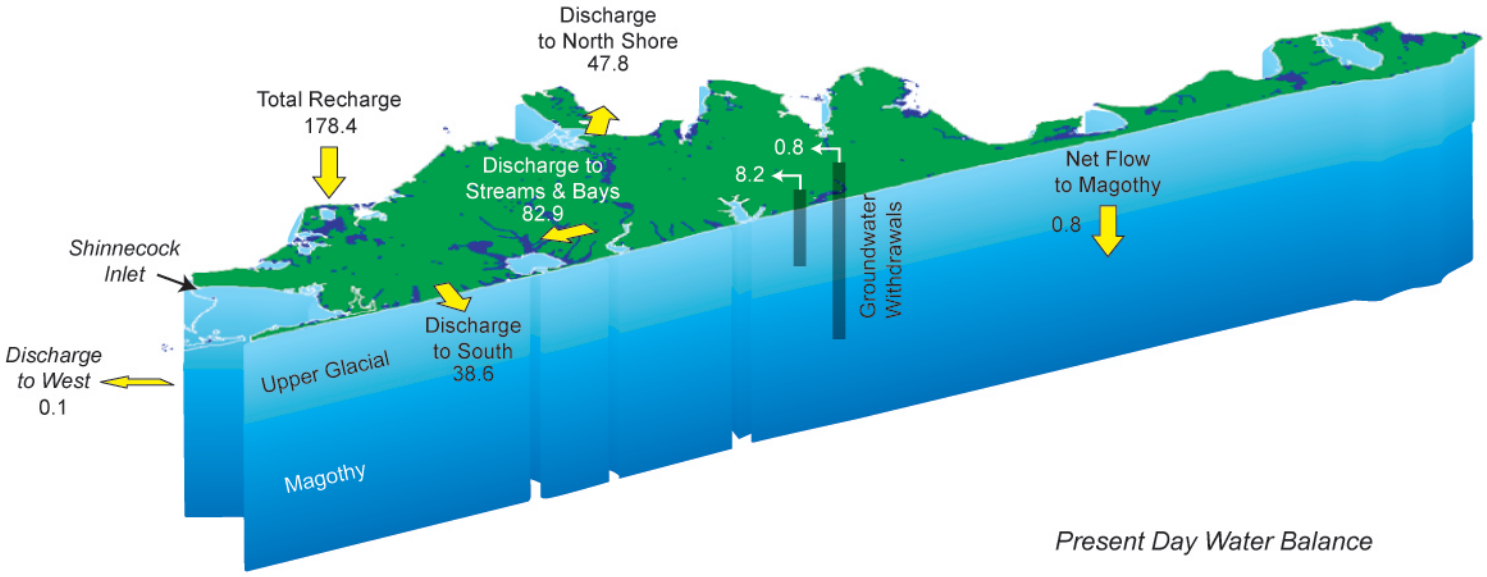
Table 3-22 South Fork Flow Model Predevelopment Water Balance (All Flows in MGD)

	Upper Glacial		Magothy		All Aquifers	
Flow	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**	**Outflow**
Total Recharge	183.4		0.0		183.4	
Water Supply Withdrawals		0.0		0.0		0.0
Streams and Bays		86.6		0.0		86.6
North Shore		54.4		0.0		54.4
South Shore		42.3		0.0		42.3
Magothy <->Upper Glacial (Net)		0.0	0.0		0.0	0.0
Main Body		0.1		0.0		0.1
Total:	**183.4**	**183.4**	**0.0**	**0.0**	**183.4**	**183.4**

Table 3-23 South Fork Flow Model Present Day Water Balance (All Flows in MGD)

	Upper Glacial		Magothy		All Aquifers	
Flow	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**	**Outflow**
Total Recharge	178.4		0.0		178.4	
Water Supply Withdrawals		8.2		0.8		9.0
Streams and Bays		82.9		0.0		82.9
North Shore		47.8		0.0		47.8
South Shore		38.6		0.0		38.6
Magothy <->Upper Glacial (Net)		0.8	0.8		0.8	0.8
Main Body		0.1		0.0		0.1
Total:	**178.4**	**178.4**	**0.8**	**0.8**	**179.2**	**179.2**

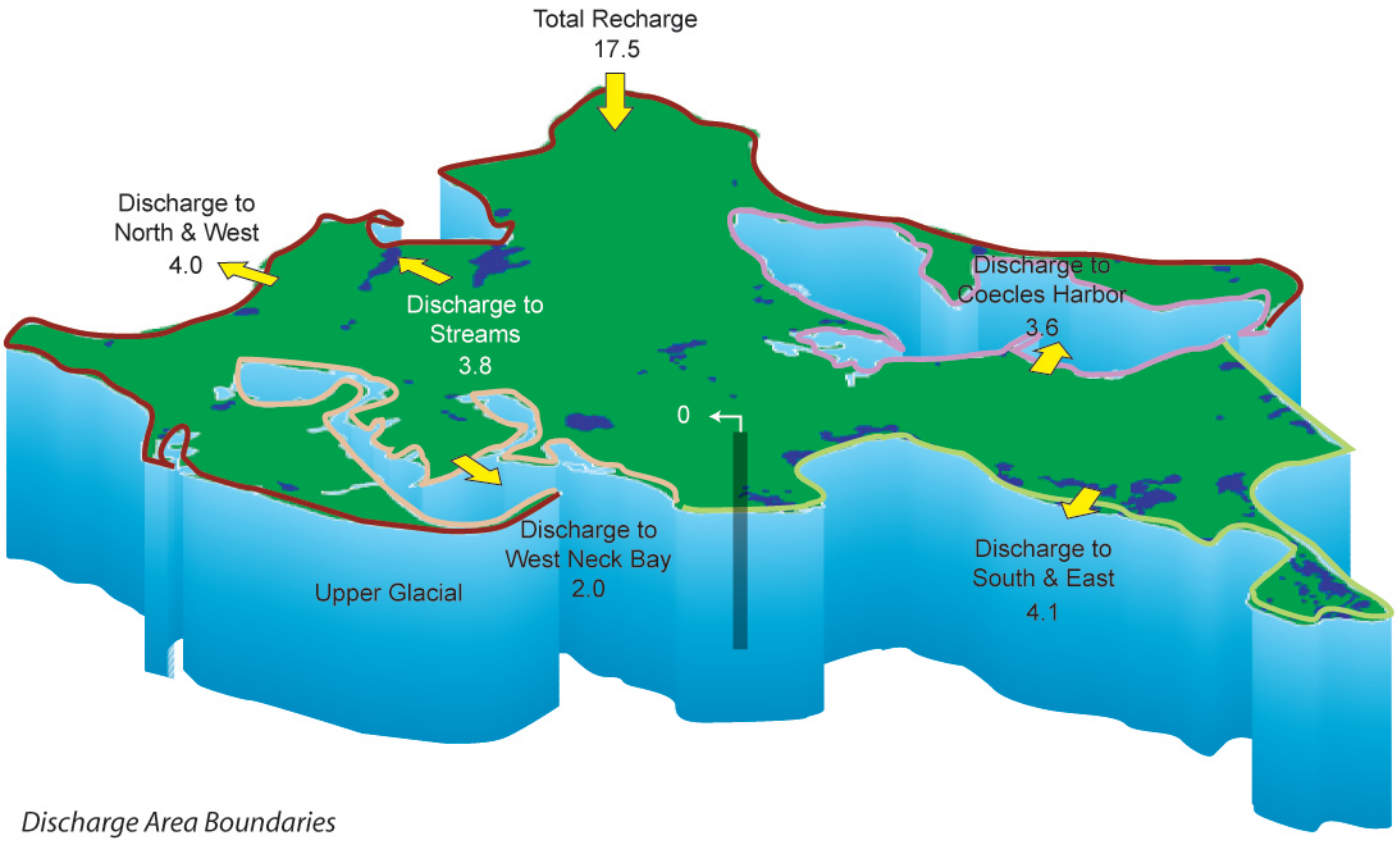




NOTE: The stratigraphic depictions do not represent actual thicknesses or depths

Figure 3-33
South Fork Flow Model
All Values in Million Gallons per Day

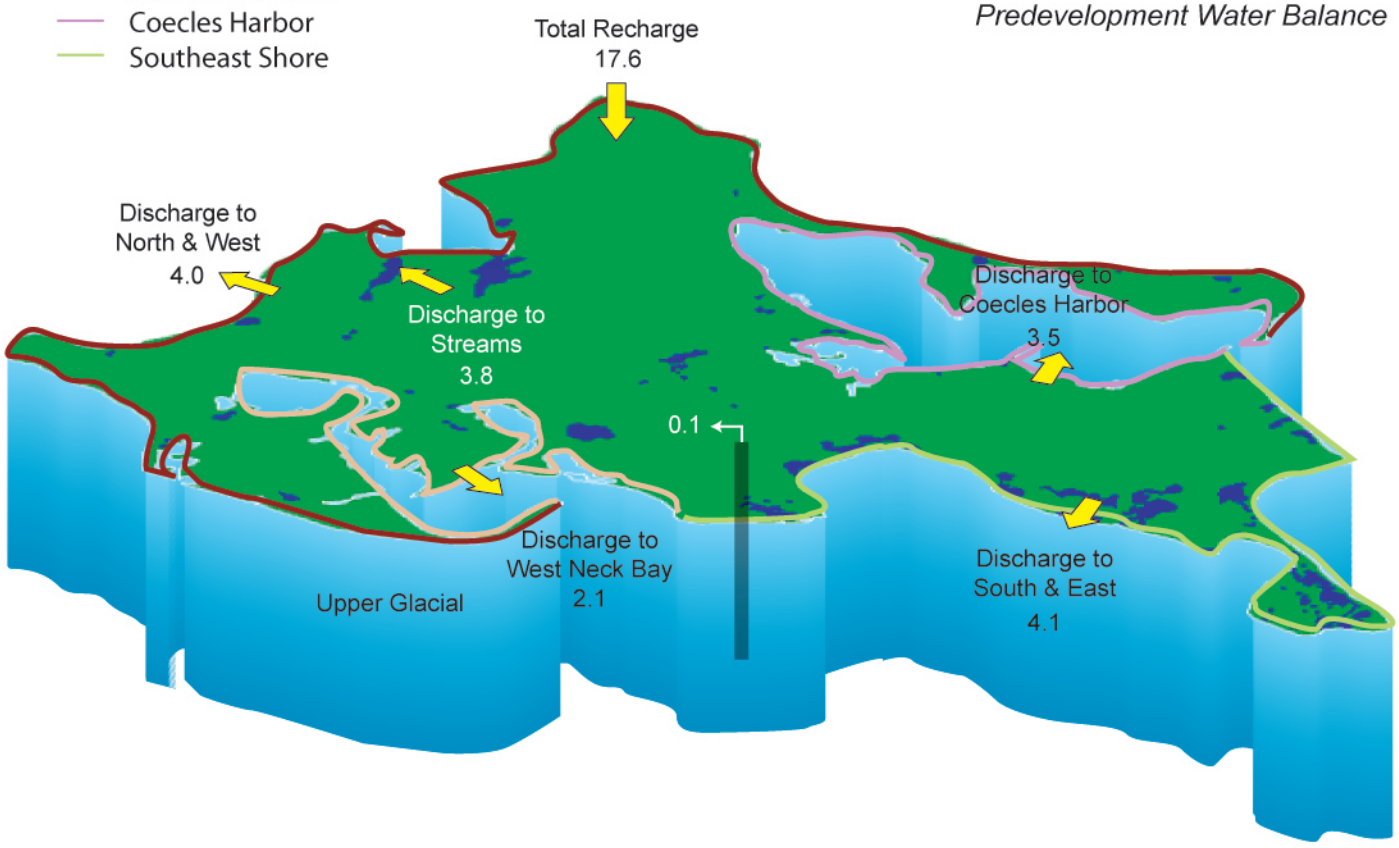
CDM



Discharge Area Boundaries

- West Neck Bay
- Northwest Shore
- Coecles Harbor
- Southeast Shore

Predevelopment Water Balance



Present Day Water Balance

NOTE: The stratigraphic depictions do not represent actual thicknesses or depths

Figure 3-34
Shelter Island Flow Model
All Values in Million Gallons per Day

CDM

Table 3-24 Shelter Island Flow Model Predevelopment Water Balance (All Flows in MGD)

	Upper Glacial	
Flow	**Inflow**	**Outflow**
Total Recharge	17.5	
Water Supply Withdrawals		0.0
Streams and Small Bays		3.8
North and West		4.0
Coecles Harbor		3.6
South and East		4.1
West Neck Bay		2.0
Total:	**17.5**	**17.5**

Table 3-25 Shelter Island Flow Model Present Day Water Balance (All Flows in MGD)

	Upper Glacial	
Flow	**Inflow**	**Outflow**
Total Recharge	17.6	
Water Supply Withdrawals		0.1
Streams and Small Bays		3.8
North and West		4.0
Coecles Harbor		3.5
South and East		4.1
West Neck Bay		2.1
Total:	**17.6**	**17.6**

Under predevelopment conditions, total recharge to Shelter Island was 17.5 mgd, of which 22 percent (3.8 mgd) discharged directly to streams and bays. The remaining groundwater that recharged the upper glacial aquifer discharged to coastal waters. Because the present day total water demand on Shelter Island is only 0.1 mgd, there is virtually no difference in the present day and predevelopment water balances. Total recharge is estimated to have increased (after rounding) by 0.1 mgd due to the return of groundwater in unsewered areas.

3.1.2.6 Countywide Water Balances

The predevelopment and present day water balances for all of Suffolk County, as determined by combining the results of the four flow models, are provided in **Tables 3-26** and **3-27** respectively.

Table 3-26 Suffolk County Predevelopment Water Balance (All Flows in MGD)

All Aquifers			Outflow as a Percentage of Total Recharge
Flow	**Inflow**	**Outflow**	
Total Recharge	1202.5		
Water Supply Withdrawals:			
Upper Glacial		0.0	0%
Magothy		0.0	0%
Lloyd		0.0	0%
Streams		520.5	43%
North Shore		302.0	25%
South Shore		250.0	21%
Peconic Bay		126.6	11%
Nassau County		3.4	<1%
Total:	**1202.5**	**1202.5**	

Table 3-27 Suffolk County Present Day Water Balance (All Flows in MGD)

All Aquifers			Outflow as a Percentage of Total Recharge
Flow	**Inflow**	**Outflow**	
Total Recharge	1367.3		
Water Supply Withdrawals:			
Upper Glacial		59.4	4%
Magothy		134.5	10%
Lloyd		2.8	<1%
Streams		506.2	37%
North Shore		304.6	22%
South Shore		233.5	17%
Peconic Bay		117.1	9%
Nassau County		9.2	<1%
Total:	**1367.3**	**1367.3**	

Only minor differences in inflows and outflows exist in the predevelopment and present day water balances. The construction of stormwater recharge basins has resulted in an increase in total recharge from 1,203 mgd prior to development, to a present day total of 1,367 mgd. Groundwater withdrawals for water supply total 197 mgd, or 14 percent of total recharge. As a result of groundwater withdrawals, and to a lesser extent, a decline in total recharge on the forks, discharge to stream baseflow has decreased by about 3 percent, from 521 mgd to 506 mgd. Outflows to the surrounding saltwater bodies as a percentage of total recharge have decreased by 2 to 4 percent; however, discharge to Long Island Sound is actually simulated to have increased by 2.6 mgd.

The slight reduction in total recharge on the North and South Forks, coupled with the water supply withdrawals may have, over the long-term, reduced net flow into the upper glacial and Magothy and resulted in localized increases in underflow from the surrounding saltwater bodies.

A slight acceleration of saltwater intrusion would therefore be expected. However, since the changes in total recharge and groundwater withdrawals on the forks are minor, year to year variations in recharge may overshadow any long-term and wide-scale movement of the interface as a result of present day stresses, except in localized areas.

3.1.2.7 Summary of Water Balance Results

On a County-wide basis, the aquifer system can sustain current and projected levels of water supply pumping.

The water balances confirm earlier assessments that on a County-wide basis, the aquifer system can sustain current and projected rates of water supply pumping. While development of a 'safe' or sustainable aquifer yield was not within the scope of this project, the water balances show that average water supply pumping is only approximately 15 percent of the average recharge rate. In fact, much of the water withdrawn in the County is returned to the aquifer system via on-site wastewater disposal systems. Consequently, throughout much of the County, significant declines of stream baseflow have not been observed. The construction of recharge basins in many parts of the island has increased recharge during the growing season (Ku, et al), so that on an annual basis, recharge to the aquifer is actually slightly higher than during pre-development conditions.

Global warming is predicted to accelerate the rate of rising sea level.

The water balances also identify the net loss of baseflow to area streams and to coastal areas that occurs in those parts of the County where water supply pumping is not returned to the aquifer via on-site septic systems or small sewage treatment plants discharging to recharge beds. Suffolk County has evaluated the impacts of sanitary sewering in the SWSD on streams and wetlands areas within that district. The post-sewering reduction in baseflow in the Carlls River is shown on **Figure 3-35**, as compared to baseflow during the same time frame in the Carmans River, just to the east of the study area, shown on **Figure 3-36**. Potential impacts of development on streams, ponds, wetlands and inter-tidal areas are best considered on a localized basis, considering area water supply pumping, development and stormwater management approaches, and sanitary wastewater management.

3.1.2.8 Sea Level Rise

In the past, sea level had been rising along the East Coast at a reported rate of between 0.34 and 0.43 inches per decade (**Climate Risk Information**, 2009). Over the past century, the rate of sea level rise has been increasing, with average sea level rise since 1900 now at 1.2 inches/decade. Global warming is predicted to further accelerate the rate of rising sea level, both as a result of the expansion of the warming oceans, and as a result of ice melt.

Figure 3-35 Carmans River Runoff and Baseflow

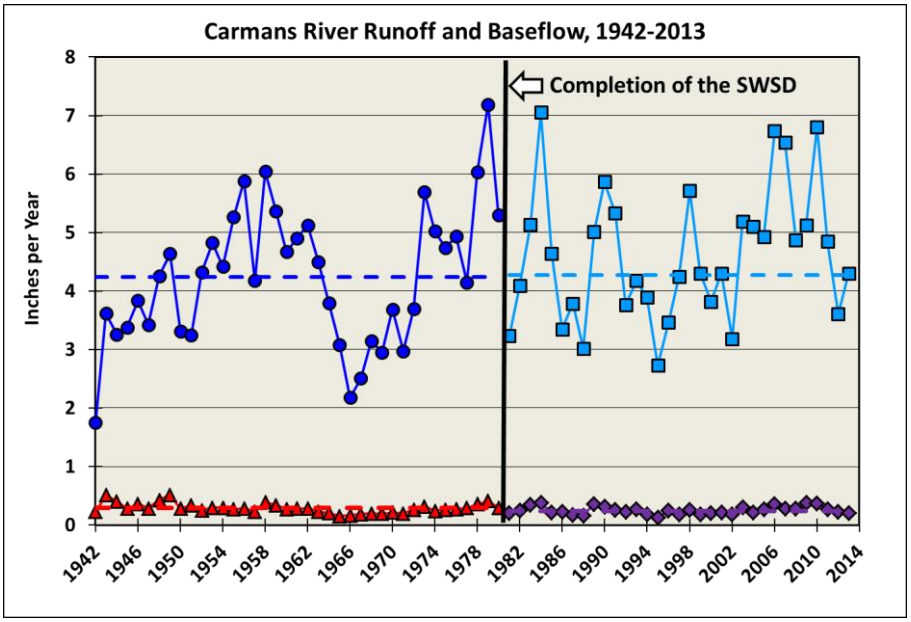
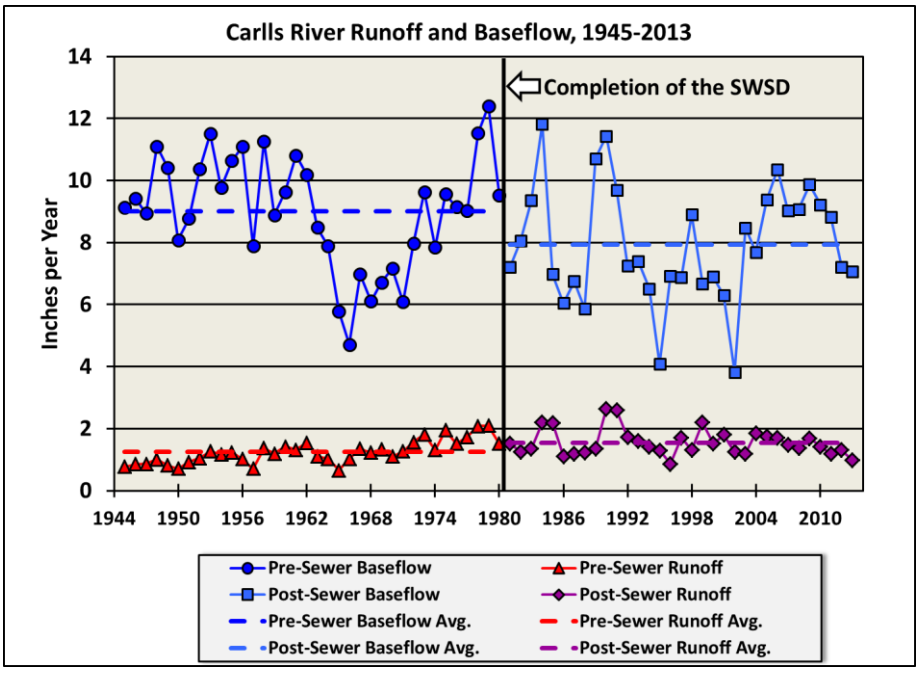
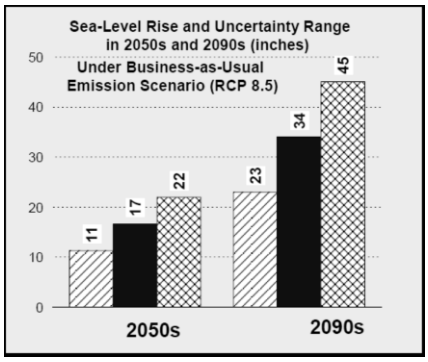


Figure 3-36 Carlls River Runoff and Baseflow





Projected sea-level rise in Nassau and Suffolk Counties based on a pessimistic "business as usual" scenario. Solid blue bars are mean values and the hatched bars indicate the 95% uncertainty range (from Zhang et al., 2014

When the draft 2010 Comprehensive Water Resources Management Plan was developed, global climate models (GCMs) used to predict increases in sea level projected the following increases in sea level elevation in the New York City area:

Decade	Increase
2020s	2 to 5 inches
2050s	7 to 12 inches
2080s	12 to 23 inches

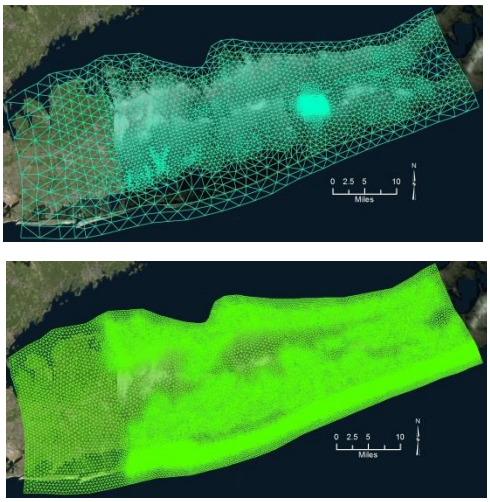
Based on information available when the analyses were conducted, (IPCC, 2001), sea level was predicted to rise at a rate of approximately 0.192 inches/year. Based on this predicted rate, a sea level rise of 2.0 feet would have occurred over a span of approximately 125 years and a sea level rise of 1.0 foot would have occurred over a span of approximately 63 years. The sensitivity of model results to increased sea level rises of 1.0 and 2.0 feet above NGVD 29 was assessed for the Main Body flow model, and the North and South Fork models as described in the Task 4.4 Memorandum.

More recent sea level rise projections have concluded that the pace of sea level rise is greater than anticipated just a few short years ago and the groundwater model simulations were refined to incorporate the most recent sea-level rise projections. For example, recent model projections indicate that sea level rise by the end of the 21st century may be as high as 45 inches, based on a reference period of 1985-2004 (Zhang et al, 2014).

As a conservative approach, the mean sea-level rise projection under the "business as usual" case as presented in Zhang et al. (2014) was utilized, projecting an increase in sea level of 34 inches. For consistency purposes, a baseline value of 0.5 feet was used as the beginning mean sea level in all model simulations. These simulation results were used to assess the potential impact to on-site sewage disposal systems, as discussed in Section 8. Model simulations were run through 2099 assuming an increase in sea level of 34 inches.

Main Body Flow Model

The Main Body flow model was updated to recent (2013) conditions of community water supply pumpage. In addition, the finite element mesh was significantly refined around the coast and coastal waterways so that resulting



Main Body flow model finite element mesh. Top: original model; bottom: refined for sea level rise analysis.

increases in the water table near the coast are refined to evaluate the potential impact to on-site waste disposal systems. In order to better represent baseflow to smaller streams, the updated mesh was intersected with surface elevation from LiDAR data obtained from the Suffolk County Department of Economic Planning. **Figure 3-37a** shows the predicted increase in upper glacial water levels assuming a 34-inch rise in sea level. The change in water level varies from 2.8 feet to less than 0.25 feet, with most of the model area showing an increase of 1 foot or less. Similar to the original sea level rise scenarios (Task 4.4), the predicted change in water level is much lower along the south shore, compared to the north shore, because increases in stream baseflow limit the water level rise in the vicinity of the non-tidal portion of the south shore streams.

Incorporating the LiDAR elevation data resulted in increased discharge to smaller streams resulting in a reduced mounding along the south shore. As these smaller streams were not represented in the original analysis, mounding is somewhat higher along the south shore in the original evaluation. **Figures 3-37b** and **3-37c**, depicting the simulated changes in Magothy and Lloyd aquifer heads to a 34-inch rise in sea level, also show a more significant head increase along the north shore compared to the south shore. Comparison of the three figures shows that the variability in head impacts between the north and south shores decreases with depth, as does the overall change in head from the current (steady-state) conditions. Total baseflow in the non-tidal portion of the south shore streams (based on present day configuration of the tidal portion) is simulated to increase by approximately 48 percent in response to a 34-inch rise in sea level. This increase accounts for many of the smaller streams and wetlands that were incorporated in the model refinement and inclusion of LiDAR data. Baseflows in the Peconic River and Nissequogue River are simulated to increase by approximately 11 percent and 2 percent respectively, similar to the results presented in Task 4.4.

Water Body	Projected Increase in Baseflow Resulting from Projected Sea Level Rise		
	2035	2050	2100
All Non-Tidal (South Shore)	10%	19%	48%
Nissequogue River & Tributaries	1%	1%	2%
Peconic River & Tributaries	2%	4%	11%

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

2035

Long Island Sound

Nassau County

Atlantic Ocean

N

Miles

0 2.5 5 10

2050

Long Island Sound

Nassau County

Atlantic Ocean

2100

Long Island Sound

Peconic Bay

Nassau County

Atlantic Ocean

Stream

Increase in Water Table (ft)

Up to 0.25

0.25 to 0.50

0.50 to 1.00

1.00 to 1.50

1.50 to 2.00

2.00 to 2.50

2.50 to 3.00

> 3.00

CDM Smith

Simulated Increase in Water Table Elevation Due to a Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-37a

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

2035

Long Island Sound

Peconic Bay

Nassau County

Atlantic Ocean

N

Miles

0 2.5 5 10

2050

Long Island Sound

Peconic Bay

Nassau County

Atlantic Ocean

2100

Long Island Sound

Peconic Bay

Nassau County

Atlantic Ocean

Stream

Increase in Head (ft)

Up to 0.25

0.25 to 0.50

0.50 to 1.00

1.00 to 1.50

1.50 to 2.00

2.00 to 2.50

2.50 to 3.00

> 3.00

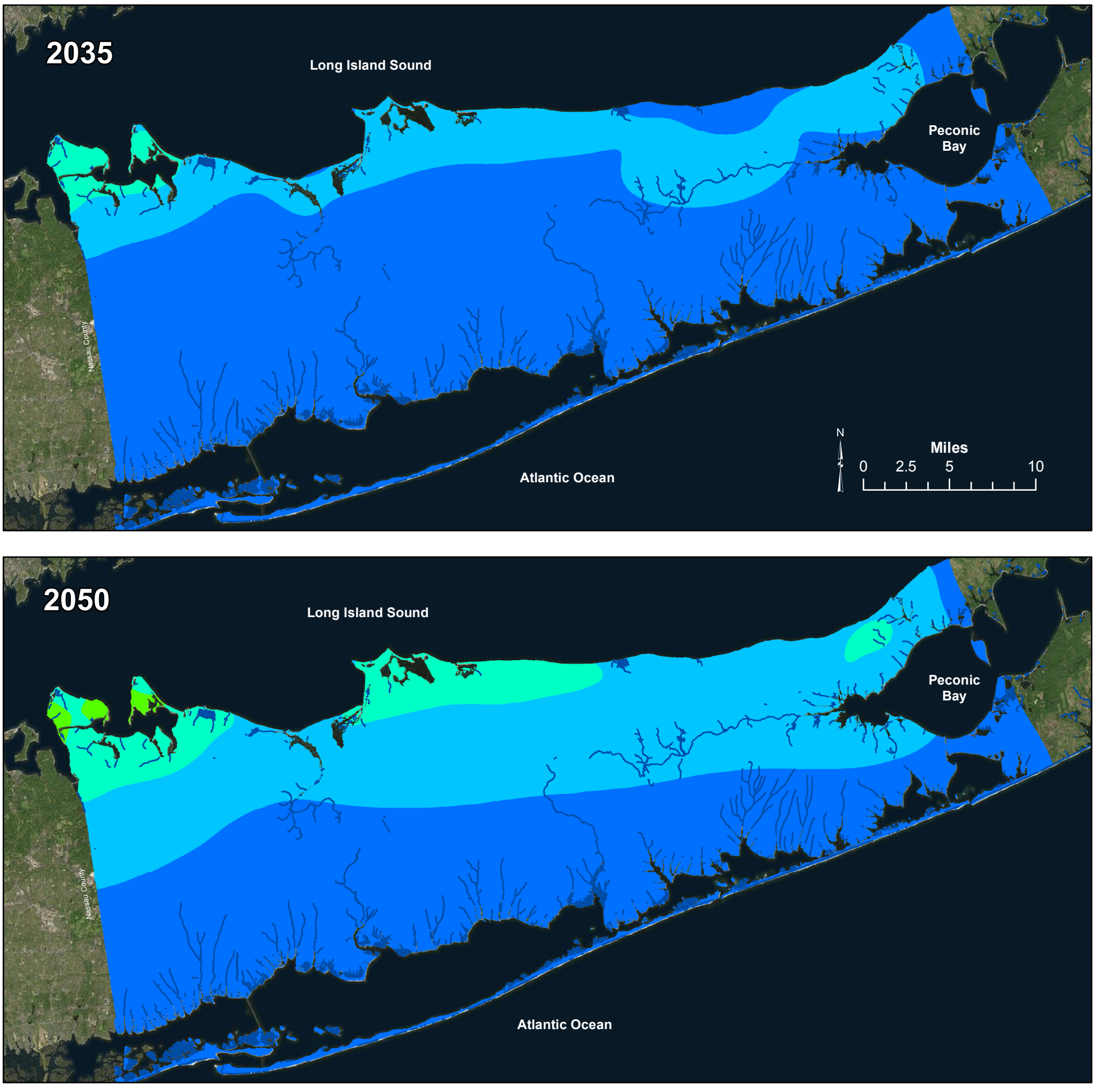
CDM Smith

Simulated Increase in Head in the Magothy Aquifer Due to a Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-37b

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Simulated Increase in Head in the Lloyd Aquifer Due to a Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-37c

North Fork Freshwater/Saltwater Interface Model

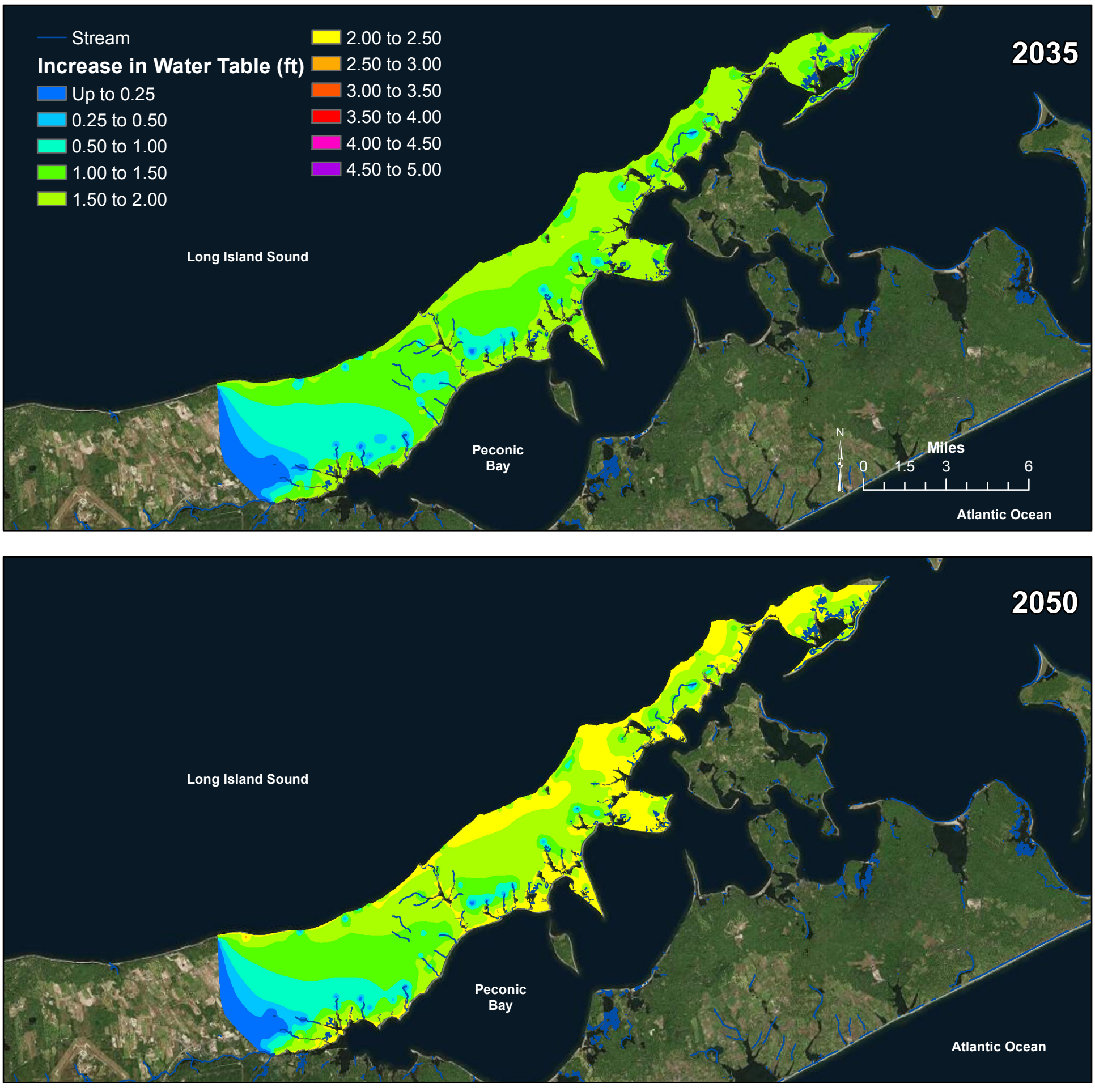
Figure 3-38 shows the predicted change in upper glacial water levels assuming a 34-inch rise in sea level. As in the Main Body flow model, the surface elevation of the North Fork model was refined by incorporating LiDAR data, thereby better representing smaller creeks. Over most of the North Fork, the change in water level varies from 1 to 2 feet. Short, non-tidal segments of streams along the southern shore of the North Fork locally limit the water level increase because of increases in stream baseflow. The relative extent of the water table impacts in the North Fork is markedly more extensive than that simulated by the Main Body flow model. This is to be expected given that the distance between water bodies (Long Island Sound and the Great South Bay) is four times greater for the Main Body compared to the North Fork (Long Island Sound and Peconic Bay).

The increase in water level beyond 3 feet around some of the tidal creeks is an anomaly resulting from the use of the regional model; detailed representations of the increased lengths of the tidal portion of the tributary creeks to the inlet that would occur as a result of the increased sea level were not incorporated in the regional model evaluation. Changes in the lengths of tidal creeks would have to be incorporated into the model to allow additional adjustment of boundary conditions along the length of the creeks to correctly simulate increased groundwater discharge to the creek, rather than the mounding that is currently depicted. The simulated freshwater/saltwater interface position following a 34-inch rise in sea level is shown in cross section on **Figure 3-39**, in black. The red line represents the current interface position. The depth to the interface is reduced most in areas where water level rise is limited by increased stream baseflow (i.e. the south shore). As shown on the figure, the simulation suggests that the interface moves inland by approximately 800 feet.

South Fork Freshwater/Saltwater Interface Model

Figure 3-40 shows the simulated change in upper glacial water levels assuming a 34-inch rise in sea level. Over most of the South Fork, the simulated change in water level varies from 1 to 2 feet. The non-tidal segments of streams throughout the South Fork locally limit the increase in water table elevation because of increases in stream baseflows. The simulated freshwater/saltwater interface position following a 34-inch rise in sea level is shown on **Figure 3-41**, in black. The red line represents the current interface position. As shown on the cross-section, the simulated interface migrates approximately 1,000 feet inland in the shallow aquifer along portions of the south shore.

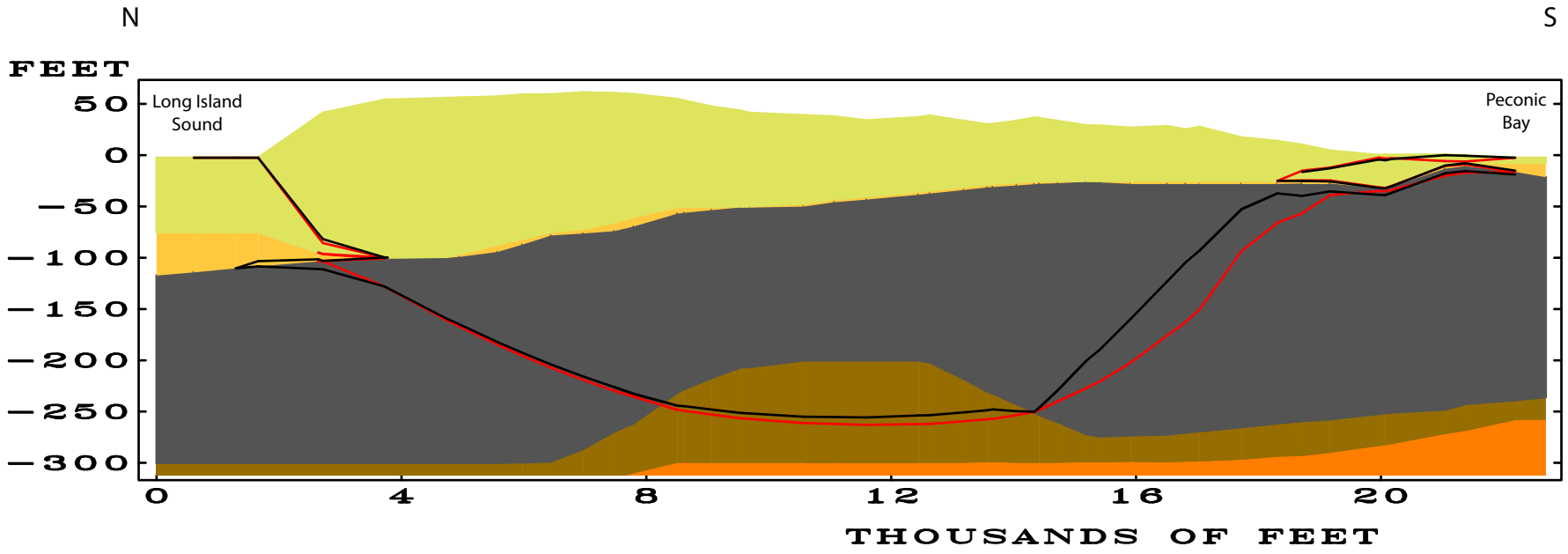
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Simulated Increase in the Water Table on the North Fork Due to a Sea Level Rise of 34 Inches by 2100

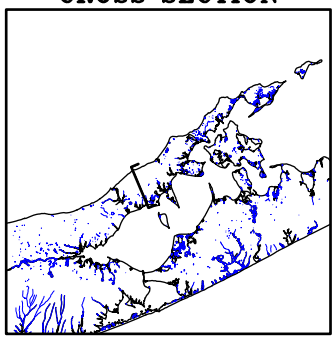
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-38



Harbor Hill Outwash
Ronkonkoma Drift
Lower Clay
Lower Drift
Magothy

CROSS SECTION



Black line represents the simulated saltwater interface after a 34-inch rise in mean sea level (time = 2100)
Red line is the simulated saltwater interface at present (time = 2014)

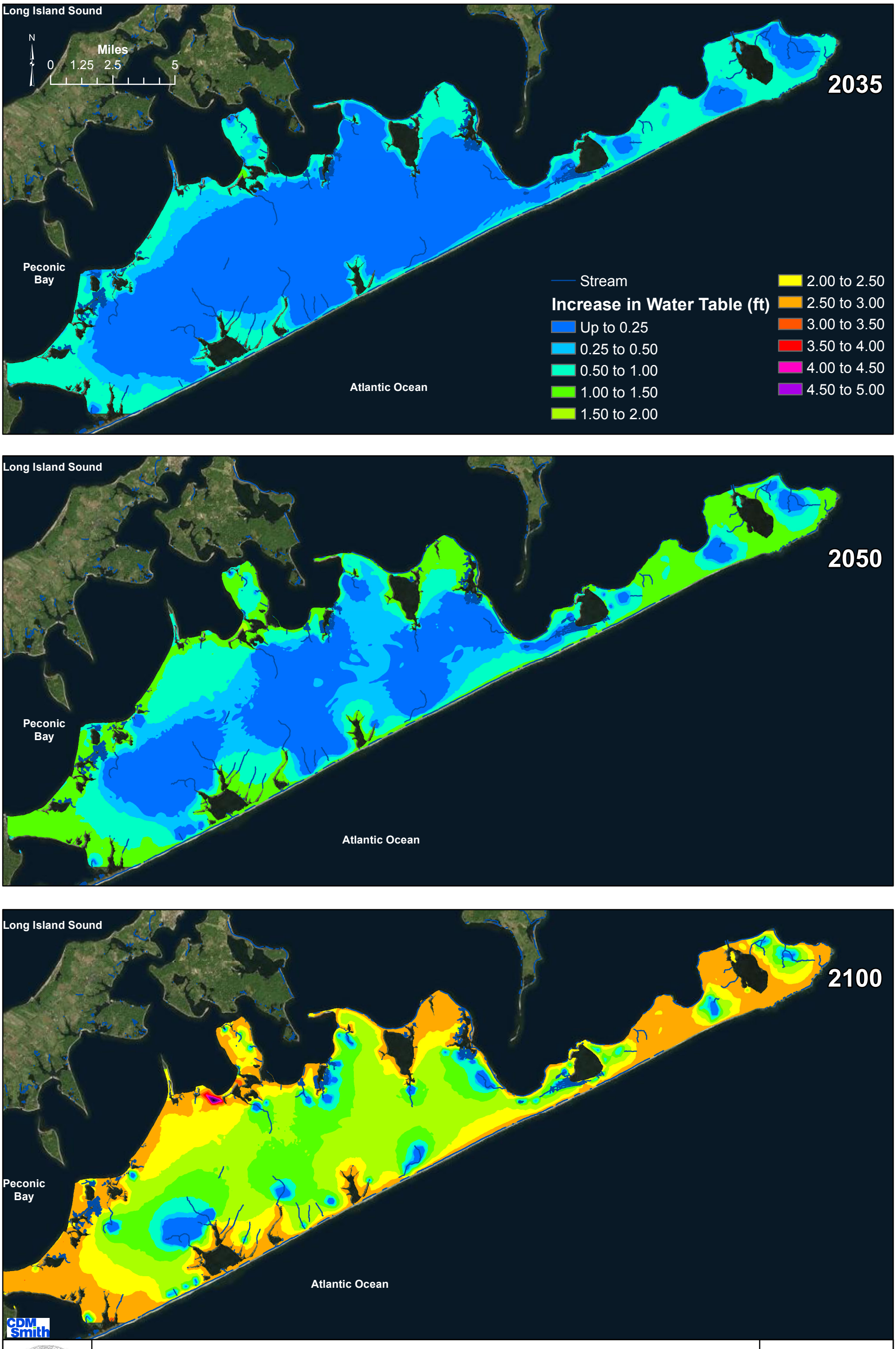
CDM Smith

North Fork Cross-Section - Simulated Impact of a 34-inch Rise in Mean Sea Level; Simulated Time = 2100

Suffolk County Comprehensive Water Resources Management Plan

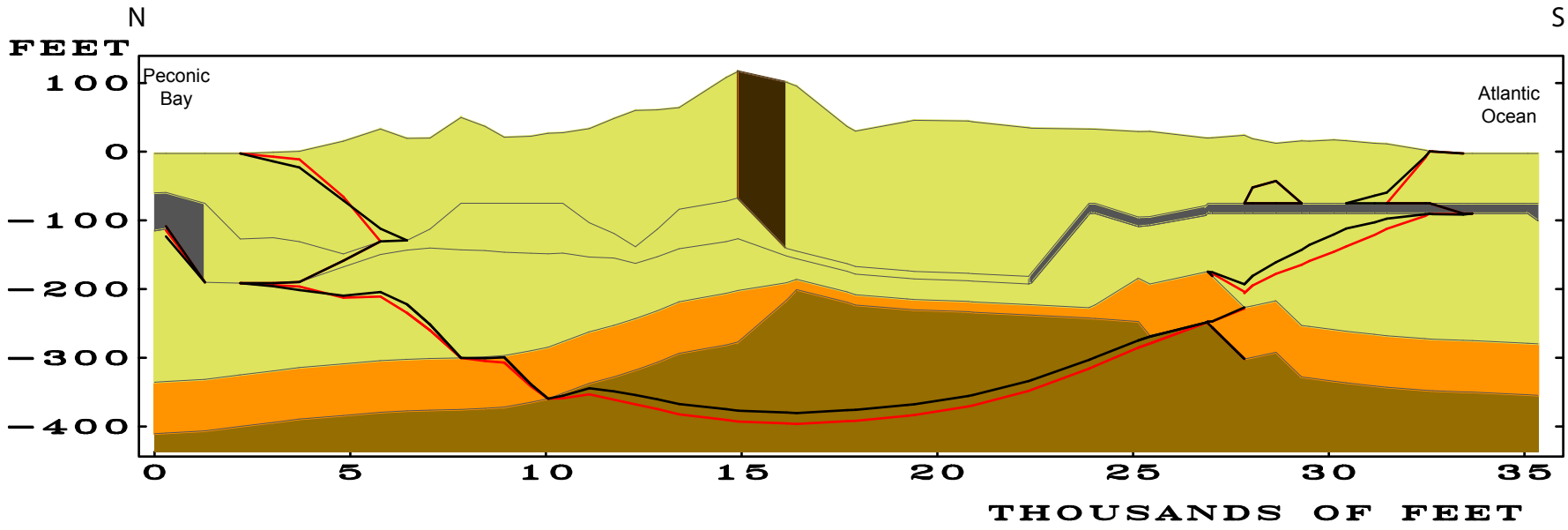
Figure 3-39

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

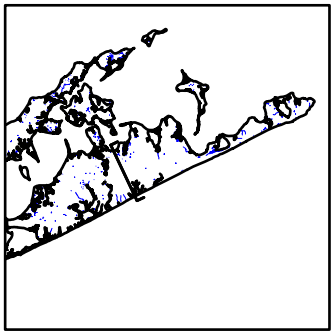


Simulated Increase in the Water Table on the South Fork Due to a Sea Level Rise of 34 Inches by 2100
DRAFT
Suffolk County Comprehensive Water Resources Management Plan

Figure 3-40



CROSS SECTION GG



- Outwash
- Till
- Upper Glacial Clay
- Magothy (upper)
- Magothy (middle)

Black line represents the simulated saltwater interface after a 34-inch rise in mean sea level (time = 2100)
Red line is the simulated saltwater interface at present (time = 2014)

CDM Smith

South Fork Cross-Section - Simulated Impact of a 34-inch Rise in Mean Sea Level; Simulated Time = 2100; DRAFT

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-41

Shelter Island Freshwater/Saltwater Interface Model

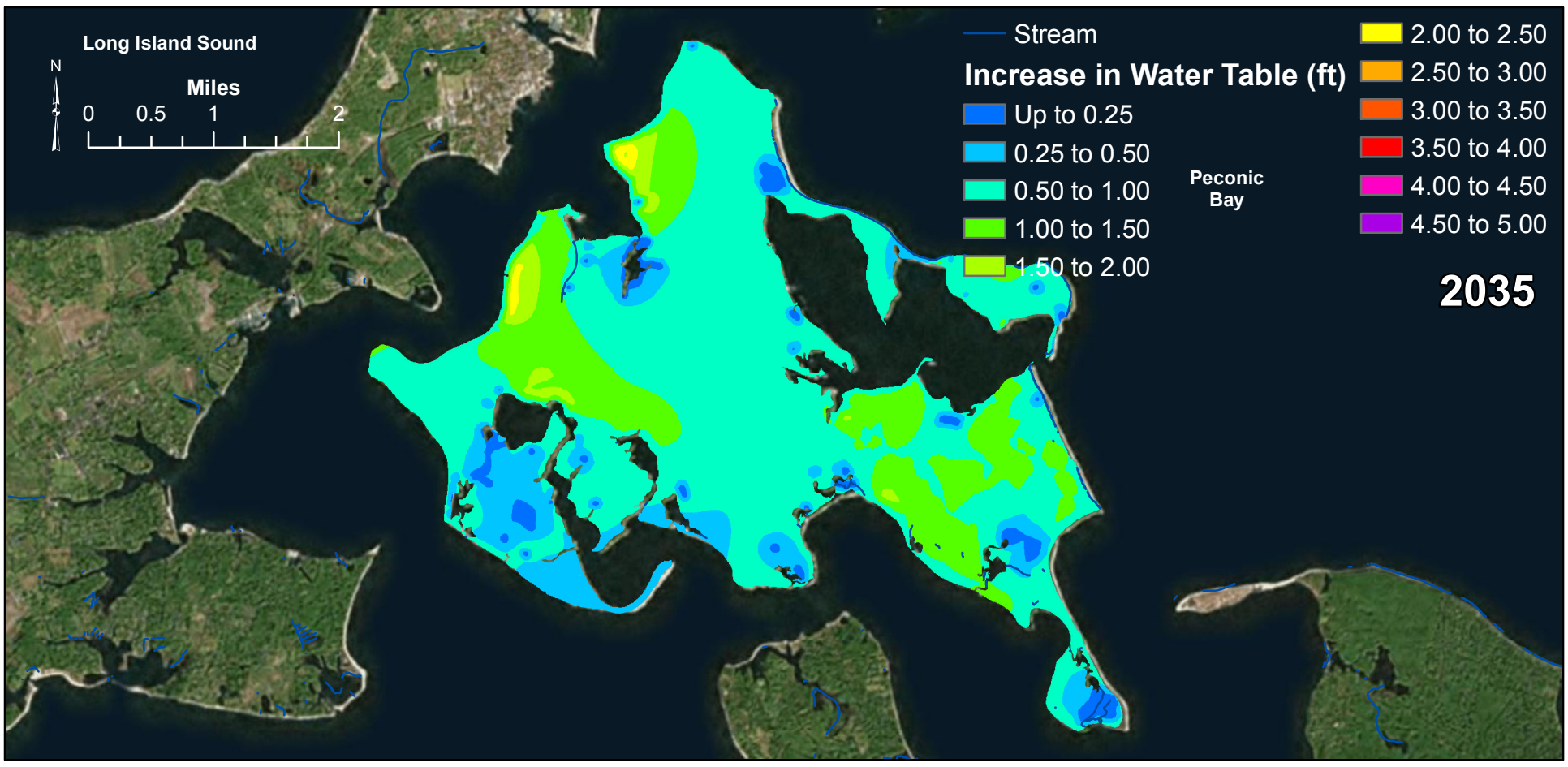
Figure 3-42 shows the simulated change in upper glacial water levels resulting from a 34-inch rise in sea level. Over most of the island, water levels are predicted to increase from 1.5 to 2 feet. The relative extent of the water table impacts in Shelter Island are similar to those simulated on the North and South Forks. The water table increases are reduced in the vicinity of Gardiner Creek (south of Dering Harbor) due to increased discharge to the creek. Similarly, water table mounding is subdued in areas surrounding West Neck Bay and Menantic Creek. The simulated freshwater/saltwater interface position following a 34-inch rise in sea level is shown in **Figure 3-43,** in black. The red line represents the current interface position. The cross section cuts from Hay Beach Point in the north to Wards Point in the south. The figure depicts a slight thinning of the freshwater lens in the upper glacial aquifer beneath the island, with some significant (>1,000) landward migration of the saltwater interface. To the south. As shown on **Figure 3-44**, the interface also becomes shallower in this area by approximately 20 to 25 feet. Similar to the Barrier Island on the Main Body, areas within Shelter Island discharge at the surface due to the increase in the water table, particularly on the Ram Island peninsula (**Figure 3-45**).

Sea level rise is projected to have significant impacts on low lying coastal areas, particularly on the forks, and along the south shore.

In the coming decades, Suffolk County will need to address the impacts of projected increases in sea level elevation. There are many uncertainties associated with the impacts of climate change, but much work has been documented by the Intergovernmental Panel on Climate Change (IPCC) and others. Recent studies and Global Climate Models indicate that sea level will continue to rise at an accelerated pace. Additional evidence indicates that precipitation is increasing in this part of the world, and that the number of extreme precipitation events is also increasing in the northeastern United States, including Suffolk County.

Sea level rise may have profound impacts on low lying coastal areas, particularly along the south shore, and on the forks. The impacts of sea level rise on the location of the saltwater interface must also be monitored and addressed from a water supply perspective. Extreme precipitation events will exacerbate existing drainage problems; significant flooding has already been observed in parts of Suffolk County (for example, Riverhead, Shelter Island and St. James).

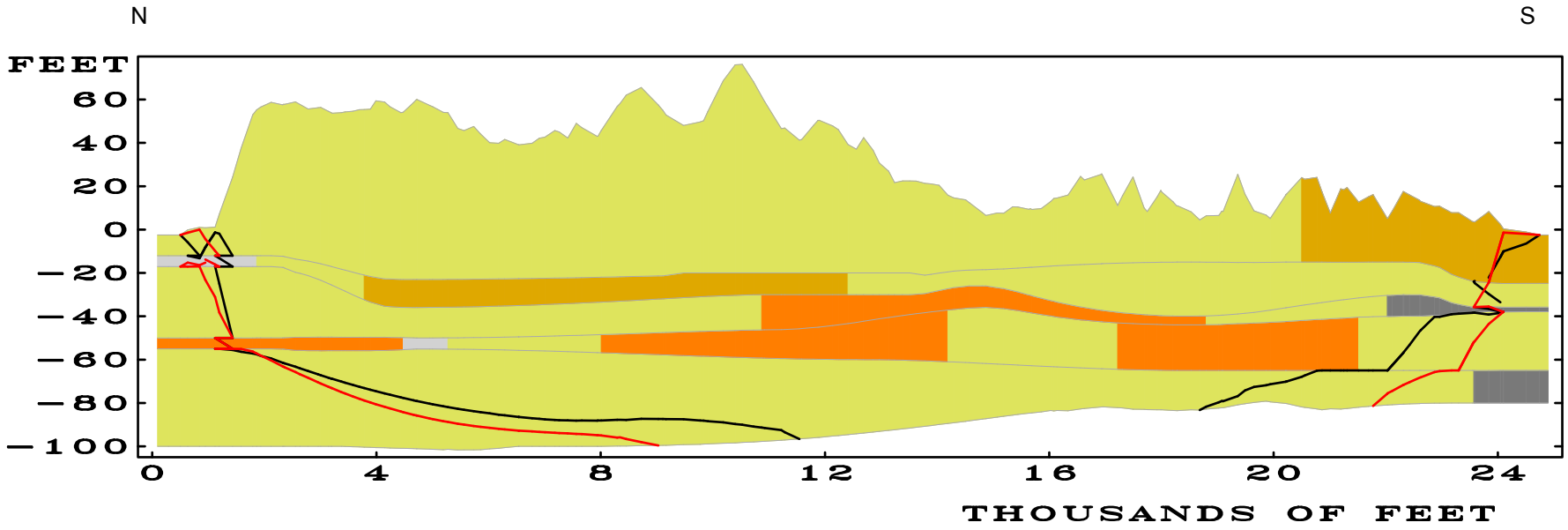
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Simulated Increase in the Water Table on Shelter Island Due to a Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-42

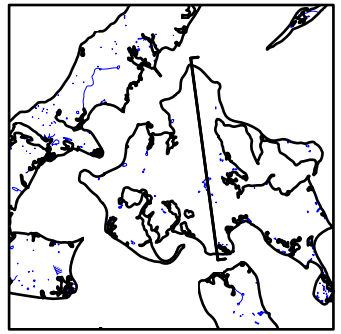


Upper Glacial Aquifer

Outwash, Sand, Gravel

Clay and Silt

CROSS SECTION



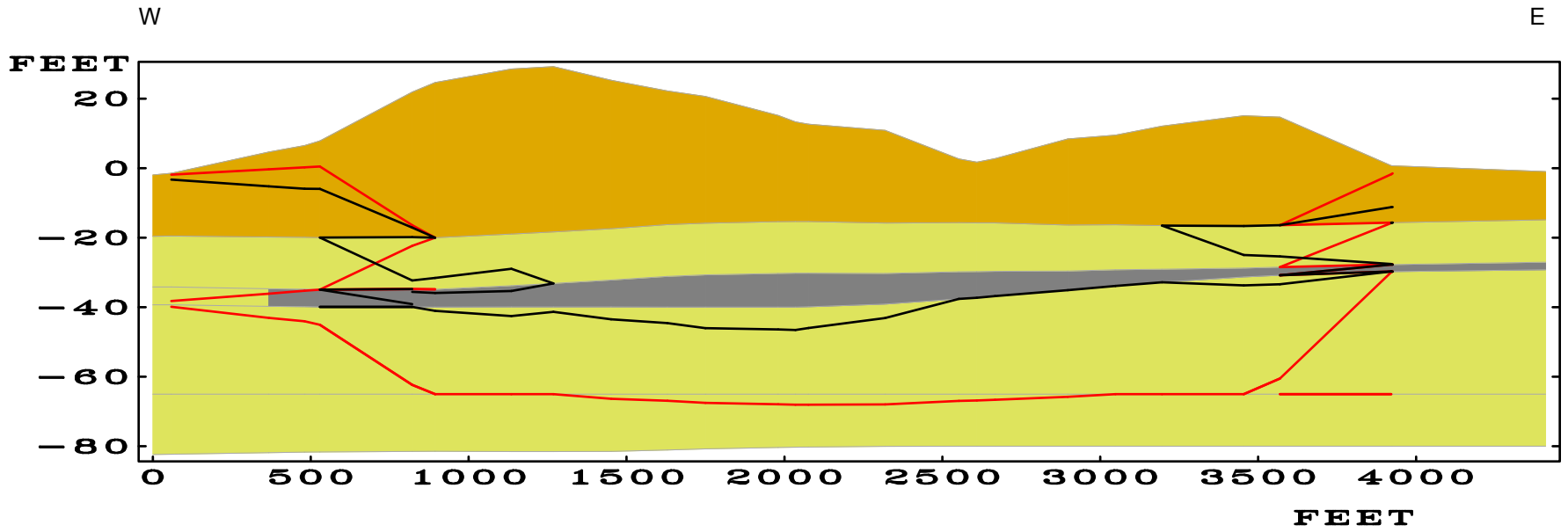
Black line represents the simulated saltwater interface after a 34-inch rise in mean sea level (time = 2100)
Red line is the simulated saltwater interface at present (time = 2014)

CDM Smith

Shelter Island Cross-Section - Simulated Impact of a 34-inch Rise in Mean Sea Level; Simulated Time = 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-43



Upper Glacial Aquifer

Outwash, Sand, Gravel

Clay and Silt

CROSS SECTION

Black line represents the simulated saltwater interface after a 34-inch rise in mean sea level (time = 2100)
Red line is the simulated saltwater interface at present (time = 2014)

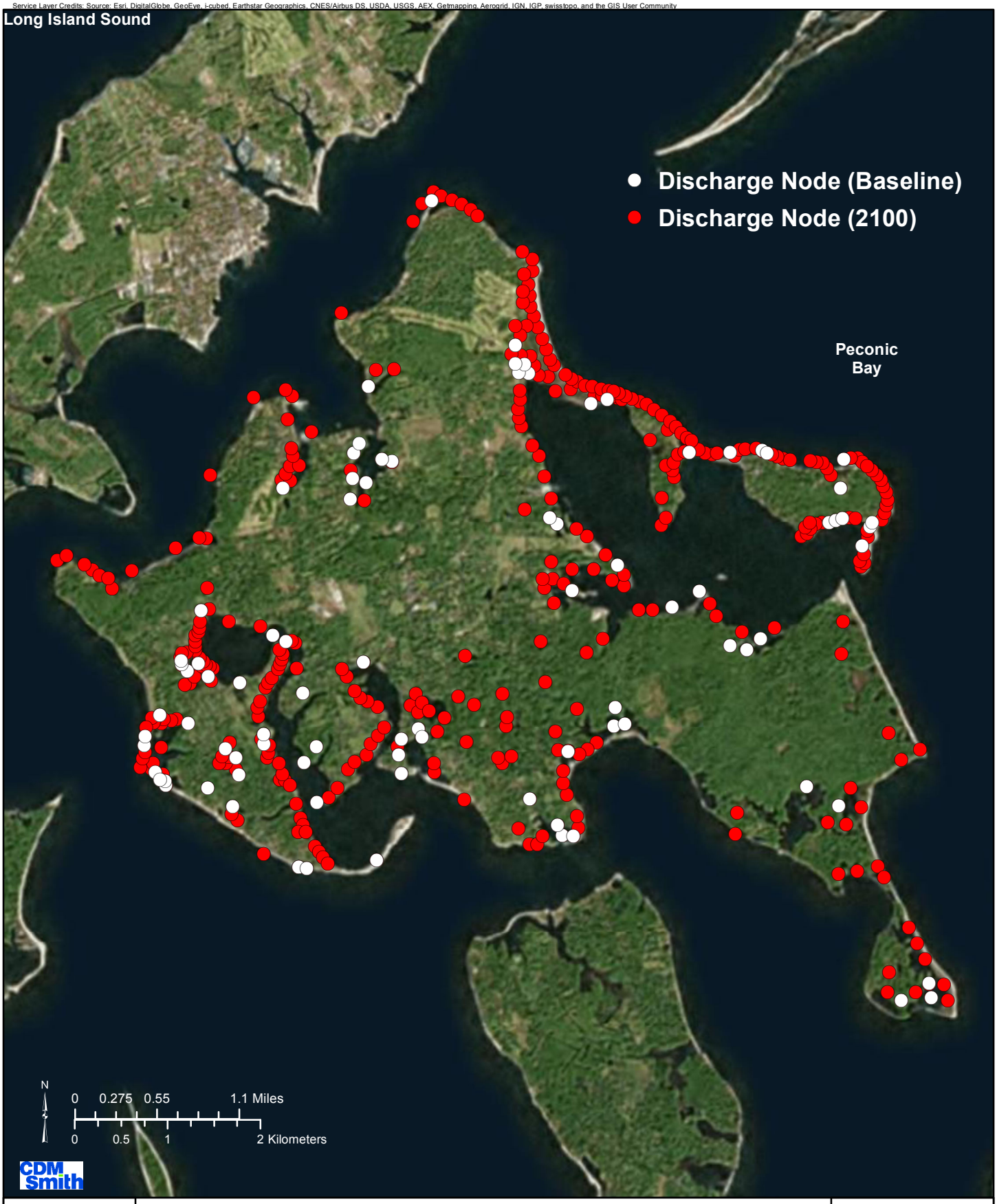
CDM Smith

Shelter Island Cross-Section - Simulated Impact of a 34-inch Rise in Mean Sea Level; Simulated Time = 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-44

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Onshore Discharge Nodes in Shelter Island Groundwater Model Baseline and Following a 34-inch Sea Level Rise (2100)

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-45

3.1.2.9 Sea Level Rise Summary

Recharge greatly exceeds water supply pumping and the County's aquifer system can continue to meet current and projected water supply pumping rates on a County-wide basis but fresh supplies are limited in some coastal areas such as Shelter Island.

Water balances developed using the Main Body and East End groundwater flow models confirm that recharge greatly exceeds water supply pumping rates, and the County's aquifer system can continue to meet current and projected rates of water supply pumping on a County-wide basis. Nevertheless, fresh supplies are limited in some coastal areas, including Shelter Island, as described further in Section 4. The water balances also identify the net loss of baseflow to area streams and to coastal areas in those parts of the County where water supply pumping is not returned to the aquifer via on-site septic systems or small sewage treatment plants discharging to recharge beds. Potential impacts of development on streams, ponds, wetlands and inter-tidal areas are best considered on a localized basis, considering area water supply pumping, development and stormwater management approaches, and sanitary wastewater management.

The impacts of climate change, including sea level rise, may be significant, particularly in coastal areas. Impacts on salt water interfaces, wastewater management and stormwater runoff must be considered.

While there are many uncertainties associated with the impacts of climate change, published research and the results of Global Climate Models consistently indicate that sea level will continue to rise at an accelerated pace. Additional evidence indicates that precipitation is increasing in this part of the world, and that the number of extreme precipitation events is also increasing in the northeastern United States, including Suffolk County. In the coming decades, Suffolk County will need to address the impacts of projected increases in sea level elevation. The impacts of rising sea level could be very significant in coastal areas and along the forks, with significant implications for water supply, storm water and sanitary waste management, as well as more widespread flooding. The impacts of sea level rise on the location of the saltwater interfaces must also be monitored and addressed from a water supply perspective. The impacts of both sea level rise and more frequent extreme precipitation events should also be monitored so that wastewater and stormwater runoff management strategies can be developed and implemented. Potential implications for wastewater management are described in more detail in Section 8 of this document.

3.2 Groundwater Resource Management Goals and Objectives

Working together with the Steering Committee, a set of groundwater resource management goals and objectives was identified, as summarized on **Table 3-28**. These goals and objectives are targeted to protect and manage groundwater quality and quantity through 2030. Although it is acknowledged that full achievement of these goals within the next twenty years may not be realized, implementation of the recommendations presented in Section 3.3 will

result in progress towards maintenance of a groundwater resource that can continue to provide a reliable high quality supply of potable water for future generations of Suffolk County residents.

The goals and objectives are consistent with the policy declarations that are articulated in the Suffolk County Sanitary Code:

§760-701: *" The designated best use of all groundwaters of Suffolk County is for public and private water supply, and of most surface waters for food production, bathing and recreation …. it is hereby declared to be the policy of the County of Suffolk to maintain its water resources as near to their natural condition of purity as reasonably possible for the safeguarding of the public health, and to that end, to require the use of all available practical methods of preventing and controlling water pollution from sewage, industrial and other wastes, toxic or hazardous materials, and stormwater runoff."*

Table 3-28 Groundwater Resource Management Goals and Objectives

Table 3-28
Groundwater Resource Management Goals and Objectives

GOAL 1: All groundwater shall be in compliance with the stricter of New York State Ambient Groundwater standards and guidance values or maximum contaminant level goals (MCLGs) to the greatest extent feasible. Water quality that is better than the existing standards should be preserved.

OBJECTIVES:

All groundwater should be in compliance with the stricter of New York State Ambient Groundwater standards and guidance values or MCLGs to the greatest extent feasible to protect, preserve and restore drinking water supplies and the ecological health of the County's surface waters.

GOAL 2: Nitrogen loading should be reduced for the protection of current and future drinking water supplies and to restore/maintain ecological functions of streams, lakes, estuaries and marine waters. Arrest and reverse the trend of increasing nitrogen concentrations in ground and surface waters to the greatest extent feasible and practical by decreasing the nitrogen loading from septic systems and fertilizers.

OBJECTIVES:

Nitrogen levels should be consistent with the Groundwater Management Zone targets for all areas developed subsequent to adoption of Article 6 of the Suffolk County Sanitary Code. For areas of pre-existing, non-conforming lots, nitrogen levels should be as close to Groundwater Management Zone targets as is reasonably achievable.

GOAL 3: Concentrations of other regulated and unregulated contaminants in groundwater should be minimized to protect current and future drinking water supplies and to restore/maintain ecological functions of streams, lakes, estuaries and marine waters. Reduce the discharge of volatile organic compounds and other regulated and other regulated contaminants to groundwater.

OBJECTIVES:

1. Measured levels of VOCs should be reduced from baseline (2005) levels.
2. Detections of regulated VOCs in monitoring and supply wells should be reduced from baseline (2005) levels.
3. Measured levels of pesticides should be reduced from baseline (2005) levels to the extent feasible and practical.
4. Detections of regulated pesticides in monitoring and supply wells should be reduced from baseline (2005) levels to the extent feasible and practical.
5. Measured levels of pharmaceuticals and personal care products in groundwater should be reduced from baseline (2005) levels to the extent feasible and practical.

Table 3-28 (Continued)
Groundwater Resource Management Goals and Objectives

GOAL 4. Land use patterns should be consistent with the protection of the County's groundwater and surface water resources, including the protection of existing and future drinking water supplies.

OBJECTIVES:

1. Advanced wastewater treatment and expansion of existing sewer districts should be utilized to reduce contaminant loading from sanitary wastewater.
2. Sub-regional areas in need of sewering to reduce contaminant loading from sanitary wastewater should be identified.
3. Areas appropriate for Transfer of Development Rights (TDRs) and for siting of new wastewater treatment plants (WWTPs) that are not located in the most sensitive public supply well contributing areas and surface water discharge areas should be identified.

GOAL 5: Groundwater levels should be maintained to protect and preserve the County's drinking water supply.

OBJECTIVES:

1. Critical areas where additional groundwater withdrawals could result in unacceptable impacts to existing wells (e.g., saltwater intrusion, reduced capacity) should be defined.
2. Unacceptable impact thresholds, such as magnitude and duration of unacceptable impacts should be defined.

GOAL 6: Groundwater levels should be maintained to protect and preserve the long term sustainability and ecological functions of existing surface water resources.

OBJECTIVES: Unacceptable impact thresholds should be defined within the twenty-five year contributing area to the County's surface water features.

GOAL 7: Existing programs to monitor, prevent contamination of, and manage Suffolk County groundwater resources should be enhanced and improved to provide the data necessary to protect the groundwater resource that provides the County's drinking water supplies, and to provide the information necessary to develop a long term approach to mitigate expected impacts of sea level rise upon existing infrastructure.

OBJECTIVES:

1. Groundwater quality and quantity monitoring programs (e.g., wells, facilities, spills) should be identified and documented.
2. The data should be entered into a database developed to facilitate data review, identification of trends and water quality concerns, and the data evaluation necessary to protect the County's drinking water supply and infrastructure.
3. Existing tools, (e.g., SWAP coverages, contributing area coverages) should continue to be maintained, updated and made available to water resource managers.

3.3 Recommendations

3.3.1 Introduction

Working together with project stakeholders, a variety of alternative approaches to protect groundwater from further contamination, to manage the impacts of existing development on the County's water resources, and to implement the additional studies needed to identify necessary targeted management plans have been identified. These recommendations generally address:

- Guidance to reduce the impacts of new development on groundwater resources;
- Recommendations for structural and non-structural methods to reduce the impacts of existing developed areas on groundwater quality;
- Establishment of a framework and programs to collect and evaluate the additional information needed to fully accomplish the resource protection goals articulated in this Plan, and
- An approach to engage County residents in resource protection.

Over the past few years, Suffolk County has integrated groundwater, surface water, and coastal habitat and resiliency objectives into a more comprehensive resource management framework. Given that sanitary wastewater is the major source of contamination affecting our water resources, the County has initiated a number of actions to address wastewater treatment and disposal, primarily focusing upon nitrogen. Recommendations to reduce nitrogen discharges to the environment are briefly identified here, but are described in more detail in Section 8 of this document. This study has not sought to duplicate on-going efforts, but instead builds upon the framework of water resource protection and management programs that have already been established in Suffolk County.

3.3.2 New Development

3.3.2.1 Recommendation for Open Space Preservation

It has been well documented that preservation of open space is the most effective means of protecting ground and surface water resources (USEPA, AWWA, Trust for Public Land). Studies throughout the country have established that open space preservation is also often the most cost-effective approach to protect source water quality. Major cities such as New York and Boston purchased land in their water supply source areas over a century ago,

to protect the resource for future generations. Recent research has confirmed the foresight of earlier generations, concluding that "allowing water quality to degrade, in addition to threatening public health, increases treatment and capital costs." (AWWA, 2004).

Water quality data collected by SCDHS and the County's water suppliers, and evaluations relating groundwater quality to land use within a well's source water area completed as part of this study also confirm that groundwater quality downgradient of areas of open space in Suffolk County (Task 5.1 and 5.2 memoranda) does not exhibit the level of contamination that is evident downgradient of commercial, industrial, residential or agricultural land uses. Because contaminants of concern such as nitrates, VOCs and pesticides are not used, stored or disposed of in protected open space areas, the potential to contaminate downgradient resources is significantly reduced, or even eliminated.

From a national perspective, the costs and benefits of open space preservation have been considered in a variety of different ways. Because there are many societal benefits associated with open space preservation, the techniques used to assess the costs and benefits consider a much broader range of criteria than water quality protection. Some researchers have concluded that it is not possible or appropriate to attempt to assign a 'cost' to the non-tangible benefits afforded by open space, which could be characterized instead as "invaluable."

A summary of 83 studies completed by the American Farmland Trust concluded that the cost of providing services such as schools, roads, police and fire protection, etc. to a property developed for residential use was greater than the tax revenue provided by that property, while the cost of providing community services to land maintained as farmland or forest was only about one third of the tax revenue that a community could expect to collect. This type of analysis does not consider secondary or long-term impacts however (e.g., that commercial/industrial development often instigates residential development or that the presence of open space can increase surrounding property values, for example). A 2010 report by the New York State Office of the Comptroller reports that even if a municipality purchases development or full ownership rights of a property, on a long term pay-back period of 15 years or longer, the municipalities realized net fiscal benefits, as a result of the maintenance of ecosystem services and limiting the growth of the demand for services.

A 2002 study of 27 water suppliers (mostly surface water supplies) reported by the Trust for Public Land and AWWA's Source Water Protection Committee

found that for every 10 percent increase in forest cover in the supplier's source area (up to about 60 percent), water treatment and chemical costs were reduced by 20 percent. New York City spent $1.5 billion to purchase upstate land in their source water area watershed, as a more cost-effective alternative to spending an estimated $6 billion to $8 billion to construct filtration facilities, and an additional $300 million each year in operating costs should the land have been developed (NCPIRG 2004, NOAA, 2010). As open space preservation in the source water area was the most cost-effective means of providing a reliable and safe supply of water to City residents, the City passed an environmental bond in 1997 to begin to fund the preservation of land in the watershed.

In Suffolk County, the SCWA has reported that based on the increased treatment required, it costs ten times more to provide water from a well with a developed contributing area than from a well where the contributing area is preserved open space (S. Jones, 2009).

Over the past six decades, Suffolk County has purchased more than 53,000 acres of land at a cost of more than $1 billion to preserve important environmental resources and significant ecological areas including wetlands, river corridors and upland habitat in addition to land for active recreation, hamlet parks, and historic and/or cultural uses. The County has also acquired the rights to 10,000 acres of productive farmland. The result of this preservation is a permanent benefit to the health and quality of life for current and future generations of Suffolk County residents. As of 2013, more than 162,500 acres, or more than 25 percent of the County has been preserved. Overall, 38,000 acres of the 55,000 Central Pine Barrens core preservation area are now in public ownership (NYS Office of Comptroller). Based on the land use information provided by the Suffolk County Department of Economic Development and Planning (2014), it is estimated that there are approximately 35,000 acres of vacant land available for development throughout Suffolk County, with the majority of that acreage located in the five eastern towns and Brookhaven. While properties purchased in the past often exceeded 100 acres, most vacant parcels that remain available today are considerably smaller. In addition to County programs, Town-specific programs such as the Community Preservation Fund, have been successful in preserving thousands of additional acres.

Continued open space preservation is recommended from a water resource protection perspective, as the most effective way to achieve the groundwater and surface water resource management goals.

The enabling legislation for the new Drinking Water Protection Program requires that a property being proposed for acquisition must meet at least one of the following five criteria:

- Freshwater/tidal wetlands and buffer lands for same
- Lands within the watershed of a coastal stream as determined by a reasonable planning or hydrological study
- Any tract of land located fully or partially within a statutorily designated Special Groundwater Protection Area
- Lands determined by the County Department of Planning to be necessary for maintaining the quality of surface or groundwater in Suffolk County
- Lands identified by the South Shore Estuary Reserve (SSER), Peconic Estuary Program (PEP), and/or the Long Island Sound Comprehensive Conservation and Management Plan (LICMP) as needed to protect coastal water resources

Within this overall planning context articulated by the Suffolk County Department of Economic Development and Planning, it is further recommended that parcels within the 50 year contributing area to public supply wells be specifically identified and assigned a high priority for purchase, particularly when there is a significant opportunity to protect and preserve existing ground or surface water quality. The areas contributing to public supply wells, based upon supplier projections of future water supply pumpage have been identified during this study and were documented as part of Task 5.5. (Please see the end of this section for an example of public supply well contributing area mappings.) These mappings will help to assess property compliance with criteria 4, above. Based on the latest available land use information provided by the Department of Economic Development and Planning there are currently over three thousand parcels (or parts thereof) located within the 50 year contributing area to community supply wells, as shown on **Figure 3-46**.

The New Drinking Water Protection Program, approved by voter referendum, is an important indication of the public's belief in the importance of Open Space preservation. It is funded by ¼% of the sales tax collected in the County. The Save Open Space program is funded through the issuance of $75 million in serial bonds ($30 million of which was targeted specifically for open space preservation), and the Environmental Legacy Fund has committed $50 million

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Vacant Land within the 50 Year Contributing Area to Community Supply Wells

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-46

from the County's capital budget, to be used in partnership with other municipalities and non-profit organizations. The cost of historic land purchases for open space preservation programs has averaged about $17,700/acre. It is anticipated that future per-acre costs will be somewhat greater, as the value of the more limited land available for development increases, the size of the remaining vacant parcels decreases, and because a number of the properties initially purchased were in the Central Pine Barrens with more limited development potential. While preservation of open space is the most effective way to protect ground and surface water quality from a water resources management perspective, it is acknowledged that many other interests also require consideration. Therefore, open space preservation must continue to be considered within a comprehensive planning framework.

Land acquisitions and preservation continue to be accomplished in Suffolk County under the auspices of a variety of programs that have different goals and objectives. Recently, the County undertook an effort to review, update and consolidate prior disparate Open Space "Master Lists" that included properties proposed for acquisition that were identified as important for open space preservation. The 2012 Comprehensive Master List Update identified 86 proposed open space sites and assemblages totaling 4,650 acres that are recommended for future open space acquisitions.

In 2013, the Suffolk County Legislature amended Chapter 1070 of the Code of Suffolk County for Real Estate Appraisal, Acquisition and Disposition Legislation to streamline the acquisition of open space, farmland and active recreation parcels. The procedure, known as "Triple A" (referencing the appraisal, acquisition and approval steps of the planning process) provides more information to lawmakers earlier in the acquisition process, and allows for the prioritization of properties to be acquired by Suffolk County through the Drinking Water Protection Program, which funds open space farmland and active recreation acquisitions.

The procedural refinement builds on work by the Department of Economic Development and Planning to evaluate and rank all properties on the County's four master lists. Taken together, the new procedural tool and the Comprehensive Master List will be used to determine the best use of limited funds based on objective criteria, including environmental rating, appraisal value, recommendations from Planning Staff and available funding.

3.3.2.2 Recommendations for New Developments

As described above, sanitary wastewater management is the most important factor affecting nitrate levels in groundwater throughout most of the County. Due to the significant contribution of groundwater baseflow to the County's

surface waters, improved sanitary wastewater management practices can also affect nitrate levels in surface waters.

In 1980 Suffolk County amended Article 6 of the Suffolk County Sanitary Code to specifically address the impacts of sanitary wastewater on the County's groundwater. Since 1980, in accordance with Article 6, on-site wastewater disposal is permitted for residential parcels in new residential subdivisions with lot sizes greater than or equal to one acre in Groundwater Management Zones III, V and VI, and greater than or equal to one half acre in all other zones; undersized lots existing prior to 1981 are exempt. Residential development on lot sizes smaller than one acre within GMZs III, V, and VI, and one half acre in all other zones, require the use of a community sewage system for wastewater treatment and disposal.

However, many existing residences with on-site wastewater disposal systems had already been constructed on smaller parcels prior to 1980. While sufficient information to quantify the number of residential parcels that were developed with on-site sanitary wastewater disposal prior to enactment of Article 6 was not available, the number of parcels less than or equal to one half acre and zoned for residential use was identified.

As previously described, data provided by the Suffolk County Department of Economic Development and Planning showed that over fifty percent of the unsewered residential parcels in the County are less than or equal to one half acre. Because the populations of the west end towns have not increased significantly since 1970, it is evident that a large portion of the smaller parcels were constructed prior to enactment of Article 6, and rely upon on-site septic systems for wastewater disposal. Nitrate levels in groundwater reflect these conditions. In fact, approximately one third of the residentially zoned properties in Brookhaven and Huntington are even smaller, at less than or equal to one quarter acre. More than three quarters of the residential properties in Babylon are less than or equal to one quarter acre; groundwater contamination resulting from the on-site septic systems prompted the implementation of the SWSD in the 1970s. Groundwater data collected by both SCDHS and the Nassau County Department of Public Works (2005) has confirmed that sanitary sewering programs have successfully reduced groundwater nitrate levels in the sewered areas.

The observed nitrogen levels in groundwater, which have continued to increase since the ***1987 Comp Plan***, result from a combination of the Article 6-compliant and the older non-compliant parcels.

As described above in Section 3.1.1.3, a modeling assessment of the impacts of unsewered residential areas of alternative densities on nitrate levels in

groundwater showed that nitrate levels are likely to exceed 10 mg/L in areas with ¼ properties, and that nitrate levels in areas with 1 acre properties would remain below 4 mg/L. New development occurs within the framework of properties that have already been developed; many pre-1980 developments include parcels that are less than ½ acre or even ¼ acre in size, hence background nitrogen levels would have already been elevated above the zero assumed background for the modeling evaluations. Building upon the body of SCDHS work over the past decades, the evaluations relating land use to observed nitrate levels completed as part of this study (e.g., documented in task memoranda 5.1, 5.2, and 18), review of density/nitrate relationships established elsewhere in the country, and these most recent model results, the Suffolk County Board of Health should consider modifying Article 6 to require a minimum lot size of one acre for unsewered properties throughout all hydrogeologic zones, ***unless*** provision is made for a higher level of treatment than is provided by a typical on-site wastewater treatment system, or, the development rights from existing undeveloped open space controlled by the developer are transferred, in accordance with standards adopted by the SCDHS in 1995.

Zone specific evaluations considering costs and benefits within the framework of other management alternatives should be completed. Hydrogeologic Zone IV is the highest priority for this consideration. Suffolk County should consider amendment of the Transfer of Development Rights (TDR) standards and Board of Review findings in accordance with these recent evaluations and in coordination with the Pine Barrens Joint Planning and Policy Commission. SCDHS transfer of development rights standards should be re-evaluated to assure protection of sensitive areas, including the 50 year contributing area to public supply wells and the 25 year contributing area to surface water features shown on **Figure 3-47**.

While this recommendation focuses upon nitrogen criteria, it was also developed in recognition of the fact that many other contaminants of potential concern such as PPCPs can also be introduced to the subsurface from on-site wastewater disposal.

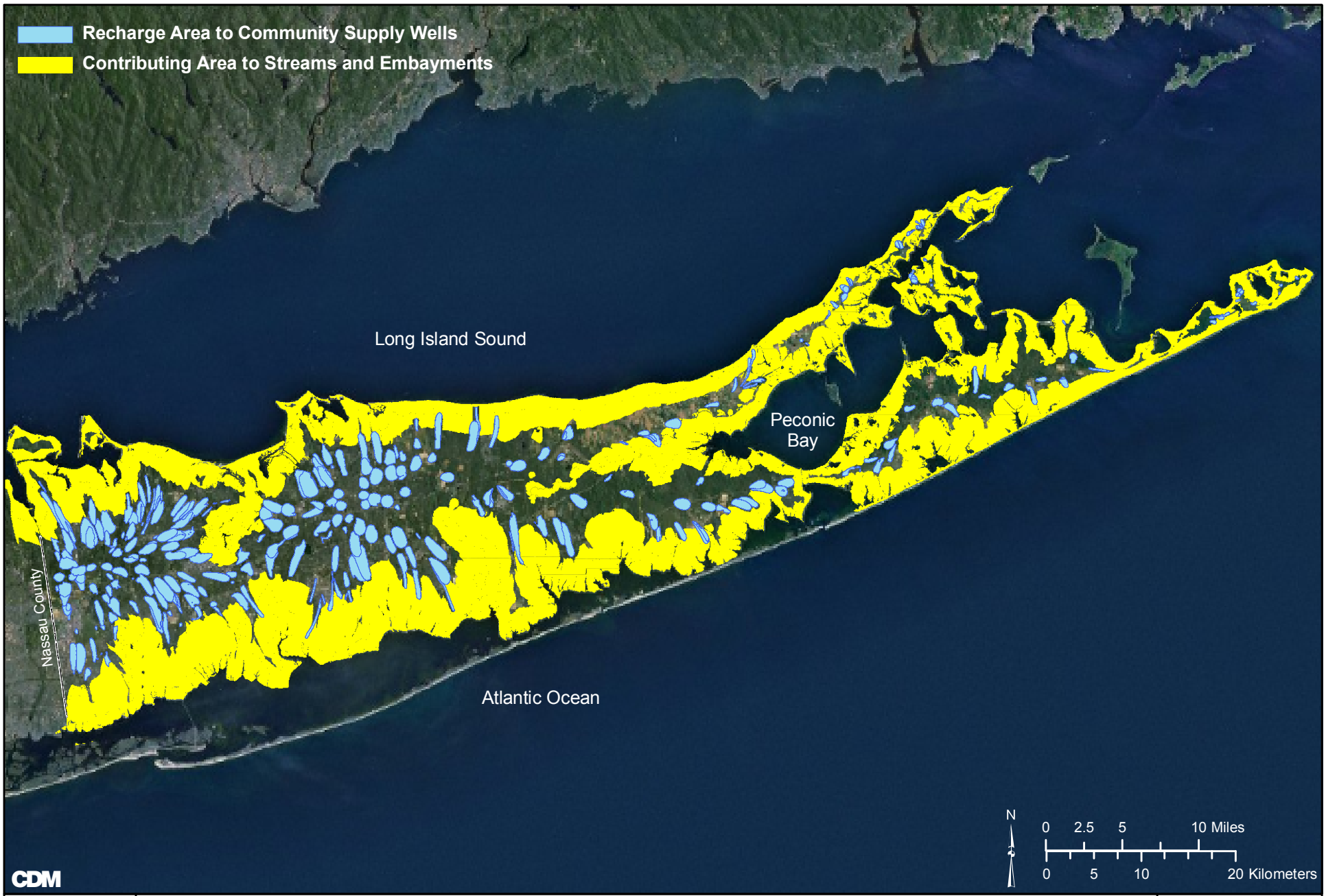
EXCLUSION ZONE ANALYSIS

Identification of Areas Requiring Special Protection

Existing water quality protection programs limit development density in the County's deep recharge zones to manage the amount of contamination introduced to the aquifer system from overlying land use. The SCDHS also considers mappings of the land surface area contributing recharge to public supply wells when reviewing development plans, to discourage siting of facilities or developments with the potential to discharge contamination that could impact a public supply well. Unsewered areas that contribute groundwater baseflow to surface water resources also have the potential to affect surface water quality.

Mappings of areas warranting special protections, strictly from a water resources management perspective, based upon criteria developed by the SCDHS to protect drinking water, groundwater recharge and surface waters were mapped. In order to accommodate "smart growth" initiatives that incorporate higher density developments, areas that did not fall within one of these protected areas could be considered further as potential receiving zones for transfer of development rights, or where increased development density could be considered. It should be noted that this evaluation does not provide a comprehensive mapping of all natural resource criteria that would necessarily be included in a siting study; it does, however identify areas of the County where development or wastewater management restrictions could be considered to be less critical from a water resource protection standpoint.

The first figure depicts the model-simulated areas contributing recharge to public supply wells within fifty years and surface waters within twenty-five years. The second figure shows the land area remaining after the deep recharge zone and special groundwater protection areas are also included. Many of these remaining areas would not be appropriate for higher density development due to their locations within environmentally sensitive areas; high density development would not be permitted based upon existing local zoning in most of the areas identified on the East End.



Areas Contributing to Community Supply Wells and Surface Waters

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-47

Developments of increased density (in areas permitted by local zoning regulations) discharge to sewage treatment plants. Because most new sewage treatment plants discharge to groundwater, the SCDHS Office of Wastewater Management (OWM) reviews the proposed discharge location to minimize potential impacts on downgradient resources, including public supply wells. SCDHS has published guidance for siting new or expanded wastewater treatment plants (WWTPs) advising that WWTPs should not be located within the zero to two year contributing area to public supply wells as identified by the 2007 source water assessments, based on the NYSDOH's assessment of the sensitivity of microbial contaminants. In addition, the County advises that the siting of WWTP discharges within the two to 50 year groundwater travel time should be minimized to the extent feasible and requires that an advanced treatment process be provided if a WWTP is located within this zone (SCDHS, 2014).

3.3.3 Existing Developed Areas

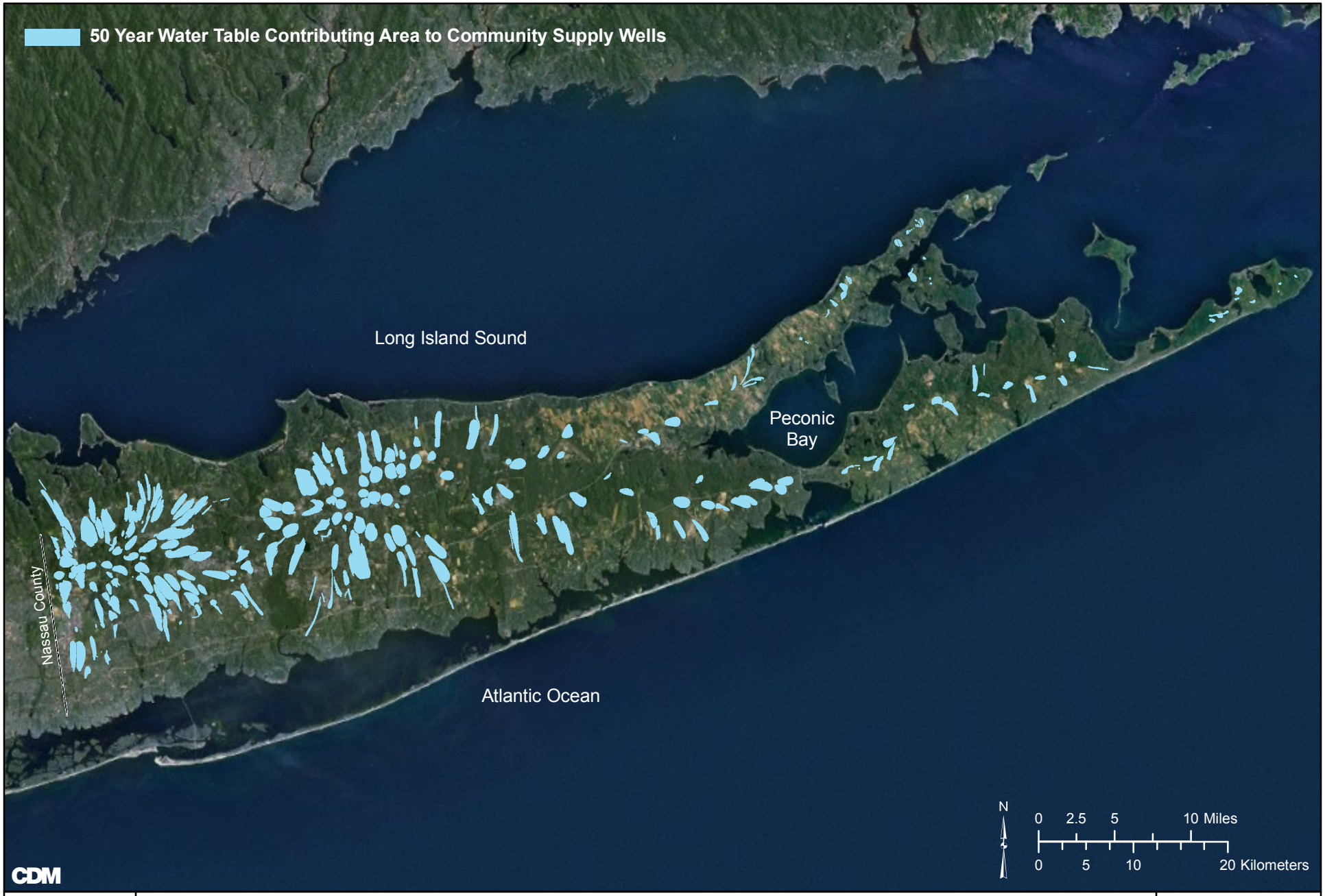
While the preceding pages outlined an approach to protect groundwater from the impacts of additional development, the following recommendations were developed to respond to the impacts of the 1.5 million existing residents of the watershed.

3.3.3.1 Recommendations to Evaluate Sanitary Wastewater Treatment and Disposal Options

Sanitary wastewater disposal and fertilization practices are the two largest sources of nitrate to the aquifer system. As described in section 3.1.1.3, unsewered areas where property sizes are less than an acre are likely to cause groundwater nitrogen concentrations that exceed target levels of 6 mg/L. In areas where property sizes are ¼ acre or smaller, groundwater levels are predicted to exceed 10 mg/L, as has been observed in several SCDHS studies.

Recognizing the impact that densely developed unsewered areas has on groundwater and surface water quality, Suffolk County has already initiated projects to reduce the impacts of sanitary wastewater disposal on groundwater. The County is prioritizing and addressing wastewater management in developed areas through a series of projects targeting study areas identified by the Suffolk County Sewer District Wastewater Treatment Task Force:

- Sewer District Capacity Study for seven unsewered areas (CP 8189)
- Expanding districts of four existing sewered areas (CP 8185)
- Expansion of Southwest Sewer District No. 3 (CP 8139)



Area Contributing Recharge to Community Supply Wells within Fifty Years

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-48

- Expansion of Kings Park Sewer District

In addition, SCDHS has conducted a study of alternative on-site sewage system technologies that could reliably reduce nitrogen levels to 10 mg/L for individual residences or smaller sub-divisions, to identify alternative systems that could provide viable, low cost systems to protect public health. This study will include monitoring those most promising alternative technologies to collect data establishing system effectiveness and to identify cost-effective alternatives to centralized sewage collection and treatment.

Following the release of the draft Comprehensive Water Resources Management Plan, Suffolk County initiated a program to establish watershed-specific nitrogen loads, identify and approve improved on-site sewage disposal system technologies, expand and/or create new Suffolk County-operated sewage districts and create privately operated decentralized sewer districts. A number of County representatives toured other states on the east coast that currently utilize alternative on-site sewage disposal technologies to reduce the impact of nitrogen from sanitary wastewater disposal on water resources. Suffolk County is currently conducting an innovative/alternative on-site wastewater treatment systems (OWTS) demonstration project for single-family residences. Four manufacturers are installing a total of nineteen demonstration systems that will be monitored throughout 2015 to assess their ability to reduce effluent nitrogen to less than or equal to 19 mg/L. The benefits and costs of these actions are being assessed, and will be used in a County-wide assessment of wastewater management, as described below and in more detail in Section 8.

It is recommended that Suffolk County complete the demonstration study, and utilize the results along with the GIS-mappings of areas contributing recharge to public supply wells and surface waters and relationships between density and nitrate levels developed during this study in a County-wide wastewater planning study that considers density, conventional wastewater treatment collection and treatment systems, alternative treatment systems, alternative on-site systems, and operational and maintenance guidelines for existing on-site systems.

The County-wide evaluation should identify any additional high priority areas within the County where a new approach to wastewater treatment and disposal is required to achieve ground and surface water quality criteria for nitrates. SCDHS can use the evaluation approach piloted for the Montauk Highway Corridor (please refer to Section 3.1.1.3) to assess the benefits of proposed sewering programs on groundwater quality. The planning study should also consider projected impacts of sea level rise upon the on-site

wastewater disposal systems in coastal areas, and include further evaluation of both the separation distance between on-site systems and the groundwater table and inspection upon property sale. It will also be essential for the County to establish an I/A OWTS program that includes the establishment of a Responsible Management Entity (RME) to oversee operations, maintenance, enforcement, and financing of systems, create a pilot program that includes demonstration projects, and amend the Suffolk County Sanitary Code and SCDHS construction standards to permit the establishment of an I/A OWTS program.

The question of whether Article 6 of the Sanitary Code should be amended to regulate the equivalent density of accessory apartments in unsewered areas has been raised occasionally. Currently, Article 6 does not provide the authority to regulate legal accessory apartments that are ancillary to a single-family dwelling. A reliable data set that identifies the locations of legal accessory apartments does not currently exist; an inventory of illegal accessory apartments would be even more difficult to develop. In general, legal accessory apartments are regulated by towns and villages. Both data and model simulations indicate that nitrogen levels in the aquifer are increasing, due in part to the larger household size considered, which would include the accessory apartments. Based on available information, Code revision to regulate accessory apartments is not recommended at this time; however as additional information becomes available, the issue should be re-evaluated.

3.3.3.2 Recommendations with Respect to Nitrate Loads from Fertilization

Suffolk County has developed and is implementing a plan to reduce the impacts of fertilizer on ground and surface water features. The Suffolk County Legislature established a goal of reducing fertilization in residential areas by 10 to 25 percent, and in 2007 passed Local Law 41-2007 to reduce nitrogen pollution by reducing the use of fertilizer throughout the County. The law notes that "*the quality of our water should be considered a higher priority than the aesthetics of lawns, and that high maintenance lawns require more nitrogen and are more likely to leach excess nitrogen, so that high maintenance lawns should be discouraged.*"

The Plan mandated by the widely acclaimed legislation includes the following components:

- A Countywide ban on fertilizer application between November 1 and April 1, to avoid applying fertilizer to frozen ground;

- A ban on fertilization of County properties, except for golf courses, athletic fields, the Suffolk County farm, and new turf establishment at public works properties;
- Codifying the County's Organic Parks Maintenance Plan, limiting fertilizer application to 3 pounds of nitrogen for each 1,000 square feet of golf course;
- Use of Best Management Practices (BMPs) at the County Farm;
- Expansion of educational programs to encourage reduction of fertilization rates and increase the use of slow-release fertilizers;
- Establishment of an inter-active website for residents to establish fertilization needs (www.healthylawns.suffolkcountyny.gov/)
- Requirement that licensed landscapers (approximately 1,200 in Suffolk County) complete a turf management course;
- Requirement that retail establishments selling fertilizers post signs, and provide educational materials describing proper fertilization rates and practices;
- Preparation of annual reports summarizing the amount and types of fertilizers sold by the County; and
- Beginning in 2014, preparation of reports at five year intervals summarizing the effectiveness of this Law.

Suffolk County Development of Economic Development and Planning has documented that sales of fertilizer in Suffolk County have declined by over 11 percent since the law took effect in 2009 (**Framework for the Future, Suffolk County Comprehensive Master Plan 2035**). Nevertheless, Suffolk County residents continue to use significantly more fertilizer than residents of any other county in New York State, indicating that additional efforts are required.

In July 2010, New York State adopted the Dishwasher Detergent and Nutrient Runoff Law to reduce phosphorus loading to the state's ground and surface waters. Reducing the amount of phosphorus that is released to the environment is much more effective and cost-effective than collecting and treating contaminated stormwater, or implementing treatment processes to reduce phosphorus levels in sanitary wastewater. Beginning in August, 2010, the sale of newly stocked phosphorus-containing dishwasher detergent for

residential use was prohibited, and the sale of dishwasher detergent containing phosphorus for commercial use was prohibited beginning July 2013.

Beginning on January 1, 2012:

- Lawn fertilizers containing phosphorus were prohibited, except for establishment of new lawns, or if data confirms that phosphorus is required;
- Application of lawn fertilizers on impervious surfaces was prohibited;
- Application of lawn fertilizers was prohibited within 20 feet of a surface water body except in cases where a vegetative buffer of ten feet or more exists, or special application techniques are employed;
- Application of fertilizer between December 1 and April 1 was prohibited state-wide.

The state-wide law does not affect agricultural or garden fertilization practices. However, to date, over 300 local vegetable, nursery, sod, and fruit farms and vineyards have participated in the tiered strategy of the Agricultural Environmental Management (AEM) Program. The AEM Program is a state-wide voluntary, incentive based process that helps farmers to make common sense decisions to achieve their business objectives while protecting and conserving natural resources and groundwater quality. Through the AEM program, the Suffolk County Soil and Water Conservation District, partners at Cornell Cooperative Extension of Suffolk County (CCE), NRCS and private sector planners and crop consultants provide on-farm environmental assessments, conservation planning and technical services.

It is recommended that farmers that participate in County preservation programs, purchase of development rights, and other programs should be encouraged to participate, by agreement, in the AEM program and adopt best management practices (BMPs) to minimize or prevent contamination from fertilizers, considering use of improved timing of fertilizer application, choice of product (e.g., slow-release formulations) and new technologies to limit fertilizer leaching and run-off.

Approximately 80 on-farm demonstration projects have been held by Cornell Cooperative Extension's agricultural research specialists in the County-funded Agricultural Stewardship program to evaluate the costs and benefits of using alternative nutrient management practices to protect groundwater quality while maintaining crop viability, and 22 sweet corn and 16 potato farms have

participated in Controlled Release Nitrogen Fertilizer demonstration projects. As conservation plans and BMPs are implemented, collection of groundwater quality data would help to assess the effectiveness of the program in reducing nutrient levels.

Suffolk County continues to work with Cornell University and Cornell Cooperative Extension to reduce nitrogen loads from fertilizer. One of the activities, the golf course challenge, is seeking to implement best management practices at East End golf courses, so that nitrate levels in downgradient groundwater are maintained at less than 2 mg/L. The County should evaluate the effectiveness of the fertilizer BMPs and based upon the results, consider working together with golf courses throughout the County for wider implementation.

Finally, Suffolk County is evaluating and updating the 2004 Suffolk County Agricultural Stewardship Program, to address current needs of the farming community and the County, including the need to protect the quality of the County's water resources, soil and natural habitats. The collaborative effort includes participants from the farming community as well as Suffolk County Department of Economic Development and Planning, SCDHS, the Peconic Estuary Program (PEP), Cornell Cooperative Extension of Suffolk County, SCWA, the Suffolk County Soil and Water Conservation District, NYSDEC, and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The updated Program describes the need for collaborative cooperation to reduce the nutrient loads from agriculture to the County's ground and surface water resources while maintaining a strong, viable agricultural industry. The primary goal of the program is to increase Suffolk County farmer completion of Tier III in the AEM program to at least 90 percent. The program will encourage participation by funding research to develop BMPs to reduce nitrogen impacts, by providing educational programs to encourage implementation of nitrogen reducing BMPs, and providing funding to continue to improve BMPs to reduce nitrogen impacts.

3.3.4 Recommendations to Address Volatile Organic Compound Contamination

Review of water quality data has shown that the highest levels of VOCs are found in wells with industrial, commercial, transportation or institutional uses within their source water areas. Nevertheless, low levels of VOCs were widely detected in groundwater throughout the County, indicating a more widespread low-level source of the observed contaminants, such as residential septic systems.

The goal of the SCDHS Office of Pollution Control (OPC) is to prevent – and mitigate – the release of toxic contaminants to groundwater and the environment. There are currently over 20,000 industrial and commercial facilities in the OPC's database; these include gas stations, dry cleaners, pharmaceutical manufacturers, metal plating and fabrication facilities, repair and fleet service facilities and other facilities using or storing hazardous substances (SCDHS, 2014). OPC has prioritized these facilities based on the contaminants used, the potential for release to the environment, and historical enforcement actions. Facilities with permitted storage are routinely inspected; those facilities with a medium or low ranking are inspected less frequently than high priority sites, due to staffing limitations. OPC has reported that in a typical year, approximately 4 percent of the 3,500 medium priority establishments and only about 1 percent of the 12,000 low or unknown priority establishments are inspected. Because the use of a particular property may change over time, the priority assigned to a particular property may remain out of date for years, until the facility is inspected again.

Consequently, as a result of the infrequent inspections, information provided by others (e.g., data developed by environmental assessments during property transfers) often identifies the release of contamination to the environment. As a result, in the past, OPC has overseen hundreds of remedial actions at medium and low priority sites each year, to mitigate contaminants that have been released to the environment via on-site septic systems.

Based on the facility location information included in the SCDHS OPC database, almost eighty percent of the regulated facilities are located in unsewered areas. Many of these facilities do not use or store significant quantities of hazardous materials on-site; however, those facilities that do utilize hazardous materials have a higher potential to introduce contamination to groundwater.

Before targeted recommendations to reduce the release of VOCs to the County's groundwater can be developed, a better understanding of the potential sources of the observed contamination is required. SCDHS OPC has developed a two phase VOC Action Plan to respond to the observed VOC contamination. The first phase of the Plan is being implemented, five new staff have been hired to allow annual inspections of underground gasoline storage facilities and dry cleaners, and increased sampling and analysis. Suffolk County has developed a scope of work for a Reducing Toxics capital project to evaluate existing industry in the County using or storing hazardous materials, including the volume of materials stored, location of storage, historical spills, potential for release and assessment of contaminant fate and transport. The contaminant inventory and characterization should form the basis for a

revised facility ranking system, and identification of potential new regulations, storage requirements, operator training requirements or inspection/enforcement procedures to improve the effectiveness of OPC programs, and to reduce the further release of toxic contaminants, including VOCs to the environment.

It is recommended that Suffolk County continue to implement this program as a priority.

As an additional task to that program, the SCDHS should also further explore the role that residential areas have in terms of VOC contamination. If residential areas are determined to be a significant source of the observed low level VOC contamination, SCDHS should respond by:

- Incorporating information on the types of household products that may contain VOCs, and preferred alternatives into the education and outreach program described below,
- Potentially regulating the use and disposal of specific contaminants of concern (e.g., household cleaners, etc.), and
- Incorporating relevant information on appropriate use and disposal of household products using VOCs into public education and outreach and school curricula development programs.

In the meantime, the high priority facilities located within the contributing areas of public supply wells that have been rated as having high or very high susceptibility to VOC contamination should be inspected.

3.3.4.1 Recommendations to Address Volatile Organic Compounds from Soil Vapor

The presence of VOCs in groundwater (e.g., at or near a USEPA or NYSDEC listed Superfund or Brownfield site) can also result in contaminated soil vapor. Contaminants in the vapor phase can migrate through the soil and eventually enter buildings through cracks in basement floors, walls, foundations, and gaps near utility conduits and sump pits. Vapor intrusion is the general term given to migration of hazardous vapors from a subsurface contaminant source, such as contaminated soil or groundwater, through the soil and eventually into indoor air. Vapor intrusion can occur in a broad range of land use settings, including residential, commercial, and industrial, and affect buildings with virtually any foundation type (e.g., basement, crawl space, or slab on grade). Vapor intrusion is similar to radon intrusion in that the mechanism of vapor transport and entry into a structure is the same. The SCDHS Department of Environmental Quality (DEQ) currently requires facility owners of VOC

release sites that have the potential to cause vapor intrusion, to perform a soil vapor investigation. SCDHS then reviews the results and determines whether further monitoring or mitigation is required. If mitigation is warranted, systems can be installed to minimize or prevent potential soil vapor exposures, enabling use and development of the overlying property.

In many cases, installation of mitigation systems prior to building construction is a proactive approach that is worthy of consideration. The costs associated with installing a system at the time of a building's construction are often significantly less than the costs associated with retrofitting a system to the building after construction is completed. These systems also have the potential to reduce any naturally occurring low-level radon gas levels and control humidity in basements. DEQ now reviews all new construction applications to determine whether a site has the potential for soil vapor intrusion. SCDHS considers this procedure to represent a precautionary approach for addressing potential soil vapor intrusion prior to construction when applications are received that are on, or in close proximity, to a NYSDEC or USEPA listed site where there is a source that can potentially contaminate soil vapor.

DEQ's review is limited in scope and may result in a recommendation to the applicant to contact the NYSDOH or NYSDEC case managers for those spill sites for information on the extent of contamination and potential control measures, where necessary.

3.3.5 Recommendations to Address Pesticides

Pesticide contamination of Suffolk County groundwater is primarily associated with agricultural land uses on the East End. Multiple programs are in place to help reduce non-point pesticide sources from agriculture; however, the overuse of pesticides on agricultural lands continues to be one of the most significant sources of contamination in agricultural areas. Programs such as the AEM program described above in Section 3.3.3.2 are being implemented to address these issues. The AEM Program is a state-wide voluntary, incentive based process that helps farmers to make common sense decisions to achieve their business objectives while protecting and conserving natural resources and groundwater quality. Through the AEM program, the Suffolk County Soil and Water Conservation District, partners at Cornell Cooperative Extension of Suffolk County (CCE), NRCS and private sector planners and crop consultants provide on-farm environmental assessments, conservation planning and technical services.

It is recommended that farmers that participate in County preservation programs, purchase of development rights, and other programs should be encouraged to participate, by agreement, in the AEM program and adopt best

Pharmaceuticals and Personal Care Products in the Environment

Suffolk County's approach to PPCPs includes monitoring, removal of PPCPs from wastewater whenever possible, research into treatability and education, including:

- Collaboration with USEPA, NYSDEC, SCWA and USGS to develop and implement a PPCP monitoring plan that tests public and private supply wells and the groundwater resource.
- Expansion of existing analytical methods to identify the presence of contaminants of concern.
- Development and implementation of a plan to monitor PPCPs in wastewater, and to test the efficacy of wastewater treatment technologies – including onsite wastewater treatment systems - in removing PPCPs.
- Support of Town STOP programs to reduce improper disposal of PPCPs to prevent them from entering the environment.
- Public education and outreach and support of consumer turn-in programs.
- Work with medical facilities to optimize management and disposal procedures

management practices (BMPs) to minimize or prevent contamination from pesticides, considering integrated pest management or products that are safer alternatives to the pesticides that have been observed to impact the County's groundwater.

Suffolk County and Cornell Cooperative Extension should continue to work closely with the agricultural community to identify crop-specific practices (e.g., integrated pest management) or products that provide safer alternatives to the pesticides that have been observed to impact the County's groundwater. It would be useful if monitoring well installation and groundwater sampling and analysis were also included to help determine the effectiveness of BMPs in reducing ground and surface water contamination. As BMPs are implemented, groundwater quality data would assess the effectiveness of the program in reducing pesticide levels. It is recommended that the agricultural community, Suffolk County and Cornell Cooperative Extension work together to install monitoring wells, and conduct targeted sampling, analysis and reporting to help assess the effectiveness of BMPs in reducing ground and surface water contamination from pesticide application.

Suffolk County is evaluating and updating the 2004 Suffolk County Agricultural Stewardship Program, to address current needs of the farming community and the County, including the need to protect the quality of the County's water resources, soil and natural habitats. The collaborative effort includes participants from the farming community as well as Suffolk County Department of Economic Development and Planning, SCDHS, the Peconic Estuary Program (PEP), Cornell Cooperative Extension of Suffolk County, SCWA, the Suffolk County Soil and Water Conservation District, NYSDEC, and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The updated Program describes the need for collaborative cooperation to reduce pesticide loading from agriculture to the County's ground and surface water resources while maintaining a strong, viable agricultural industry. The primary goal of the program is to increase Suffolk County farmer completion of Tier III in the AEM program to at least 90 percent. The program will encourage participation by funding research to develop BMPs to reduce pesticide impacts, by providing educational programs to encourage implementation of pesticide reducing BMPs, and providing funding to continue to improve BMPs to reduce pesticide impacts.

As part of the Agricultural Stewardship Program, fifteen orchards are currently implementing integrated pest management plans.

3.3.6 Recommendations to Address Pharmaceuticals and Personal Care Products

New information is published nearly every day on the detection, fate and transport characteristics, or potential effects of one or another of the PPCPs. It is recommended that SCDHS continue to monitor the literature and regulatory initiatives concerning PPCPs, including research on:

- Development of methods (e.g., analytical techniques) to identify PPCPs at the very low concentrations expected in the environment, development of efficient methodologies to analyze mixtures of compounds, development of cost-effective analytical methods;
- Identification of priority or target compounds that can be used for rapid/cost effective screening for PPCPs;
- Fate of PPCPs in the environment (including subsurface environment/groundwater);
- Exposure;
- Effects of low levels of PPCPs on human health and the environment;
- Establishment of sensible analytical detection limits and treatment goals;
- Additive effects of PPCPs with similar modes of action, and finally
- Treatability.

It is just not possible to monitor for all of the contaminants of emerging concern (CECs), including PPCPs that could potentially be present in the environment, given that more than 88 million organic and inorganic chemicals have been registered with Chemical Abstracts Services, and thousands of new chemicals are listed each day. It should not be necessary to monitor for all of these parameters, however the subset of compounds with potential human-health impacts that ultimately should be monitored has not yet been identified. In addition, analytical methods to detect the extremely low levels of some PPCPs and their metabolites that may exist in the environment are not yet available. While analytical protocols to detect some PPCPs have been developed, cost effective methods to rapidly detect the presence of many of the other compounds that may be present have not.

SCDHS should continue to conduct targeted monitoring as summarized below:

- Increase the number of sample analyses available from the Public and Environmental Health Laboratory (PEHL) to analyze each sample from all community supply wells as part of annual facility inspections, as well as samples from non-community and the private drinking water wells;
- To the extent staffing permits, the PEHL should explore expansion of existing analytical methods to increase the number of PPCPs analyzed, particularly focusing on those already identified in our groundwater resources, summarized on **Table 3-29** below.
- Continue targeted monitoring, focusing on wells downgradient of laundromats, hospitals and nursing homes, using a similar approach to the focused plan implemented for the Pesticides Monitoring Program;

Table 3-29 Recommended New Analytes for SCDHS PEHL

PCCP	Use
Cotinine	Metabolite of nicotine
Diltiazem	Antihypertensive
Hydrochlorothiazide	Diuretic
Meprobamate	Anti-anxiety agent
Metropolol	Antihypertensive
Naproxen	Anti-inflammatory
4-Nonylphenol	Surfactant, known estrogen disruptor
Phenobarbital	Barbituate
Sulfamethoxazole	Antibiotic
Tramadol	Analgesic
Tributyl phosphate (TBP)	Plasticizer and solvent
Triphenyl phosphate (TPP)	Plasticizer
Tri (2-butoxy-ethyl) phosphate (TBEP)	Plasticizer
Tri (2-chloro-ethyl) phosphate (TCEP)	Plasticizer and flame retardant
Tri (2-dichlorisopropyl) phosphate	Plasticizer, suspected estrogen disruptor

As of January 1, 2015, Suffolk County requires that public supply wells be tested for 1,4-dioxane (http://legis.suffolkcountyny.gov/Resos2014/i1334-14.pdf). A

new chemist will join the SCDHS PEHL to analyze samples for this contaminant.

SCDHS and SCWA are embarking on a cooperative agreement to expand monitoring of CECs to begin to immediately address this recommendation. Initially, SCWA will analyze approximately 50 SCDHS samples from small public supply and private wells for seven PPCPs and one CEC. This cooperative initiative will enable SCHDS to begin to assess the occurrence of these potential contaminants so that follow-up monitoring and management actions can be implemented, in cooperation with NYSDOH.

While there have been significant advances in the number of compounds that can be measured at increasingly lower detection limits, the approach to linking the detection of CECs to human health or ecological effects is not clear cut. For example, pharmaceuticals ingested by mammals are often excreted as the unaltered parent compound to only a small degree and many pharmaceuticals, steroids, and biogenic and anthropogenic hormones are chemically changed by human or animal digestive tracts by formation of glucuronide or sulfate conjugates (Berg et al., 2007). Thus in addition to studying the parent compound, it is necessary to examine the metabolic by-products of these compounds. For example, gemfibrozil, a lipid regulating pharmaceutical, is excreted mostly as the glucuronide conjugate, with less than 2% excreted as unchanged gemfibrozil (RxList, 2014).

Considering the number of possible chemicals and their degradates that could be analyzed, our historical and current paradigms for evaluating occurrence, fate, and toxicity cannot keep pace with chemical development and commercialization, let alone regulatory evaluation. The objective of identifying all of the constituents and their degradation products that may be of concern in wastewater effluent is a seemingly unsurmountable task.

With respect to monitoring for potential biological impacts, the use of biological surrogates has had a long history in protecting human health and, in fact the current risk assessment framework includes testing using in vivo animal models to extrapolate endpoints that can be translated to regulatory limits e.g., MCL for drinking water. However, with the number of chemicals and mixtures of chemicals and chemical transformation products, this approach is limited and high-throughput screening methods are being evaluated to provide information on the mechanisms of biological toxicity at a relatively small cost (Snyder, 2014).

Even with the limitations of extrapolation from a cellular response to human health outcomes, high throughput assays could provide a more comprehensive

view of chemical constituents present in water as well as an assessment of their cumulative (mixture) toxicity.

Equipment to perform most in vitro cellular bioassays is significantly less expensive than those required for mass spectrometric techniques used for targeted analyses. Although many cell bioassays, such as the Ames test or Microtox®, are available commercially, EPA continues to develop a wide array of assays that could be made publicly available for very little cost to water agencies. Cell culture equipment is already available in many water laboratories, and plate-scanning spectrophotometers can be procured at reasonable costs that are at least an order of magnitude less than commonly employed liquid chromatography tandem mass spectrometer equipment. The proliferation of 384 well-plate assays along with robotics for liquid handling also will continue to reduce labor and supply costs while simultaneously increasing reproducibility. These types of high throughput assays will continue to be developed and applied for water quality evaluations, allowing for rapid and relatively inexpensive characterization of the mixtures of chemicals that may occur in water (Snyder, 2014).

In addition to monitoring, Suffolk County should continue to collaborate with water management colleagues and review the latest findings from other jurisdictions. Of equal importance, is continued public outreach and education efforts to encourage appropriate disposal of pharmaceuticals through take-back programs at pharmacies or other collection programs, such as "Operation Medicine Cabinet".

3.3.7 Recommendations – Wastewater Treatment

Sanitary wastewater management is one of the most significant issues facing Suffolk County in terms of groundwater resource protection in both existing developed areas and in currently undeveloped areas. Prior to development, precipitation falling on the ground surface recharged the aquifer system, and the recharged precipitation travelled down through the aquifer system to eventual discharge to fresh streams, intertidal areas, harbors, coastal embayments or other marine waters. Prior to extensive development, private wells were used to withdraw potable supply from the aquifer; most of the water withdrawn was returned to the aquifer system via on-site cesspools or septic systems. The sanitary wastewater introduced nitrogen and bacteria to the aquifer system, but this was successfully diluted by the greater volume of recharging precipitation and did not cause widespread impacts. Eventually, the sanitary wastewater recharged by more and more residents exceeded the assimilative capacity of the resource in densely developed areas, causing noticeable impacts to the aquifer, drinking water supply and surface water ecology, and prompting implementation of wastewater management measures.

Sanitary wastewater management options were implemented to protect the groundwater resource, as indicated by compliance with the 10 mg/L drinking water standard for nitrogen. As mentioned above, there are currently three sanitary wastewater management options utilized in Suffolk County – discharge to a centralized sewage collection and treatment system, discharge to an alternative community treatment system, and discharge to an on-site sanitary wastewater disposal via septic systems or cesspools in accordance with Article 6 density requirements.

Centralized sewage treatment and collection systems such as SWSD No. 3 were established to reduce levels of observed wastewater parameters in groundwater located beneath densely developed areas. Provision of a centralized sanitary wastewater collection and treatment is an effective way to reduce the impacts of development on ground and surface water features; conventional treatment schemes remove suspended solids, organic material, and deactivate pathogens via disinfection. More advanced treatment processes can be used to remove nutrients such as nitrogen to protect drinking water and prevent eutrophication and destruction of ecological communities. As previously described, nitrogen levels in sanitary wastewater vary considerably; typical secondary wastewater treatment processes reduce influent total nitrogen concentrations by 50 percent or less. Additional treatment processes utilized at biological nutrient removal (BNR) facilities can further reduce nitrogen levels to less than 10 mg/L, and sometimes to as low as 4 to 6 mg/L.

In addition to the significant economic costs associated with centralized sewage collection and treatment, there are other potential environmental impacts. For example, discharge of the treated effluent off-shore results in a net loss of water from the aquifer system that may have detrimental impacts on area streams, pond levels and wetlands as the elevation of the groundwater table declines and baseflow contributions are reduced. In addition, the energy requirements associated with operating a treatment plant, and treating and disposing of sludge, greatly exceed the requirements associated with passive on-site disposal systems, and conventional wastewater treatment does not address all contaminants of concern, such as some organics and PPCPs.

There are currently close to 200 of the alternative treatment systems permitted by SCDHS and NYSDEC that are in operation in the County today; these systems are required to meet effluent nitrogen limits of 10 mg/L. The effectiveness and utilization of alternative technologies has been widely considered in other coastal areas; most notably in Massachusetts at the Massachusetts Alternative Septic System Test Center (MASSTC), in Rhode Island, and in New Jersey. The MASSTC, a collaborative effort of the Massachusetts Office of Coastal Zone Management, the Barnstable County

Department of Health and the Environment, UMass Dartmouth School of Marine Science and Technology, Massachusetts Environmental Trust, and the Massachusetts Department of Environmental Protection, has studied the effectiveness of nitrogen removal of alternative systems for close to ten years. The results indicate a wide variety of effectiveness, and demonstrate that over half of the systems (referred to as innovative/alternative systems, or I/A systems) were not successful in consistently achieving the 19 mg/L state standard. The MASSTC work highlighted an important study conclusion: "Towns that contemplate the wide-scale use of I/A systems to address nutrient issues should understand that the oversight of operation and maintenance of I/A systems is an essential part of ensuring a level of success. Quite simply, I/A systems that are not regularly inspected and occasionally monitored will not achieve treatment objectives." (**Performance of Innovative Alternative Onsite Septic Systems for the Removal of Nitrogen in Barnstable County, Massachusetts, 1999-2007**). This finding is consistent with the experience of SCDHS OWM, as documented in the Task 5.2 memorandum (**Future Land Use Impacts**, CDM, 2008).

In 2007 and 2008, SCDHS OWM began to work even more closely with treatment plant owners and operators to improve facility operations, and a new policy requiring legal action and mandatory fines for violations was implemented. Effluent quality data available from 2008 showed that within that first year, treatment had improved such that nearly 70 percent of the plants had achieved the 10 mg/L discharge limit for nitrogen. SCDHS OWM is also revising Suffolk County Sanitary Code Article 7 Sewage or Industrial Waste Treatment Facilities Operation and Maintenance Standards. These revised standards, which will clearly define the increased responsibilities of plant operators, engineers, will help the County continue to improve treatment effectiveness and protect groundwater quality.

When effectively operated, these STPs successfully remove a significant nitrogen load from the County's groundwater. SCDHS estimated that the total flow currently discharged to groundwater from these STPs totals approximately 10.8 MGD and introduces less than 900 pounds of nitrogen per day to the aquifer. By comparison, if the areas served by these facilities were developed in accordance with Article 6 density limitations for use of on-site wastewater treatment systems, approximately 1,800 pounds of nitrogen, or double the cumulative STP load, would be discharged.

When successfully operated and maintained, these systems are, in many cases, capable of significantly reducing the nitrogen load to groundwater. However, they do require considerable operator attention to consistently and successfully operate, they require considerable SCDHS oversight, and they do

not necessarily remove all organics and PPCPs that may be contained in the effluent. Recognizing the impact that densely developed unsewered areas has on groundwater and surface water quality, Suffolk County has already begun to develop projects to reduce the impacts of sanitary wastewater disposal on groundwater. For example, as described above, SCDHS is conducting a study of alternative on-site sewage system technologies that could reliably reduce nitrogen levels to 10 mg/L for individual residences or smaller sub-divisions, to identify alternative systems that could provide viable, low cost systems to protect public health.

The last wastewater management alternative described above, on-site wastewater disposal systems, is currently utilized by approximately 74 percent of County residents. Septic systems are widely used throughout the world, they are passive systems that successfully reduce organic loading to the environment. However, reported nitrogen removal rates within household systems vary widely and are not always easy to assess. In fact, influent nitrogen concentrations are also highly variable, depending on factors such as number of loads of laundry being washed, number of showers taken, etc.

While some jurisdictions require frequent septic system pump out, this is primarily to prevent scum or solids overflow from clogging the leaching field. In fact, some research has shown that this practice can actually reduce the level of treatment provided within a properly sized tank, as it takes two to three years for microbe diversity to be established sufficiently for digestion. Hence, more frequent pump-outs should not be required for most properly designed and operating systems. In addition, existing wastewater treatment plants in the County currently do not have adequate capacity to accept the increased scavenger waste load that would be generated should pumping be required at the frequent intervals that are sometimes proposed. SCDHS Office of Wastewater Management should continue to monitor the literature and experience elsewhere in coastal areas, coordinate with SCDPW's scavenger wastewater treatment planning efforts and revisit this issue if new information becomes available.

SCDHS currently requires a three foot separation distance between high groundwater elevation and the bottom of a leaching pool (with limited exception in areas of shallow groundwater where two foot separations may be acceptable for systems with five leaching pools). SCDHS monitoring has shown that this separation has been adequate for conversion of ammonia to nitrate in the unsaturated aerobic zone. Considering the predicted impacts of increasing sea level, SCDHS will be required to address this issue, particularly in coastal areas, in the coming years as described further in Section 8. As described below, SCDHS should continue to monitor groundwater levels. Within the

context of an overall County planning effort to respond to rising sea levels, SCDHS will need to develop an approach to address wastewater management in areas where the separation distances are predicted to decline.

When properly sited (e.g., appropriate density), all three of these approaches are capable of enabling the groundwater resource to achieve the 10 mg/L groundwater standard for nitrate on a regional basis. However, lower nitrate levels in groundwater discharging to some surface waters may be required to meet water body-specific water quality and ecologic goals. Either nitrogen or phosphorus may be the limiting nutrient in a particular surface water body. In general, phosphorus is typically the limiting nutrient for algal growth and productivity in fresh water systems, and nitrogen is usually the limiting nutrient in marine water bodies. Like nitrogen, phosphorus may be introduced to the aquifer system by sanitary wastewater or by fertilization. Unlike nitrogen, dissolved phosphorus is more likely to sorb onto sediments, and is not as mobile. Therefore, most discussions of nutrient loads to surface waters from groundwater baseflows focus on nitrogen.

One of the most significant impacts of human development is discharge of toxic contaminants, including VOCs. As described above in Section 3.3.4, approximately 80 percent of the facilities in the SCDHS OPC database discharge to septic systems; approximately 20 percent are located within sewered areas. Nassau County reports a significant decline in VOC levels in groundwater over the past twenty years, which they attribute to the installation of sanitary sewers and other regulatory programs. The County reports that during the mid-1980s, VOCs exceeded 5 µg/L in 50 percent of raw water samples from both upper glacial and Magothy monitoring wells, while VOCs exceeded the 5 µg/L threshold in only 15 percent of samples collected from 2000 to 2003 (NCDPW, 2005). Nevertheless, while some level of VOC removal in the small sewage treatment plants can be expected, they are designed to provide treatment of sanitary wastewater rather than VOCs that may be introduced to the waste stream.

In addition to MTBE, PCE, TCE, and 1,1,1-TCA have been among the VOCs most frequently reported in Suffolk County groundwater and surface waters in recent years. All three have had industrial, commercial and household uses in the past. PCE, a cleaning agent used by over 80 percent of United States dry cleaners and in many household consumer products, is reportedly the most widely detected VOC in groundwater at Superfund sites. In the past, 1,1,1-TCA was used extensively in household products such as adhesives and adhesive cleaners, lubricants, general purpose liquid cleaners and spray degreasers, oven cleaners, spot removers, shoe polish, and fabric finishes; however, it is no longer used in common household products. Manufacture of 1,1,1-TCA after

January 1, 2002 was banned, due to its impact on the ozone layer. Groundwater quality data confirms that levels of 1,1,1-TCA and MTBE have indeed declined as a result of being banned. As a result of regulatory initiatives, and as manufacturers move towards 'greener' products and production alternatives, it is anticipated that potential sources of PCE and TCE will also be reduced.

Nevertheless, these, and other VOCs should be analyzed as part of the County's comprehensive data collection program in an effort to identify the major source(s) of these contaminants to the environment so that the most cost-effective approaches to reduce their release can be identified and implemented.

A comprehensive discussion of the County's expanded efforts to plan, develop and implement a wastewater management program to address nitrogen reduction needs is presented in Section 8 of this document.

3.4 Establishment/Enhancement of Groundwater Monitoring Programs

Monitoring the County's groundwater resource is an essential function in terms of protecting human health (e.g., compliance with MCLs or drinking water standards, early identification of contamination) that should not be compromised. Monitoring data also provides the information necessary to identify areas and/or contaminants of concern and to evaluate cause and effect relationships with respect to sources of contamination and resulting water quality. Summaries of the monitoring programs that should be continued and/or implemented are provided below.

Through the decades, SCDHS has implemented a number of County-wide and focused local groundwater monitoring programs to characterize water quality and water quantity for a wide variety of purposes. These programs have ranged from County-wide evaluations to site-specific investigations and have been implemented to respond to a wide variety of objectives, as indicated by the following examples:

- Monitoring groundwater levels to construct County-wide water table mappings used by builders for site plan development;
- Routine monitoring of water supply wells to confirm that public supplies are in compliance with applicable water quality standards;
- Regional assessments such as the study of groundwater levels and water quality within the SWSD to evaluate the impacts of sanitary sewering;

- Focused studies to assess the impacts of specific land use types such as the program exploring the impacts of vineyards and golf courses on pesticides levels, and
- Site-specific investigations at areas of known or suspected contaminant release to the environment.

Existing data collected over the years is sufficient to provide a baseline with which to track future trends for almost all water quality and water quantity parameters. A County-wide monitoring program should continue to be implemented to provide the data necessary to ably manage and protect the County's groundwater resource, and to assess the success of groundwater management programs.

In general, efficient and successful groundwater monitoring programs need to consider a number of factors, including:

- Aquifer thickness;
- Degree of aquifer confinement;
- Pumping intensity, screened interval and location;
- Aquifer properties; and
- Expected parameter variability.

Because the Suffolk County program is already well established, the recommendations below suggest a continuing program that is focused on the critical issues identified during this study, rather than a program design based on a goal of statistical extrapolation of limited results to the entire County.

Monitoring is broken into two sub-programs addressing water quality and water quantity.

3.4.1 Groundwater Quality Monitoring

The current condition of the aquifer system has been extensively documented through prior and on-going sampling programs that include routine monitoring of community water supply wells by individual water suppliers and the SCDHS, routine monitoring of non-community supply wells, targeted monitoring of private wells in areas of known or suspected contamination, and sampling and analysis of monitoring wells, primarily in areas of known or suspected contamination. Baseline values for a wide range of parameters have been developed, and contaminants of concern have been identified as described in the task 4.1 memorandum. Most PPCPs are not currently

monitored – and in fact, cannot be monitored at this time. There are potentially hundreds, if not thousands of PPCPs and their metabolites and breakdown products that may be released to the environment. Although not all are PPCPs, Chemical Abstracts Services reports that more than 88 million organic and inorganic chemicals have been registered, more than 65 million chemical products are available commercially, and approximately 15,000 new chemicals are added per day (www.cas.org).

It should not be necessary to monitor for all of these parameters, however the subset of compounds with potential human-health impacts that ultimately should be monitored has not yet been identified. In addition, analytical methods to detect the extremely low levels of some PPCPs and their metabolites that may exist in the environment are not yet available. While analytical protocols to detect some PPCPs have been developed, cost effective methods to rapidly detect the presence of many of the other compounds that may be present have not. More information on potential monitoring approaches for PPCP was described in Section 3.3.5, above.

The primary objectives of an on-going water quality monitoring program are to:

- Continue to track and evaluate trends in key water quality parameters such as nitrates, VOCs and pesticides by comparing them to current conditions;
- Identify the main causes of any trends of deteriorating water quality;
- Characterize the extent of any contamination threatening drinking water supplies or downgradient surface water features; and
- Identify emerging contamination concerns and their sources.

It is recommended that this be accomplished by the continued use of data obtained from a variety of sources, including public supply well monitoring and monitoring well sampling and analysis, supplemented by the results of private well sampling and special studies, such as the on-going pesticides monitoring program. All samples should be analyzed for the comprehensive set of parameters that can be provided by the SCDHS PEHL, as summarized on **Table 3-30**. Proposed components of the program are summarized below.

3.4.1.1 Drinking Water Supply Well Monitoring

In accordance with the regulatory requirements of both the Safe Drinking Water Act and Part 5 of the New York State Sanitary Code, SCDHS requires all public suppliers to monitor source water. In general, sampling frequency varies

from quarterly to tri-annually, although suppliers such as the SCWA proactively sample more frequently and for more parameters than are required. The list of parameters is extensive, and includes inorganic compounds, principal organic contaminants, unspecified organic contaminants, and pesticides. The program is described in the Task 7.2 memorandum. SCDHS also monitors each community and non-community source (well) on an annual basis; the program includes testing for many contaminants of concern that do not currently have established drinking water quality criteria.

Because Suffolk County water suppliers obtain their supply from an aquifer overlain by the homes of some 1.5 million residents, it is recommended that SCDHS continue the current drinking water supply monitoring program that exceeds Federal and State monitoring requirements, to continue to ensure that safe potable water in compliance with all applicable criteria is provided to County residents.

Long term SCDHS monitoring data collected from approximately 941 public supply wells, as summarized on **Table 3-31**, provides a good regional perspective on water quality and water quality trends. The wells monitored vary from year to year, but in general provide a very good County-wide distribution of monitoring points. Overall, this component of the program would provide samples from hundreds of monitoring points, including 378 from the Magothy aquifer, the aquifer that provides the majority of the County's public supply. Because there is a long period of record of water quality data collected at public supply wells, it provides a valuable overview of water quality status and trends, allowing assessment of decade's long changes in water quality.

Groundwater quality data obtained from water supply wells can provide a very different representation of water quality than data obtained from monitoring wells. In general, the supply well screens are much longer (e.g., 50 feet or more) than monitoring well screens, and hence characterize a much greater zone within an aquifer. Supply wells withdraw water at a much greater rate than monitoring wells; the water is recharged over a much greater area, and consequently is more likely to reflect water quality from a variety of land use types than a monitoring well. Historical water quality data, as represented by samples from untreated public supply wells, has shown considerable variation over time at some wells (Task 4.1 Groundwater Quality) in response to variations in water supply pumping. In addition, public supply wells tend to be

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES - WATER ANALYSIS

Requestor Name: JOE TEST
Location: 123 MAIN ST., HAUPPAUGE
Sample Location: TEST
Treatment: TEST

Request No.: PR14-0003
Sample Date: 12/15/2014
Sanitarian: SCDHS LABORATORY
Field No.: 001-777-14-12-15

Notes: '<' symbol means "less than" indicating no detection. mg/L = milligrams per liter; ug/L = micrograms per liter. Alkalinity is reported as mg/L as CaCO3. '*' symbol means level found exceeds the maximum contaminant level (MCL), or action level for lead and copper. Moderately restricted sodium diet should not exceed 270 mg/L. Severely restricted should not exceed 20 mg/L. The MCL for nickel is a proposed limit. Any MCL's not shown below have not been established.

		Result	MCL				Result	MCL	
Results for Sample Group: ALDICARB PESTICIDES analyzed by Suffolk County Department of Health Services									
Total Aldicarb (calc)	<	0.		ug/L	Carbaryl	<	0.5	50.00	ug/L
Aldicarb	<	0.5	3.00	ug/L	1-Naphthol	<	0.5	50.00	ug/L
Aldicarb-Sulfoxide	<	0.5	4.00	ug/L	Methomyl	<	0.5	50.00	ug/L
Aldicarb-Sulfone	<	0.5	2.00	ug/L	Propoxur (Baygon)	<	0.5	50.00	ug/L
Carbofuran	<	0.5	40.00	ug/L	Methiocarb	<	0.5	50.00	ug/L
3-Hydroxycarbofuran	<	0.5	50.00	ug/L	Methiocarb sulfone	<	0.5	50.00	ug/L
Oxamyl	<	0.5	50.00	ug/L					
Results for Sample Group: BACTERIOLOGICAL analyzed by Suffolk County Department of Health Services									
TColi	<	ABSENT	ABSENT		EColi	<	ABSENT	ABSENT	
Results for Sample Group: CHLORINATED PESTICIDES analyzed by Suffolk County Department of Health Services									
alpha-BHC	<	0.2	5.00	ug/L	4,4-DDD	<	0.2	5.00	ug/L
beta-BHC	<	0.2	5.00	ug/L	4,4-DDT	<	0.2	5.00	ug/L
gamma-BHC (Lindane)	<	0.02	0.20	ug/L	Endrin	<	0.01	2.00	ug/L
delta-BHC	<	0.2	5.00	ug/L	Endrin aldehyde	<	0.2	5.00	ug/L
Heptachlor	<	0.04	0.40	ug/L	Chlordane	<	0.2	2.00	ug/L
Heptachlor epoxide	<	0.02	0.20	ug/L	Alachlor	<	0.2	2.00	ug/L
Aldrin	<	0.2	5.00	ug/L	Methoxychlor	<	0.1	40.00	ug/L
Dieldrin	<	0.2	50.00	ug/L	Endosulfan II	<	0.2	5.00	ug/L
Endosulfan I	<	0.2	5.00	ug/L	Endosulfan Sulfate	<	0.2	50.00	ug/L
Dacthal	<	0.2	50.00	ug/L	1,2-dibromoethane	<	0.01	0.05	ug/L
4,4-DDE	<	0.2	50.00	ug/L	1,2-dibromo-3-chloropropane	<	0.02	0.20	ug/L
Results for Sample Group: DACTHAL PESTICIDES analyzed by Suffolk County Department of Health Services									
Monomethyltetrachloroterephthalate	<	5.	50.00	ug/L	Tetrachloroterephthalic acid	<	5.	50.00	ug/L
Results for Sample Group: HERBICIDE METABOLITES analyzed by Suffolk County Department of Health Services									
Didealkylatrazine (G-28273)	<	0.8	50.00	ug/L	Dichlorvos	<	0.6	50.00	ug/L
Deisopropylatrazine (G-28279)	<	0.2	50.00	ug/L	Propamocarb hydrochloride	<	0.3	50.00	ug/L
Desethylatrazine (G-30033)	<	0.4	50.00	ug/L	2,6-Dichlorobenzamide	<	0.5	50.00	ug/L
Imidacloprid	<	0.2	50.00	ug/L	Ibuprofen	<	0.2	50.00	ug/L
Imidacloprid Urea	<	0.2	50.00	ug/L	Gemfibrozil	<	0.4	50.00	ug/L
Alachlor OA (Oxanilic Acid)	<	0.4	50.00	ug/L	Metalaxyl	<	0.2	50.00	ug/L
Alachlor ESA (Sulfonic Acid)	<	0.2	50.00	ug/L	Metolachlor	<	0.2	50.00	ug/L
Metolachlor metabolite (CGA-37735)	<	0.2	50.00	ug/L	Tebuthiuron	<	0.3	50.00	ug/L
Metolachlor OA (CGA-51202)	<	0.3	50.00	ug/L	Caffeine	<	0.2	50.00	ug/L
Metolachlor ESA (CGA-354743)	<	0.3	50.00	ug/L	Dinoseb	<	0.3	7.00	ug/L
Metolachlor metabolite (CGA-41638)	<	0.3	50.00	ug/L	Bisphenol A	<	0.2	50.00	ug/L
Metolachlor metabolite (CGA-40172)	<	0.3	50.00	ug/L	Diuron	<	0.2	50.00	ug/L
Metolachlor metabolite (CGA-67125)	<	0.3	50.00	ug/L	Phenytoin (Dilantin)	<	0.2	50.00	ug/L
2-HydroxyAtrazine (G-34048)	<	0.3	50.00	ug/L	4-Hydroxyphenytoin	<	0.5	50.00	ug/L
Malaoxon	<	0.2	50.00	ug/L	Diethyltoluamide (DEET)	<	0.2	50.00	ug/L
Trichlorfon	<	0.3	50.00	ug/L	Acetaminophen	<	0.2	50.00	ug/L
Siduron	<	0.3	50.00	ug/L					
Results for Sample Group: METALS analyzed by Suffolk County Department of Health Services									
Beryllium (Be)	<	0.2	4.00	ug/L	Cadmium (Cd)	<	1.	5.00	ug/L
Aluminum (Al)	<	5.		ug/L	Antimony (Sb)	<	0.2	6.00	ug/L
Titanium (Ti)	<	1.		ug/L	Tellurium	<	0.5		ug/L
Vanadium (V)	<	1.		ug/L	Barium (Ba)	<	1.	2000.00	ug/L
Chromium (Cr)	<	1.	100.00	ug/L	Mercury (Hg)	<	0.3	2.00	ug/L
Manganese (Mn)	<	0.001	0.30	mg/L	Thallium (Tl)	<	0.2	2.00	ug/L
Cobalt (Co)	<	1.		ug/L	Lead (Pb)	<	1.	15.00	ug/L
Nickel (Ni)	<	0.2	100.00	ug/L	Thorium (Th)	<	2.		ug/L
Copper (Cu)	<	5.	1300.00	ug/L	Uranium	<	0.5	30.00	ug/L
Zinc (Zn)	<	5.	5000.00	ug/L	Calcium	<	0.1		mg/L
Germanium	<	0.5		ug/L	Iron (Fe)	<	0.1	0.30	mg/L
Arsenic (As)	<	1.	10.00	ug/L	Iron + Manganese (Combined, Calc)	<	0.	0.50	mg/L
Selenium (Se)	<	1.	50.00	ug/L	Potassium	<	0.1		mg/L
Strontium	<	1.		ug/L	Magnesium	<	0.1		mg/L
Molybdenum (Mo)	<	1.		ug/L	Sodium (Na)	<	1.		mg/L
Silver (Ag)	<	2.5	100.00	ug/L					
Results for Sample Group: PERCHLORATE analyzed by Suffolk County Department of Health Services									
Perchlorate	<	0.2	18.00	ug/L					
Results for Sample Group: RADIOLOGICAL analyzed by Suffolk County Department of Health Services									
Gross alpha	<	1.	15.00	pCi/L	Tritium	<	200.	20000	pCi/L
Gross beta	<	1.	50.00	pCi/L					

RESULTS CONTINUED ON NEXT PAGE....

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES - WATER ANALYSIS

Requestor Name: JOE TEST
Location: 123 MAIN ST., HAUPPAUGE
Sample Location: TEST
Treatment: TEST

Request No.: PR14-0003
Sample Date: 12/15/2014
Sanitarian: SCDHS LABORATORY
Field No.: 001-777-14-12-15

Notes: '<' symbol means "less than" indicating no detection. mg/L = milligrams per liter; ug/L = micrograms per liter. Alkalinity is reported as mg/L as CaCO3. '*' symbol means level found exceeds the maximum contaminant level (MCL), or action level for lead and copper. Moderately restricted sodium diet should not exceed 270 mg/L. Severely restricted should not exceed 20 mg/L. The MCL for nickel is a proposed limit. Any MCL's not shown below have not been established.

RESULTS CONTINUED FROM PRECEDING PAGE

		Result	MCL	
===== Results for Sample Group: STANDARD INORGANICS analyzed by Suffolk County Department of Health Services =====				
pH-Lab	=		su	
Specific Conductivity-Lab	=		um/cm	
Chloride (Cl)	<	3.	250.00	mg/L
Sulfate (SO4)	<	5.	250.00	mg/L
Ammonia (NH3-N)	<	0.5		mg/L
Nitrite (NO2-N)	<	0.1	1.00	mg/L
Nitrate	<	0.5	10.00	mg/L
Bromide	<	0.5		mg/L
Orthophosphate	<	0.5		mg/L
Fluoride	<	0.2	2.20	mg/L
T. Alkalinity	<	1.		mg/L
Hexavalent Chromium	<	0.03		ug/L

		Result	MCL	
===== Results for Sample Group: SEMI-VOLATILE ORGANICS METHOD 525 analyzed by Suffolk County Department of Health Services =======				
1,2,4 Trichlorobenzene	<	0.2	5.00	ug/L
1-Methylnaphthalene	<	0.2	50.00	ug/L
2-Methylnapthalene	<	0.2	50.00	ug/L
Acenaphthene	<	0.2	50.00	ug/L
Acenaphthylene	<	0.2	50.00	ug/L
Acetochlor	<	0.2	50.00	ug/L
Alachlor	<	0.2	2.00	ug/L
Allethrin	<	0.2	50.00	ug/L
Anthracene	<	0.5	50.00	ug/L
Atrazine	<	0.1	3.00	ug/L
Azoxystrobin	<	0.2	50.00	ug/L
Benfluralin	<	0.5	50.00	ug/L
Benzo(A)Anthracene	<	0.5	50.00	ug/L
Benzo(B)Fluoranthene	<	0.2	50.00	ug/L
Benzo(GHI)Perylene	<	0.2	50.00	ug/L
Benzo(K)Fluoranthene	<	0.2	50.00	ug/L
Benzo(A)Pyrene	<	0.02	0.20	ug/L
Benzophenone	<	0.2	50.00	ug/L
Benzyl butyl phthalate	<	0.2	50.00	ug/L
Bis(2-ethylhexyl)adipate	<	0.5	50.00	ug/L
Bis(2-ethylhexyl)phthalate	<	3.	6.00	ug/L
Bisphenol A	<	0.5	50.00	ug/L
Bloc	<	0.2	50.00	ug/L
Bromacil	<	0.5	50.00	ug/L
Butachlor	<	0.2	50.00	ug/L
Butylated hydroxyanisole	<	1.	50.00	ug/L
Butylated hydroxytoluene	<	0.5	50.00	ug/L
Carbamazepine	<	0.5	50.00	ug/L
Carbazole	<	0.2	50.00	ug/L
Carisoprodol	<	0.5	50.00	ug/L
Chlordane	<	0.2	2.00	ug/L
Chlorofenvinphos	<	0.2	50.00	ug/L
Chlorothalonil	<	1.	50.00	ug/L
Chloroxylenol	<	0.2	50.00	ug/L
Chlorpyriphos	<	0.2	50.00	ug/L
Chrysene	<	0.2	50.00	ug/L
Cyfluthrin	<	0.2	50.00	ug/L
Cypermethrin	<	0.5	50.00	ug/L
Dacthal	<	0.2	50.00	ug/L
Deltamethrin	<	0.5	50.00	ug/L
Dibenzo(A,H)Anthracene	<	0.2	50.00	ug/L
Dibutyl Phthalate	<	1.	50.00	ug/L
Dichlobenil	<	0.2	50.00	ug/L
Dichlorvos	<	0.5	50.00	ug/L
Dieldrin	<	0.2	50.00	ug/L
Diethyl phthalate	<	1.	50.00	ug/L
Diethyltoluamide (DEET)	<	0.2	50.00	ug/L
Dimethyl phthalate	<	0.2	50.00	ug/L
Dioctyl Phthalate	<	0.2	50.00	ug/L
Disulfoton	<	0.5	50.00	ug/L
Disulfoton sulfone	<	0.2	50.00	ug/L
Endosulfan Sulfate	<	0.2	50.00	ug/L
EPTC	<	0.2	50.00	ug/L
Ethofumesate	<	0.2	50.00	ug/L
Ethyl Parathion	<	0.2	50.00	ug/L
Fluoranthene	<	0.2	50.00	ug/L
Fluorene	<	0.2	50.00	ug/L
Hexachlorobenzene	<	0.1	1.00	ug/L
Hexachlorobutadiene	<	0.2	5.00	ug/L
Hexachlorocyclopentadiene	<	0.1	5.00	ug/L
Hexachloroethane	<	1.	5.00	ug/L
Hexazinone	<	1.	50.00	ug/L
Indeno(1,2,3-cd)Pyrene	<	0.2	50.00	ug/L
Iodofenphos	<	0.2	50.00	ug/L
Iprodione	<	0.5	50.00	ug/L
Isofenphos	<	0.5	50.00	ug/L
Kelthane	<	0.5	50.00	ug/L
Malathion	<	0.5	50.00	ug/L
Metalaxyl	<	0.2	50.00	ug/L
Methoprene	<	0.2	50.00	ug/L
Methoxychlor	<	0.1	50.00	ug/L
Methyl Parathion	<	0.2	50.00	ug/L
Metolachlor	<	0.2	50.00	ug/L
Metribuzin	<	0.2	50.00	ug/L
Naled (Dibrom)	<	0.2	50.00	ug/L
Naphthalene	<	0.2	50.00	ug/L
Napropamide	<	0.2	50.00	ug/L
Pendimethalin	<	0.2	5.00	ug/L
Pentachlorobenzene	<	0.2	50.00	ug/L
Pentachloronitrobenzene	<	0.2	50.00	ug/L
Permethrin	<	0.2	50.00	ug/L
Phenanthrene	<	0.2	50.00	ug/L
Piperonyl butoxide	<	0.5	50.00	ug/L
Prometon	<	0.5	50.00	ug/L
Prometryne	<	0.2	50.00	ug/L
Propachlor	<	0.2	50.00	ug/L
Propiconazole (Tilt)	<	0.2	50.00	ug/L
Pyrene	<	0.5	50.00	ug/L
Resmethrin	<	0.2	50.00	ug/L
Ronstar	<	0.2	50.00	ug/L
Simazine	<	0.07	4.00	ug/L
Sumithrin	<	0.2	50.00	ug/L
Tebuthiuron	<	0.5	50.00	ug/L
Terbacil	<	0.5	50.00	ug/L
Triadimefon	<	0.5	50.00	ug/L
Triclosan	<	0.5	50.00	ug/L
Trifluralin	<	0.5	50.00	ug/L
Vinclozolin	<	0.5	50.00	ug/L
Total Triazines + Metabolites (Calc)...	<	0.	4.00	ug/L

		Result	MCL	
===== Results for Sample Group: SURFACTANTS analyzed by Suffolk County Department of Health Services ==============================				
Surfactants-MBAS	<	0.1		mg/L

RESULTS CONTINUED ON NEXT PAGE....

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES - WATER ANALYSIS

Requestor Name: JOE TEST
Location: 123 MAIN ST., HAUPPAUGE
Sample Location: TEST
Treatment: TEST

Request No.: PR14-0003
Sample Date: 12/15/2014
Sanitarian: SCDHS LABORATORY
Field No.: 001-777-14-12-15

Notes: '<' symbol means "less than" indicating no detection. mg/L = milligrams per liter; ug/L = micrograms per liter. Alkalinity is reported as mg/L as CaCO3. '*' symbol means level found exceeds the maximum contaminant level (MCL), or action level for lead and copper. Moderately restricted sodium diet should not exceed 270 mg/L. Severely restricted should not exceed 20 mg/L. The MCL for nickel is a proposed limit. Any MCL's not shown below have not been established.

RESULTS CONTINUED FROM PRECEDING PAGE

===== Results for Sample Group: VOLATILE ORGANICS analyzed by Suffolk County Department of Health Services =====

	Result	MCL			Result	MCL	
Chlorodifluoromethane	< 0.5	5.00	ug/L	Ethylbenzene	< 0.5	5.00	ug/L
Dichlorodifluoromethane	< 0.5	5.00	ug/L	o-Xylene	< 0.5	5.00	ug/L
Chloroethane	< 0.5	5.00	ug/L	m & p-Xylene	< 0.5	5.00	ug/L
Bromomethane	< 0.5	5.00	ug/L	m-Xylene	< 0.5	5.00	ug/L
Chloromethane	< 0.5	5.00	ug/L	p-Xylene	< 0.5	5.00	ug/L
Trichlorofluoromethane	< 0.5	5.00	ug/L	Total Xylenes	< 0.5	5.00	ug/L
Vinyl Chloride	< 0.5	2.00	ug/L	2-Chlorotoluene	< 0.5	5.00	ug/L
Methylene Chloride	< 0.5	5.00	ug/L	3-Chlorotoluene	< 0.5	5.00	ug/L
1,1 Dichloroethane	< 0.5	5.00	ug/L	4-Chlorotoluene	< 0.5	5.00	ug/L
trans 1,2 Dichloroethene	< 0.5	5.00	ug/L	Diethyl Ether	< 0.5	50.00	ug/L
Chloroform	< 0.5	80.00	ug/L	Acrylonitrile	< 0.5	5.00	ug/L
1,2 Dichloroethane	< 0.5	5.00	ug/L	Ethyl Methacrylate	< 0.5	50.00	ug/L
1,1,1 Trichloroethane	< 0.5	5.00	ug/L	T. Chlorotoluene	< 0.5	5.00	ug/L
Carbon Tetrachloride	< 0.5	5.00	ug/L	1,3,5 Trimethylbenzene	< 0.5	5.00	ug/L
1-Bromo-2-Chloroethane	< 0.5	5.00	ug/L	1,2,4 Trimethylbenzene	< 0.5	5.00	ug/L
1,2 Dichloropropane	< 0.5	5.00	ug/L	m,p-Dichlorobenzene	< 0.5	5.00	ug/L
Trichloroethene	< 0.5	5.00	ug/L	1,2 Dichlorobenzene (o)	< 0.5	5.00	ug/L
Chlorodibromomethane	< 0.5	80.00	ug/L	1,3-Dichlorobenzene (m)	< 0.5	5.00	ug/L
2-Bromo-1-Chloropropane	< 0.5	5.00	ug/L	1,4-Dichlorobenzene (p)	< 0.5	5.00	ug/L
Bromoform	< 0.5	80.00	ug/L	p-Diethylbenzene	< 0.5	5.00	ug/L
Tetrachloroethene	< 0.5	5.00	ug/L	1,2,4,5 Tetramethylbenzene	< 0.5	5.00	ug/L
cis-1,2-Dichloroethene	< 0.5	5.00	ug/L	1,2,4 Trichlorobenzene	< 0.5	5.00	ug/L
Freon 113	< 0.5	5.00	ug/L	1,2,3 Trichlorobenzene	< 0.5	5.00	ug/L
Dibromomethane	< 0.5	5.00	ug/L	Ethenylbenzene (Styrene)	< 0.5	5.00	ug/L
1,1 Dichloropropene	< 0.5	5.00	ug/L	Isopropylbenzene	< 0.5	5.00	ug/L
Methyl Isothiocyanate	< 2.	50.00	ug/L	n-Propylbenzene	< 0.5	5.00	ug/L
Carbon Disulfide	< 0.5		ug/L	tert-Butylbenzene	< 0.5	5.00	ug/L
Methyl Methacrylate	< 0.5	50.00	ug/L	sec-Butylbenzene	< 0.5	5.00	ug/L
n-Propane	< 2.	50.00	ug/L	p-Isopropyltoluene	< 0.5	5.00	ug/L
1,1 Dichloroethene	< 0.5	5.00	ug/L	n-Butylbenzene	< 0.5	5.00	ug/L
Bromodichloromethane	< 0.5	80.00	ug/L	Hexachlorobutadiene	< 0.5	5.00	ug/L
2,3 Dichloropropene	< 0.5	5.00	ug/L	Methyl-Tert-Butyl-Ether (MTBE)	< 0.5	10.00	ug/L
cis-1,3-Dichloropropene	< 0.5	5.00	ug/L	Naphthalene	< 0.5	50.00	ug/L
trans-1,3-Dichloropropene	< 0.5	5.00	ug/L	1,4-Dichlorobutane	< 0.5	5.00	ug/L
1,1,2 Trichloroethane	< 0.5	5.00	ug/L	Methyl Sulfide	< 0.5	50.00	ug/L
1,1,1,2 Tetrachloroethane	< 0.5	5.00	ug/L	Dimethyldisulfide	< 0.5	50.00	ug/L
1,1,2,2-Tetrachloroethane	< 0.5	5.00	ug/L	Bromobenzene	< 0.5	5.00	ug/L
1,2,3 Trichloropropane	< 0.5	5.00	ug/L	2-Butanone (MEK)	< 20.	50.00	ug/L
2,2 Dichloropropane	< 0.5	5.00	ug/L	Tetrahydrofuran	< 20.	50.00	ug/L
1,3 Dichloropropane	< 0.5	5.00	ug/L	Allyl chloride	< 0.5	5.00	ug/L
Bromochloromethane	< 0.5	5.00	ug/L	Methacrylonitrile	< 0.5	5.00	ug/L
tert-Butyl-Ethyl-Ether	< 0.5	50.00	ug/L	d-Limonene	< 0.5	50.00	ug/L
tert-Amyl-Methyl-Ether	< 0.5	50.00	ug/L	Propanal	< 15.	50.00	ug/L
Benzene	< 0.5	5.00	ug/L	Isobutane	< 2.	50.00	ug/L
Toluene	< 0.5	5.00	ug/L	n-Butane	< 2.	50.00	ug/L
Chlorobenzene	< 0.5	5.00	ug/L				

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Table 3-31 Public Supply Well Monitoring Points

Town	Community Wells[1]			Non-Community Wells[2]			Total
	Upper Glacial	Magothy	Lloyd	Upper Glacial	Magothy	Lloyd	
Babylon	3	64	0	3	0	0	**70**
Brookhaven	79	110	0	13	0	0	**202**
East Hampton	43	5	0	15	0	0	**63**
Huntington	43	58[3]	5	0	0	0	**106**
Islip	14	87	0	0	0	0	**101**
Riverhead	10	14	0	1	0	0	**25**
Shelter Island	13	0	0	11	0	0	**24**
Smithtown	15	42	0	0	0	0	**57**
Southampton	52	24	0	10	0	0	**86**
Southold	54	4	0	11	0	0	**69**
Total	**326**	**408**	**5**	**64**	**0**	**0**	**803**

Notes:
1. Based on wells with nitrogen samples from 2009-2014 in the SCDHS Blacksmith Database, 2014. Not all wells are/were active as of 2014.
2. Based on non-community supply wells in Blacksmith database sampled for nitrogen between 2009-2014.
3. Three wells are designated as being screened into the Raritan, as per SCWA.

sited in areas where good water quality is expected, to minimize any public health concerns and to minimize treatment costs. An assessment of water quality based completely upon untreated samples from public supply wells therefore does not provide a complete picture of aquifer water quality, and it is also important to characterize aquifer conditions based on discrete samples collected from monitoring wells, as described below.

3.4.1.2 Countywide Groundwater Quality Trend Monitoring

Until 1996, SCDHS sampled more than 500 monitoring wells on an annual basis as part of a countywide water quality monitoring program. In recent years, this program has been significantly curtailed due to budget and staffing constraints. It is recommended that this program be resumed, albeit on a more limited basis consistent with available resources, to support the objectives of tracking countywide and aquifer-wide trends in key water quality parameters.

The wells should be distributed throughout the County, considering:

- Greater coverage in areas of greatest use;
- Coverage downgradient of each of the major land use categories;
- At least three wells on the North Fork, three wells on the South Fork, and three wells on Shelter Island;
- Selection of wells that already have a reasonably long sampling history.

The USGS National Water Quality Assessment Program recommends that a minimum of 20 to 30 wells per aquifer or one well per 100 square kilometers is needed to track regional trends in groundwater quality. Given the size of Suffolk County, this would mean at least 60 wells within each of the three major aquifers (Upper Glacial, Magothy, and Lloyd).

Given the current distribution of public supply wells in the County, it is recommended that a monitoring network including sixty wells in the upper glacial aquifer, and approximately a dozen existing wells in the Magothy aquifer be used to supplement the water quality data that SCDHS obtains from the community supply wells on an annual basis, as shown on **Figure 3-49**. The shallow upper glacial aquifer is the first to be affected by contaminants introduced at the ground surface; water quality in the unconfined aquifer presages future water quality of the deeper aquifers. Therefore the greatest number of monitoring wells is proposed for the upper glacial aquifer.

The Lloyd Aquifer is confined by the Raritan Clay, and water supply pumping is limited to water withdrawn from seven wells located in the northwest part of the County. While monitoring the Lloyd aquifer would provide valuable information on the state of the resource, it is not currently one of the highest monitoring priorities. Should the SCWA begin to utilize water from the Lloyd aquifer in the future, a more extensive Lloyd monitoring network should be established at that time.

SCDHS maintains a well drilling crew and equipment that is capable of installing monitoring wells of various depths throughout the County, installing wells and evaluating groundwater quality in offshore areas using an offshore barge that has a mounted Geoprobe unit, and applying all associated Geoprobe tools (geophysics through the resistivity probe, monitoring of VOCs through the membrane interface probe (MIP), etc.). In addition, the SCDHS has their own geophysical tools, including gamma logging capability to evaluate stratigraphy and induction logging to evaluate the location of the saltwater interface in coastal regions.

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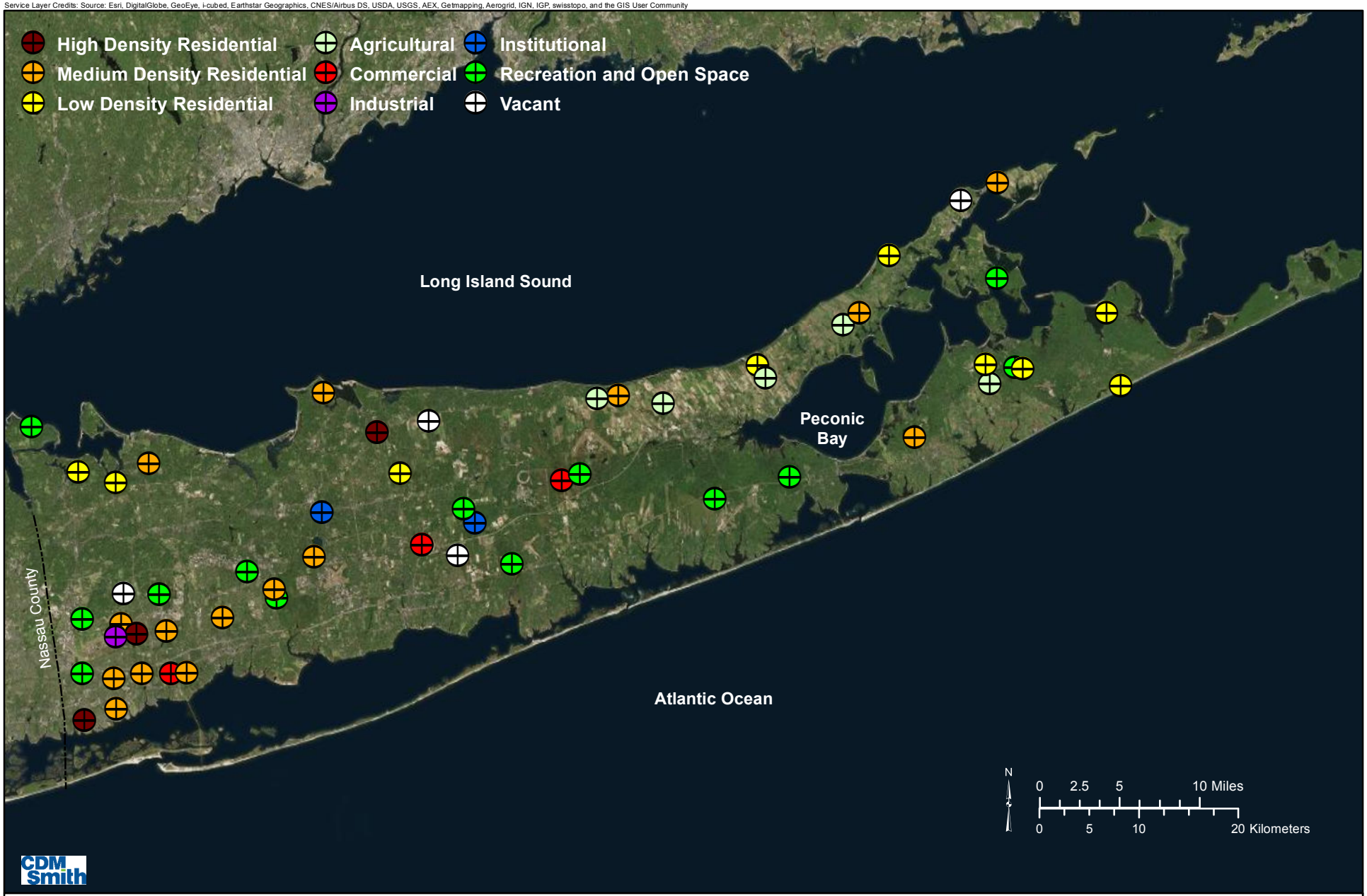


Land Use and Monitoring Wells

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-49

It is recommended that SCDHS consider addition of new monitoring points in uncharacterized zones of the deeper aquifers, such as coastal areas of the north shore, and the Magothy and Lloyd aquifers on the south shore, as time and resources allow. Comprehensive sampling of the wells identified on **Figure 3-49** and **Table 3-31** should occur on an annual basis. The upper glacial wells have been selected to be generally consistent with the percentage of each major land use type present in Suffolk County at this time, as summarized on **Table 3-32**. This sampling should be further coordinated with the surface water monitoring described in Section 5. All samples should be analyzed by the SCDHS Public and Environmental Health Laboratory, for the list of contaminants identified in **Table 3-30**, above.

3.4.1.3 Saltwater Intrusion Monitoring

There are several areas of potential saltwater intrusion, primarily located on the North and South Forks, on Shelter Island, and in other coastal areas of the North Shore. In addition, the saltwater interface in the Magothy aquifer along the south shore is currently located offshore south of the barrier island. The saltwater interface is believed to be slowly moving northward as a result of the long term increase in sea level over the past 18,000 years, as the system moves towards a new equilibrium.

Saltwater intrusion is a relatively slow moving occurrence, with rates of advance generally in the tens of feet per year. The slow advance, combined with the relatively sharp transition from saltwater to fresh water, makes tracking the advance particularly challenging. For most SCWA well locations, upconing is also an important consideration. As of 2014, SCWA closely monitors wells at thirteen wellfields for chlorides and/or specific conductance; these results are reported to NYSDEC.

It is recommended that SCDHS site two saltwater intrusion outpost wells in each of the areas of potential future saltwater intrusion, with one or more wells located as close to the current position of the zone of transition as possible, and one situated between the nearest public supply or group of private wells and the estimated position of the saltwater – fresh water interface. Saltwater intrusion monitoring wells should be constructed of PVC, to allow electromagnetic induction logging along the entire casing to identify any zones of saltwater intrusion. The wells should be screened near the bottom of the aquifer being monitored.

In-situ measurements of specific conductance at saltwater interface sentinel wells using instruments such as the Solinst Levelogger® and associated telemetry system or equivalent would provide useful and timely information relating any movement of the saltwater interface in response to increased

water supply or irrigation pumping to allow for prompt response if appropriate. Alternatively, sampling could be conducted on a quarterly basis, with all samples analyzed for chlorides.

Table 3-32 Monitoring Wells and Suffolk County Land Uses

Land Use Type	Number of Monitoring Wells	Well List (NYSDEC ID or "S-Number")
Low Density Residential	**9**	*1512, 45053, 46962, 48438, 48580, 51582, 58961, 61015, 78170*
Medium Density Residential	**15**	*22660, 45212, 46284, 51578, 52649, 53329, 56347, 62405, 63811, 63823, 64202, 64212, 64853, 66580, 92395*
High Density Residential	**3**	*47974, 56350, 64216*
Commercial/Industrial/Utilities	**4**	*47226, 47756, 64535, 67539*
Institutional	**2**	*47675, 62404*
Open Space	**13**	*43811, 43820, 45718, 47224, 47228, 47232, 48437, 48583, 66134, 67553, 69934, 75441, 92403*
Agriculture	**5**	*10390, 48426, 51567, 51580, 71573*
Vacant	**6**	*47746, 47976,67538, 72782*

Looking ahead to the future, airborne electromagnetic (AEM) geophysics is a relatively new technique that has been used to identify saltwater intrusion in freshwater coastal aquifers in Australia and Italy. Airborne electromagnetics

can increase the data quality and coverage of the occurrence of saline groundwater in tidal and coastal areas, lagoons, estuaries, and river deltas while reducing the acquisition costs and time. The application of airborne electromagnetics for groundwater monitoring and modeling has increased in the past decade due to better systems and processing and inversion methodologies. Airborne electromagnetic systems have increased their penetrating power and their data quality, and application to depths below 300 feet exist (Viezzoli et al, 2009). To date, no successful applications have been identified in the United States, and little about its applicability in developed areas with surface interference has been published. The development and application of Airborne Electromagnetics technology to regional saltwater intrusion studies should be tracked, as it could have potential application for the North and South Forks.

3.4.1.4 Special Studies Monitoring

The County-wide groundwater quality trend monitoring program described above should be kept completely separate from monitoring associated with known or expected areas of contamination so that regional trends, or broader relationships between land use and water quality can be better established. For areas that have been identified as areas of concern, targeted monitoring programs should be established or continued. Wells associated with these areas should have a different identifier, and sampling should be targeted to the specific contaminants that are associated with each area.

Special studies areas are described in more detail below.

Agricultural Area Monitoring – Agricultural monitoring would be primarily focused on the forks. The existing network of shallow monitoring wells in Aquebogue, Jamesport, Orient, Sagaponack and Water Mill that have been sampled on a quarterly basis for nitrates since March 2003 should continue to be sampled and analyzed in March, June, September and December. In addition to nitrates and pesticides, the crop(s) planted in the upgradient fields should be noted during the growing season sampling events, as nutrient requirements and downgradient nitrogen levels are known to be crop-specific. This sampling will be important to assess the effectiveness of AEM programs, and to identify any additional nitrogen and pesticide control needs.

These wells can overlap with the regional water quality network of wells. The number of agricultural wells used in the regional quality study should be limited to approximately five, to maintain the same ratio of agricultural wells to total wells sampled as the ratio of agricultural land use to total land area.

Pesticides Monitoring **–** Pesticides monitoring should continue in accordance with the existing on-going program to continue to monitor levels of pesticides and their degradates in the environment, and to assess any trends resulting from changes in pesticides used, changes in pesticide application resulting from BMP implementation and relationships between crop types and pesticide detections.

Industrial Areas and WWTP Discharge Areas - There have been numerous site investigations associated with known releases of contamination to groundwater. These investigations are designed to identify and map contaminant plumes with the goal of identifying potentially impacted water supplies, and developing remediation strategies to protect public health. The wells installed and sampled as part of these site investigations should not be part of the overall County monitoring program. The results of water quality sampling of wells that are monitored as part of on-going investigations and remedial efforts should be reported to SCDHS DEQ OWR for incorporation into the database.

In other areas where contaminant levels are higher than background and cause for concern, up to three wells specific to each area should be identified and sampled annually. Wells should be located considering the contributing areas of the nearest public supply wells to provide a network of early warning wells where appropriate; well siting should also consider location with respect to facilities identified as "high" priority by SCDHS OPC. Wells associated with investigation of these contaminant areas should be flagged with a separate well identifier from the Countywide monitoring well system.

Based on current land use in the County, only a single well would be included in the set of wells used for regional water quality evaluations, to maintain the same ratio of industrial area wells to total wells sampled as the ratio of industrial land use to total land area in the County.

3.4.1.5 Summary

An overview of a minimum proposed monitoring program is presented here. The monitoring program should be developed in more detail by review of historical monitoring data and assessment of continued well accessibility and integrity. SCDHS should replace wells that are not readily accessible, and wells that do not have significant periods of record with wells within the contributing area of the same land use type that have longer periods of record.

3.4.2 Groundwater Quantity Monitoring

Suffolk County historically has had a very strong water level monitoring program in cooperation with the USGS. This has allowed production of

detailed water level contour maps for the upper glacial aquifer. To assess trends in water quantity, it is important to continue to measure water levels on an annual basis. When combined with stream baseflow measurements, a complete picture of water quantity trends can be documented each year.

3.4.2.1 Water Levels

In the past, quarterly water level sampling was conducted to track seasonal changes as well as annual trends in water levels. This study has shown that consumptive use of water in Suffolk County is relatively low when compared to the amount of water recharged and the extent and depth of the aquifer system. It is, therefore, not necessary to maintain quarterly water level readings for the complete monitoring well network. Currently, SCDHS collects a synoptic set of water level readings from 300 wells each year in March, in coordination with the USGS taking water levels in 125 wells. This program should be continued. Wells in the network that have the longest record of water level readings should be included in particular.

SCDHS should use this information to confirm the continued ability of the groundwater models to reliably represent conditions in the aquifer system. Then, based upon historical precipitation events, the model should be used to simulate the water table elevation resulting from a period of wetter than average non-growing season conditions. This predicted seasonal high water table mapping, supplemented by the required on-site boring information, can then be used by the Office of Wastewater Management as they conduct site plan reviews. In conjunction with groundwater modeling efforts, this data should be utilized to support evaluation of localized flooding in areas such as Lake Ronkonkoma.

3.4.3 Data Management and Reporting

As a minimum, all drinking water, ground water quality and quantity and surface water quality and quantity information should be entered into a new integrated database. Field data should be entered via portable hand held devices (e.g.; tablet such as an iPad or other mobile device) to reduce the time needed for transcription, data entry and data availability. Field and laboratory data should be regularly reviewed after routine uploading. SCDHS DEQ OWR should be responsible for maintaining this database. This database would comprise a portion of the proposed Capital Project 4081, the Environmental Health Information Management System (EHIMS) described by SCDHS that would encompass all of the Environmental Health programs. In addition to the groundwater, surface water and drinking water supply data, the database would incorporate data currently located within 30 different databases, including:

- Community, Non-Community and Bottled Water Supply Plant Inspections
- Private Well Inspection and Sampling
- Groundwater Pollution Investigations and Sampling
- Community Water Supply Plan Review
- Bathing Beaches
- Individual Water and Sewer Construction Plan Review
- Reality Subdivision Water and Sewer Plan Review
- State Pollutant Discharge Elimination System (SPDES)
- Sewage Treatment Plant Monitoring
- Petroleum Bulk Storage Tank Plan Review Inspection and Registration
- Enforcing Toxic and Hazardous Materials Storage regulations, which involve plan review, inspection and permitting of commercial and industrial facilities
- Sampling of Marine and Surface Waters for Chemical, Bacteriological and Algal Quality
- Environmental Remediation
- Public and Environmental Health Laboratory (PEHL) Laboratory Information Management System data integration with water quality databases
- State Environmental Quality Review (SEQR) Reviews

Integration of all of the existing databases addressing water quality and water quantity, as well as the factors affecting water quality and water quantity (e.g., facilities, spills, etc.) into a single database that could be viewed using a GIS interface would provide a number of benefits. For example, all of the datasets could be accessed by any user, instead of limiting access to an individual or group with access to and knowledge of a particular type of software; information currently residing within different databases could be mapped simultaneously to help assess water resource implications, and the data back-

up would protect against the impacts of any hardware malfunctions (e.g., individual personal computer failure) or facility disaster (e.g., paper records).

Alternatively, it could be part of a larger, comprehensive Countywide database as recommended by IBM's Smarter Cities Challenge Report. The data would be readily available to all departments within the County to help to identify public health concerns and water resources issues, to identify appropriate management actions, to assess priorities and guide decision making. This data would be readily accessible so that queries relating to ground or surface water quality or data trends can be readily answered, issues can be rapidly and appropriately addressed, and the County can have the information to develop responses to long range concerns such as sea level rise. Finally, the data should be made available to other stakeholders outside the County such as SCWA, NYSDEC, the estuary programs, etc., so that timely decisions can be made based on the best available information.

It is recommended that SCDHS prepare a concise annual report summarizing the results of the countywide groundwater and surface water quality and quantity monitoring.

The report should contain, at a minimum, the following information:

- Background information on precipitation over the sampling period;
- Water supply pumping from each of the major water use categories, and monthly pumping from community supplies;
- Mapping of ground water levels, and figures depicting baseflow and stream flow; figures showing groundwater baseflow as a percentage of total stream flow;
- "Dot plot" type graphics depicting countywide water quality within each aquifer for each parameter of concern (e.g., nitrates, most often detected VOCs, pesticides, PPCPs);
- Statistics on water quality comparing annual water quality with baseline (1987, 2005 and 2013) years (baseline year dependent upon parameter of concern);
- Trend graphs of contaminants of concern for selected indicator wells, as well as trends in the minimum, mean, and maximum concentrations from all the wells;
- Water level graphs of selected indicator wells showing trends;

- Saltwater interface monitoring results depicting chloride concentrations with time;
- Results of nitrogen and pesticide analyses in monitoring wells characterizing agricultural areas;
- Identification of any newly observed contaminants of concern for future targeting;
- Tables summarizing surface water quality data identifying any contaminants of concern identified;
- Figures depicting trends in nitrate concentrations at sampling stations in the Long Island Sound, Peconic Estuary and South Shore Estuary; and
- Tables summarizing water quality data at the estuary program sampling locations and figures showing time histories of nitrogen and dissolved oxygen at key estuary program sampling locations.

In addition, each document should identify the apparent most significant issues affecting the resource and identify any additional priorities for monitoring and/or research.

Over the years, new monitoring tools and improved analytical capabilities have facilitated the identification of increasing numbers of contaminants in the environment, and the presence of these constituents can be detected at lower and lower concentrations. In addition, new tools and more powerful computer capabilities have facilitated the synthesis of various types of data and information (e.g., GIS information, groundwater modeling output and groundwater quality data for example) and are conducive to presentation of data and results in comprehensive graphical representations, which are more robust and much faster to produce than in years past. The need to utilize and enhance the ability to use, analyze and share data within a GIS framework has previously been documented in the draft 2010 Comprehensive Water Resource Management Plan and supporting task memoranda going back as far as 2008.

As appropriate, the data should be used to update the groundwater models, and for model application to:

- Support site investigations;
- Evaluate impacts of changing conditions (e.g., simulation of the impacts of sea level rise on the water levels and the saltwater

interface, simulation of the impact of drought on water levels, stream base flows and saltwater interfaces);

- Evaluate remedial alternatives;
- Delineate source water areas for new or proposed wells;
- Assess the impacts of proposed developments on downgradient water quality, in accordance with the procedure documented in the Task 5.2 memorandum (Future Land Use Impacts, CDM 2008).

It is presumed that the County would assign a groundwater model caretaker (it would be appropriate for this professional to be assigned to SCDHS DEQ OWR) who would also review the modeling section of any reports (e.g., remedial investigations/feasibility studies, remedial design reports, etc.) submitted for County review. A single individual would fulfill both the model caretaker function and would support other on-going County programs. A brief summary of the model revisions and subsequent verification of the model calibration should be prepared for incorporation into the annual groundwater and surface water quality report. The monitoring report should be distributed to other County agencies, NYSDEC, SCWA and water suppliers to support their resources management efforts and should also be made available electronically via the Suffolk County website.

3.5 Public Outreach and Education

Because Suffolk County residents live within the recharge areas for all of the public supply wells and surface water resources, it is critical that all take an active role in protecting these resources. A wide variety of public education and outreach programs are already in place at the federal, state, County and local levels to address topics such as stormwater pollution, lawn fertilization, conservation, proper use and disposal of hazardous household wastes and pharmaceuticals and personal care products, etc. However, the slow increase in nitrate levels in our aquifers, the continued detection of low levels of various contaminants in the ground and surface waters and the increasing demands upon the water supply infrastructure for landscape irrigation indicates that a more assertive effort is required.

A report prepared in 2005 by the National Environmental Education & Training Foundation (NEETF) entitled **Environmental Literacy in America** reported that 78 percent of the American public does not understand that runoff from agricultural land, roads, and lawns is now the most common source of water pollution and nearly half of Americans (47 percent) believes that industry accounts for most water pollution. Similar questions were posed

to residents of the Long Island Sound watershed as part of a survey conducted in 2006 by the Stony Brook University Center for Survey Research as part of a USEPA grant. The results were analyzed by resident location; 49 percent of Long Island respondents believed that waste dumped by factories is the main source of water pollution. The role of personal responsibility and environmental stewardship needs to be emphasized in the County's public outreach efforts, given our dependence on our groundwater supply, and the significance of our surface waters must be more widely conveyed.

The Task 10 memorandum described a number of existing and overlapping public education programs, and identified a variety of potential enhancements. Overall, the existing programs are reaching a very small percentage of the County's 1.5 million residents. The IBM Smarter Cities Challenge Report (IBM, 2014) also identified the need for the County to engage County residents and visitors to embrace their role as stewards of water quality and motivating them to take action. A more ambitious approach is required and recommended here.

It is recommended that the SCDHS re-establish their public outreach and education program. The coordinator should work closely with the Suffolk County Department of Public Works (SCDPW, stormwater program), the SCDEE (fertilization program), the water suppliers (conservation programs), the Long Island Sound (LIS), Peconic Estuary Program (PEP) and South Shore Estuary Reserve (SSER) program coordinators, and the Towns (Stop Throwing Out Pollutants, STOP), to identify opportunities to leverage outreach opportunities and venues and coordinate water resources protection messages. Development of a school-based program is recommended to reach hundreds of thousands of residents annually. Members of this target audience will bring the message home to their families to further disseminate the information and hopefully motivate broad-based changes in behavior throughout the County. As the students themselves age, the information will be part of the knowledge base that motivates their behavior.

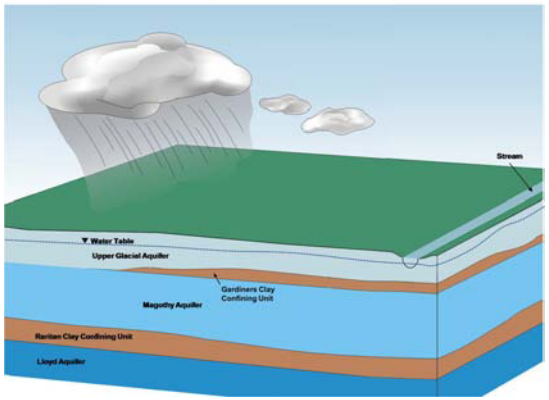
Initially, a series of at least three lesson plans (for primary school, middle school and Earth Science target audiences) should be prepared and provided to all school districts in the County, either for integration into the science curriculum, or for delivery on Earth Day. The 45-minute sessions could be developed using materials already available at http://www.epa.gov/epahome/students.htm ,http://water.usgs.gov/education.html, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=8&minmeasure=1), http://www.classroomearth.org, the National Environmental Education Foundation website (http://neefusa.org/programs/classroom_earth.htm), the Water Environment

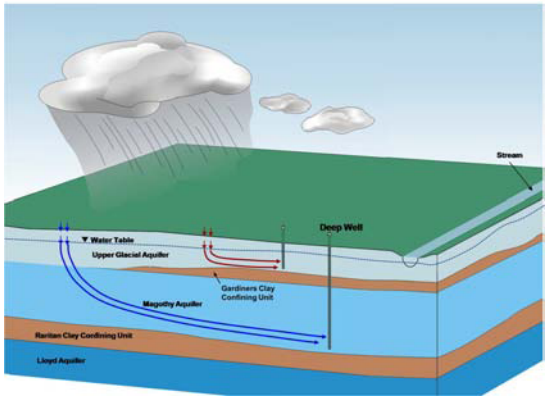
Federation website or estuary program websites such as longislandsoundstudy.net. Materials obtained from these websites could also be modified to PowerPoint-based presentations using Suffolk County-specific materials. An example simple set of PowerPoint slides that could be used to introduce the County's source of potable water, how human activity can impact groundwater quality, and groundwater's contribution to stream baseflow is provided by **Figure 3-50**.

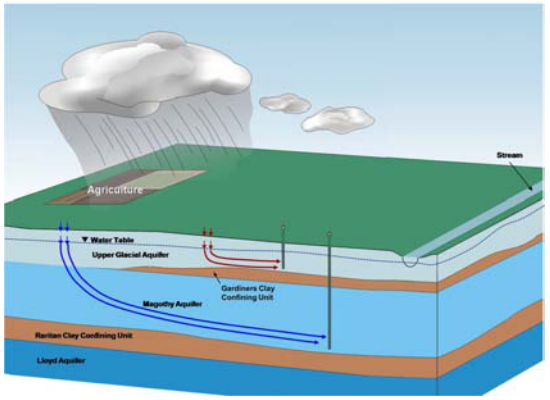
Each year's lesson should begin with a brief 'quiz' or survey to assess both the knowledge and the behavior of the student with respect to water resources. The knowledge assessment portion of the survey would include questions such as "Where do you get your water from?" the behavior assessment section of the survey would pose questions such as "How often do you clean up after your dog?" and "Do you water your lawn every day?" Survey questions should be grade-appropriate.

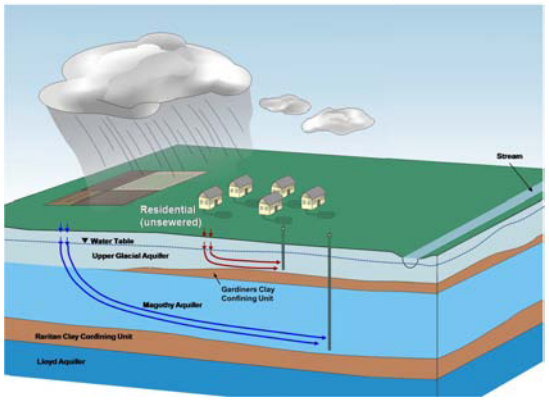
The lesson plans should address:

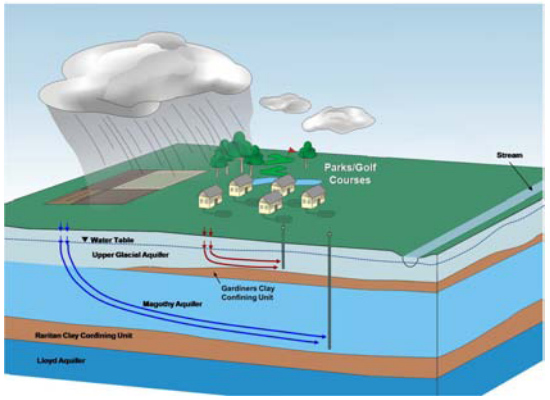
- Overview of the importance of clean water;
- Overview of Suffolk County water supply, the Suffolk County aquifer system and water cycle;
- Overview of the County's surface water resources;
- Example of how above-ground activities affect groundwater quality and surface water quality, including introduction to stormwater runoff and wastewater disposal;
- Identification of specific actions that students and their families should take to protect and preserve ground and surface water resources;
- Visual aids and discussion opportunities – students respond better to seeing things/stories than words on paper;
- Use of hands-on activities, including lab or field work if possible to engage the students; and
- Hands-on homework, such as identifying the nearest storm drain to their home, or completing one of the on-line activities on the USEPA website.

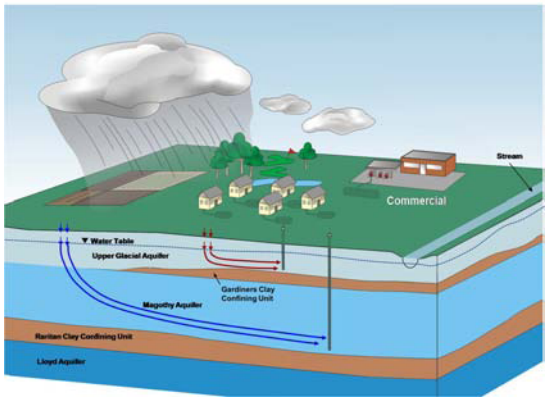


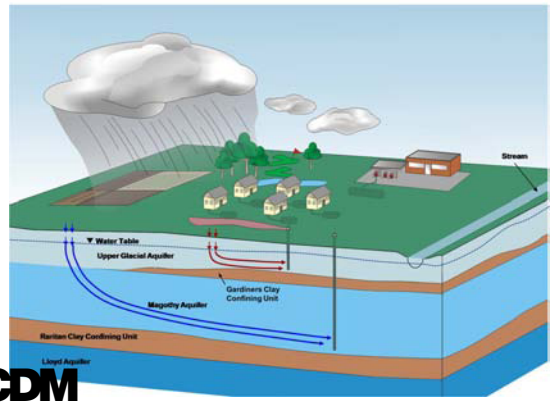


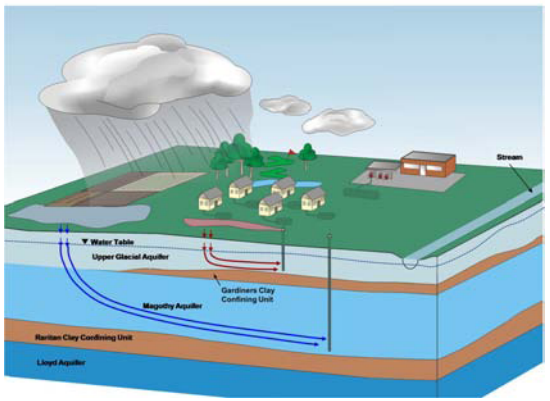


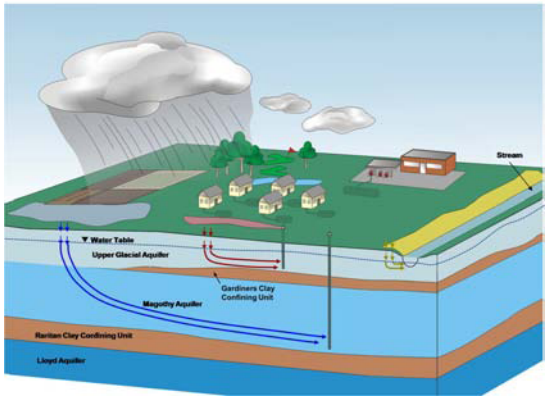












CDM

Sample Power Point Lesson:
Potential Groundwater Pathways to Supply Wells & Surface Waters

Suffolk County Comprehensive Water Resources Management Plan

Figure 3-50

Classes should close with another quiz or survey. While the knowledge assessment would remain the same as prior to the lesson, to assess how effectively the lesson was in communicating the material to the students, the behavior assessment would be slightly different than the pre-lesson assessment. The post-lesson behavior questions would be posed as "how likely are you to clean up after your dog?" and "how often will you water your lawn?"

Both the pre-lesson and post-lesson survey should be comprised of multiple choice questions (e.g. how often do you clean up after your dog would be answered all of the time, most of the time, some of the time, hardly ever, or never) so that they can be readily scored. The results should be compiled on a grade and district basis, and forwarded to the County's public education coordinator.

The survey results should be monitored to assess the program's success, to identify the knowledge base of each age group, to identify existing behavior's contributing to pollution, and to modify subsequent year's messages to achieve the desired outcomes.

3.6 Summary of Recommendations

Groundwater management recommendations are summarized on **Table 3-33.**

Table 3-33 Groundwater Protection Recommendations

Table 3- 33
Groundwater Protection Recommendations

Undeveloped Areas

Within the existing Suffolk County Open Space Preservation planning context, parcels within the 50 year contributing area to public supply wells should be identified and assigned a high priority for purchase, particularly when there is a significant opportunity to protect and preserve existing groundwater quality.

Consider modifying Article 6 to require one acre density throughout all hydrogeologic zones, *unless* provision is made for a higher level of treatment than is provided by a typical on-site wastewater treatment system, or, the development rights from existing undeveloped open space controlled by the developer are transferred, in accordance with SCDHS standards. This would be subject to a zone-specific evaluation considering the extent and location of affected areas, resulting benefits, and costs in relation to other management alternatives.

SCDHS TDR standards should be re-evaluated to ensure protection of areas contributing recharge to public supply wells. Development rights should not generally be transferred into a public supply well contributing area without a local offset; and no more than two dwelling units per acre should be considered unless provision is made for a higher level of treatment than is provided by a typical on-site wastewater treatment system.

Existing Developed Areas (*Wastewater Management Recommendations are Described in More Detail in Section 8 of this Document)*

SCDPW should complete the alternative on-site wastewater management system pilot program and develop a range of approvable advanced alternative on-site wastewater treatment options for residential and non-residential applications.

The results of SCDHS and SPDPW wastewater management studies should be used along with the GIS-mappings of areas contributing recharge to public supply wells and relationships between density and nitrate levels developed during this study in a County-wide wastewater planning study that considers density, conventional and alternative wastewater treatment collection and treatment systems, alternative on-site systems, and operational and maintenance guidelines for existing on-site systems. Any additional high priority areas within the County where a new approach to wastewater treatment and disposal is required to achieve groundwater quality criteria for nitrates should be identified.

SCDHS OWM should continue to maintain active involvement with small sewage treatment plant system manufacturers, owners and operators, to maintain compliance with 10 mg/L nitrate effluent limits.

The effectiveness of Local Law 41-2007 in reducing groundwater nitrogen levels should be carefully evaluated and documented. If it does not achieve the objective of reducing fertilization by 10 to 25 percent, Peconic Estuary Program fertilization recommendations should be implemented on a County-wide basis.

Farmers that participate in County preservation programs, purchase of development rights, and other programs should be encouraged to participate, by agreement, in the AEM program and implement BMPs to reduce nitrogen release to groundwaters.

Table 3- 33 (Continued)
Groundwater Protection Recommendations

VOC Reductions

The SCDHS Office of Pollution Control should continue to implement the VOC Action Plan, to identify and inspect high priority facilities, initiate enforcement actions to bring non-compliant facilities into compliance and implement clean-up activities as necessary. Inspection priorities should be reassessed annually.

The SCDHS OPC Reducing Toxics Capital Program should be implemented to develop an approach to prioritize inspection of facilities using, storing or disposing of regulated contaminants, inspect the facilities in accordance with the established approach, and initiate enforcement and clean-up activities. Inspection of facilities within the 50-year source water area of supply wells with high or very high susceptibility to VOC impacts should be prioritized.

The SCDHS should continue to identify the sources of observed VOC contamination, identify source reductions and investigate the role of household products. If residential areas are identified as significant sources, the County should respond by:

- Incorporating information on the types of household products that may contain VOCs, and preferred alternatives into the education and outreach program
- Increasing awareness of and participation in Town STOP programs
- Identifying viable alternatives to harmful products and incorporating information on appropriate use and disposal of household products using VOCs into the public education and outreach and school curricula development programs

Pesticides

The County should work with NYSDEC to develop a comprehensive pesticide management strategy, including establishment of a pesticide rating/testing system guiding registration and re-registration.

The County should continue to update the Agricultural Stewardship Program.

Farmers that participate in County preservation programs, purchase of development rights, and other programs should be encouraged to participate, by agreement, in the AEM program and implement BMPs to reduce pesticide release to groundwaters.

Alternative pest management approaches or products should be identified to provide the agricultural community with safer alternatives to protect both groundwater quality and crops.

Outreach and education should be conducted to increase public and commercial applicator awareness of pesticide impacts and encourage use of safer replacements when possible.

Table 3-33 (Continued)
Groundwater Protection Recommendations

Pharmaceuticals and Personal Care Products

Existing PEHL analytical methods should be expanded to include the PPCPs cotinine, diltiazem, hydrochlorothiazide, meprobamate, metropolol, naproxen, 4-nonylphenol, phenobarbital, sulfamethoxazole, tramadol, Tributylphosphate (TBP), Triphenylphosphate (TPP), Tri (2-butoxy-ethyl) phosphate (TBEP), Tri (2-chloro-ethyl) phosphate (TCEP), Tri (2-dichloroisopropyl) phosphate (TDPP) and the Ames test.

A targeted monitoring program, possibly focusing on wells downgradient of laundromats, hospitals and nursing homes, should be conducted to assess the level and extent of any PPCP contamination using a similar approach as developed for the Pesticides Monitoring Program.

Findings from other jurisdictions should be reviewed and assessed to guide water management and policy decisions.

Public outreach and education efforts encouraging appropriate disposal of pharmaceuticals should be continued.

Groundwater Monitoring Programs

The existing Drinking Water Supply Well Monitoring program should be continued.

The Countywide groundwater quality trend monitoring program should be reinstated to assess trends, provide early warning of water quality concerns, and assess Plan effectiveness in improving groundwater quality.

Saltwater intrusion monitoring should be initiated to identify any impacts of water supply or irrigation pumping, drought, or sea level rise on the saltwater interfaces.

The existing Agricultural Area Monitoring program should be continued.

A targeted program of monitoring industrial areas and sewage treatment plant discharge areas should be implemented to better quantify the impacts of these land use types and wastewater management alternatives upon groundwater quality.

The existing cooperative annual water level monitoring program with USGS should be continued to assess trends in water levels and identify any flooding, drought and sea level rise impacts. The predicted high water table should be modeled.

Table 3-33 (Continued)
Groundwater Protection Recommendations

Database Development and Reporting
A new user-friendly, integrated geo-spatially referenced database should be developed to include all well, pumping, water quality, facility and discharge information so that data can be readily accessed and shared with stakeholders. This comprehensive database should be integrated with surface water data and wastewater management data (inspection records, discharge monitoring reports, on-site wastewater management systems).

Annual reports on groundwater quality should be published.

Health impacts of closed sites with groundwater contamination should be re-evaluated considering the vapor pathway.

SCHDS should use new data to update the County's groundwater models, apply the models to evaluate water resources issues, update the Source Water Assessment Evaluations (SWAP) as appropriate and share the results with stakeholders by incorporation into the annual water quality reports.

Public Outreach and Education
Suffolk County should coordinate with federal, state and local stakeholders, the three estuary programs and water suppliers to leverage public education and outreach concerning water resources protection, non-point sources, conservation, household hazardous waste, PPCPs, fertilization, etc. The County should work with Suffolk County schools to integrate specific lesson plans into Earth Day and Earth Science curricula throughout the County.

3.7 Implementation

3.7.1 Implementation Framework

The framework for implementation of the groundwater resource management recommendations is included in Section 9. The recommendations are intended to provide the framework to guide groundwater quality protection in the years ahead, within the context of adaptive management. **Table 9-1** identifies the "owner", or entity responsible for initiating and coordinating implementation of each key milestone that must be achieved or action that must be taken to fully implement each recommendation, along with other stakeholders or collaborators whose participation will be required. The time frame for implementation of each recommendation is identified as short term (less than five years), medium (five to ten years) or long term (over ten years). Successful implementation of each recommendation is subject to a variety of variables, including funding availability, as well as other factors that will influence the timing of implementation, or even whether the recommendation can be fully implemented (e.g., community support). Most of the key activities associated with protection of groundwater quality have already been initiated.

It is the County's intention that this table provide a flexible framework to guide water resource management, acknowledging that implementation of each recommendation is likely to be affected by changing priorities and opportunities and the availability of key resources, including funding.

The recommendations to improve groundwater quality will also support the ability to provide a safe and reliable potable supply to Suffolk County residents (please see Section 4). Because the County's surface waters are groundwater fed, implementation of recommendations to improve groundwater quality will also help to improve surface water quality (please see Section 5). Recommendations to implement wastewater management are explained in detail in Section 8 and a complete set of recommendations may be found in Section 9 of this Plan. There are numerous direct and indirect costs and benefits associated with various Plan recommendations. A comprehensive analysis of these costs and benefits was out of the scope of this Plan, and should be further explored as implementation of individual recommendations is considered, to the extent practicable.

Clean potable water supply and sanitation are often cited as the most important needs in developing countries and as the most effective means of protecting public health. Due to the efforts of water resource managers on federal, state, county and local levels, Suffolk County residents have access to both. It is critical that County residents do not take access to a safe, reliable supply of clean water for granted; it will continue to be

available only to the extent that existing regulations are enforced and enhanced as necessary to protect the aquifer from contamination.

When the British Medical Journal polled experts in 1999 about what they considered to be the greatest medical advance since 1840 (the year the Journal's precursor began publishing), the majority picked public sanitation, ranking it above both antibiotics and anesthesia. "Without a doubt, the widespread adoption of sanitation systems and indoor plumbing in the early 20th century was the most significant innovation in nearly doubling the average lifespan of Europeans and Americans, rapidly decreasing deadly diseases and creating a healthier, more comfortable living environment for the modern world" and "Experts in the early 1900s estimated that public sanitation systems saved thousands, perhaps millions of lives by preventing the spread of infectious diseases" (Hutchinson, 1999). Johan P Mackenbach, professor of public health at the University Medical Center Rotterdam in the Netherlands quantified the benefits of public supply and sanitation in that country, "In the Netherlands .... the first large municipality with piped drinking water was Amsterdam (1854) .... by the end of the century around 40 percent of Dutch people had piped drinking water, and in the early 20th century sewerage systems covered more than half the population. Between 1870 and 1970 age standardised mortality in the Netherlands fell by almost 75 percent. "

The cost to Suffolk County associated with implementation of the groundwater resource management recommendations will be primarily associated with:

- Implementing the sewering and on-site wastewater management programs described further in Section 8 of this document
- Continuing to fill vacant positions/restoring positions within the County to fully implement the VOC Action Plan and Reducing Toxics programs, and pesticide and PPCP initiatives as well as enhancement of existing monitoring programs in response to changing needs and priorities (e.g., increase the analyses that can be performed by the PEHL) and
- Funding Capital Project 4081 to establish and implement an integrated data management program, to:
  - Improve efficiency and effectiveness;
  - Enhance collaboration with other stakeholders
  - Support public outreach and education opportunities.

Full implementation of Plan goals is a long-term process, which will need to be accomplished in phases. It will require coordination and collaboration with agencies and organizations on the federal, state, county and local level, a careful reevaluation of resource allocation issues, and will also necessitate exploring grant opportunities and other innovative and alternative funding mechanisms. Suffolk County should continue to work with state and federal agencies and stakeholders to explore implementation options to cost-effectively execute Plan recommendations.

Water quality management includes water quality protection through improved methods of collecting, organizing, evaluating and communicating data and facility inspections to County water resource managers and to other agencies and water purveyors. Prevention of releases of contamination to groundwater by improved and more efficient inspection, record keeping and communication helps to preserve the integrity of the aquifer through prevention of contaminant releases.

Protecting the resource by prevention of contaminant releases is typically much more cost effective than the cost of clean-up or the cost of a lost resource.

Protecting the resource by prevention of contaminant releases is typically much more cost effective than the cost of clean-up or the cost of a lost resource. EPA has documented the average cost of clean-ups of a variety of types of contaminated sites, ranging from the least costly category, underground storage tanks at $125,000/site, to drycleaners at $403,000/facility, through Manufactured Gas Plants (MGPs) whose clean-ups typically range from $3M to $10M/site to RCRA corrective actions that averaged $11.4M/facility. The average cost of operating a pump and treat system to remediate a DNAPL site was reported as $10M (EPA, 2004). Given the number of these sites that are undergoing cleanup in Suffolk County (over 100 listed Superfund sites, and over 200 sites remediated annually under SCDHS oversight, avoiding Superfund listing), the above remediation costs are clearly well in excess of the costs of programs targeted at prevention and management.

From a strictly economic viewpoint, it is clear that investment in the resources to inspect, monitor and regulate facilities with the potential to introduce contamination to the environment will reduce the need to spend significantly more funds to remediate a site and/or mitigate impacts.

SCDHS's well drilling crew's ability to respond quickly and effectively to well drilling needs has enabled them to support groundwater projects for a variety of cooperators, including:

- Cornell Cooperative Extension
- New York State Department of Environmental Conservation
- New York State Department of Health
- Peconic Estuary Program
- Riverhead Water Authority
- Southampton University
- Suffolk County Department of Parks
- Suffolk County Department of Public Works
- Suffolk County District Attorney's office
- Suffolk County Water Authority
- SUNY at Stony Brook
- Town of Islip
- Town of Shelter Island
- Town of Southampton
- United States Department of Agriculture
- United States Drug Enforcement Agency
- United States Environmental Protection Agency
- United States Geological Survey

The County's ability to mobilize quickly and investigate the impacts of contaminant releases in a timely manner provides a significant public health benefit.

3.7.2 Implementation Responsibilities

Responsibilities for many of the groundwater resources management activities identified are currently shared by a number of agencies, on the federal, regional, state, county, town and local levels as previously documented in the Task 2.1, 2.2, 2.3 memorandum. Suffolk County has the authority to implement many of the groundwater protection recommendations identified in Section 9 and most of the groundwater protection recommendations would be implemented by SCDHS, SCDEDP and SCDPW. Other key collaborators who will support implementation efforts include SCWA, USEPA, USGS, NYSDOH, NYSDEC, Towns, Estuary programs and Cornell Cooperative Extension of Suffolk County.

Water quality data shows that groundwater quality has continued to decline despite management efforts on the federal, state, county and local levels, indicating that additional efforts and continued vigilance will be essential to protect and preserve the resources for continued use and enjoyment by future generations. It is essential that the County take a long term view with respect to water resource protection, as there will be no quick-fix solutions available if the current trends are permitted to continue.

With the regulatory authority provided in the Suffolk County Sanitary Code, SCDHS currently has the primary responsibility for implementing most of the recommendations identified. The IBM Smarter Cities Report has recommended that water resource management responsibilities be centralized under a single coordinator. While many other agencies share responsibility for various aspects of water resources management, continue to play very significant roles in water resource protection, and may administer similar overlapping programs, it is recommended that a single agency have primary responsibility for program coordination. Clearly defined roles and responsibilities will help to ensure that the work is completed as required to protect the County's water resources. SCDHS has an established framework for groundwater monitoring and data collection, regulatory authority to monitor drinking water supplies and potential point sources of contamination, and the capability of using powerful tools such as computer models and GIS to evaluate most contemporary water resources issues.

Nearly all of the proposed groundwater resource management recommendations are targeted to begin implementation in the short term; e.g., within five years. In fact, the County has already initiated many key actions (e.g., initiating identification and piloting of alternative on-site wastewater treatment systems). Nevertheless, full implementation of groundwater resources management recommendations is likely to take decades, and will also be contingent upon available resources.

Nonetheless, all agencies involved with water resources management must be responsible for sharing the information and the results of their evaluations to inform and guide programs being implemented under the auspices of County agencies, State and Federal regulators, Town and village governments, and water suppliers. Ready access to accurate information is increasingly important given the ramifications of land use and policy decisions that rely upon accurate and timely data and data interpretation.

3.7.3 Assessment Monitoring

Implementation monitoring has two objectives:

- To monitor implementation of the Plan recommendations, and
- To monitor the effectiveness of the Plan recommendations in achieving the Plan goals and objectives.

Specific groundwater management recommendations generally fall into one of

Implementation of the recommendation identified in the framework will be monitored. Monitoring has two objectives:

- To monitor implementation of the Plan recommendations, and
- To monitor the effectiveness of the Plan recommendations in achieving the Plan goals and objectives.

It is important to monitor the effectiveness of the Plan recommendations in achieving the stated goals and objectives, focusing on measures of progress that are quantifiable; the USEPA has reported that if indicators cannot be measured, then it is not possible to identify progress towards achieving goals. The effectiveness of these recommendations in achieving water resource protection goals and objectives will be assessed according to key performance indicators, summarized in **Appendix K**.

Annual monitoring of Plan effectiveness and early assessments of Plan effectiveness will allow the County to modify their approach within an adaptive management framework and make improvements as necessary – ineffective actions and programs should be discarded and those recommendations that are most effective can be further enhanced.

Well Number: **S-109750**

Owner (Purveyor): SCWA
Owner's Well Designation (Local #): 1
Location (Site Name): LANDSCAPE DRIVE
Town: Babylon
Screened Interval (MSL): -571.7 To -632.2
Aquifer: Magothy
Depth (ft below ground surface): 814
Simulated Pumping Rate (gpm): 325.3193
Minimum Time of Travel (Yrs): 34.4
Subgrids used in Model: 5

Table S-109750-1: Land Use Summary

Land Use Type	Land Use Area (Acres) in Time Of Travel							
	2	5	25	50	75	100	Total	%
Institutional Sewered				1.84	0.03	0.00	1.87	0.5
Institutional Unsewered					11.24	17.07	28.32	8.3
Low Density Residential Sewered				11.74	2.08	0.00	13.82	4.1
Low Density Residential Unsewered				7.62	73.47	0.40	81.48	23.9
Medium Density Residential Sewered				76.82	11.30	0.00	88.11	25.9
Medium Density Residential Unsewered				9.43	24.43	26.44	60.30	17.7
Open Space				11.63	9.73	33.03	54.38	16.0
Transportation				3.17	3.20	5.86	12.23	3.6
Totals				**122.24**	**135.47**	**82.80**	**340.51**	

Table S-109750-1A: Contaminant Prevalence Summary By Land Use

Contaminant Category	By Land Use				
	2	5	25	75	100
Nitrates					M
Pesticides				L	L
VOCs					L

Table S-109750-2: Potential Point Sources of Contamination

Source Type	# of Sources in Time Of Travel						
	2	5	25	50	75	100	Total
Petroleum Bulk Storage Facility				1			1
Totals				**1**			**1**

Table S-109750-2: Potential Point Sources of Contamination (Contd.)

Time Of Travel (Years): **50**

State ID #	Type	City	Zip
	PBSF	Huntington	

Table S-109750-3: Contaminant Prevalence Summary

Contaminant Category	By Land Use					By Point Source					Combined				
	2	5	25	75	100	2	5	25	75	100	2	5	25	75	100
Nitrates					M					L					M
Pesticides				L	L				L	N				L	L
VOCs					L					H					H

Table S-109750-4: Well Sensitivity

Contaminant Category	Sensitivity				
	2	5	25	75	100
Microbials	H	M	L		
Nitrates					H
Pesticides			H	M	L
VOCs					H

Table S-109750-5A: Well Susceptibility Determination

Contaminant Category	Susceptibility				
	2	5	25	75	100
Microbials			L		
Nitrates					H
Pesticides				L	L
VOCs					VH

Table S-109750-5B: Well Susceptibility Summary

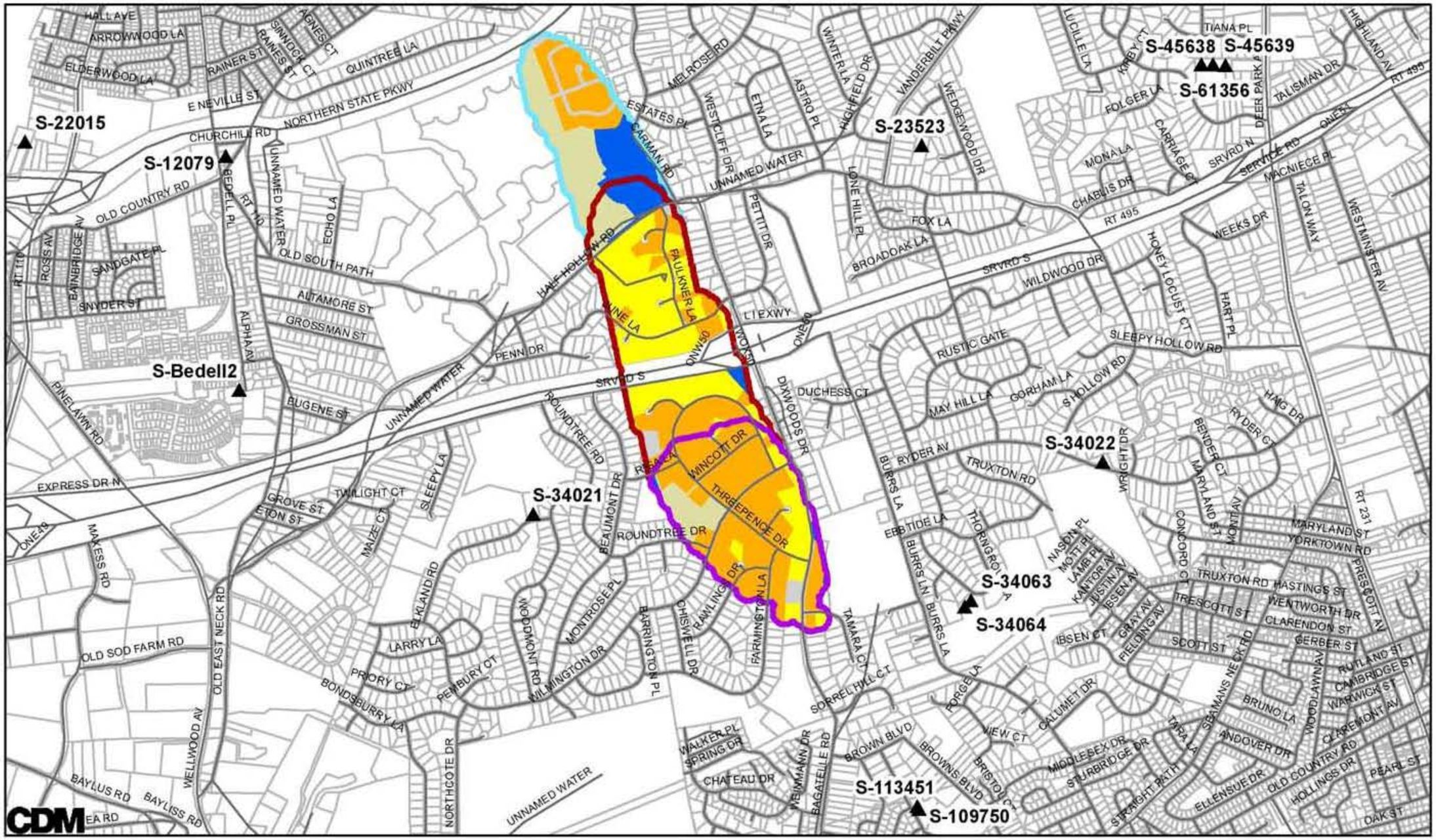
	Contaminant Category			
	Microbials	Nitrates	Pesticides	VOCs
Susceptibility	L	H	L	VH

Notes:

1. Values shown in the Time Of Travel 100 column for VOCs and Nitrates are aggregates for the entire area

2. For microbials, Contaminant Prevalence assessments do not include any land use or point sources in contributing areas greater than 25-years Time of Travel.

3. For pesticides, all sources in times of travel below 25 years have been aggregated into the 25 column



Travel Time (Years)

- 0 to 2
- 2 to 5
- 5 to 25
- 25 to 50
- 50 to 75
- 75 to 100

Land Use Classifications

- Low Density Residential
- Med Density Residential
- High Density Residential
- Commercial
- Industrial
- Institutional
- Open Space
- Agricultural
- Vacant
- Transportation
- Utilities
- Water Handling & Maint
- Surface Waters

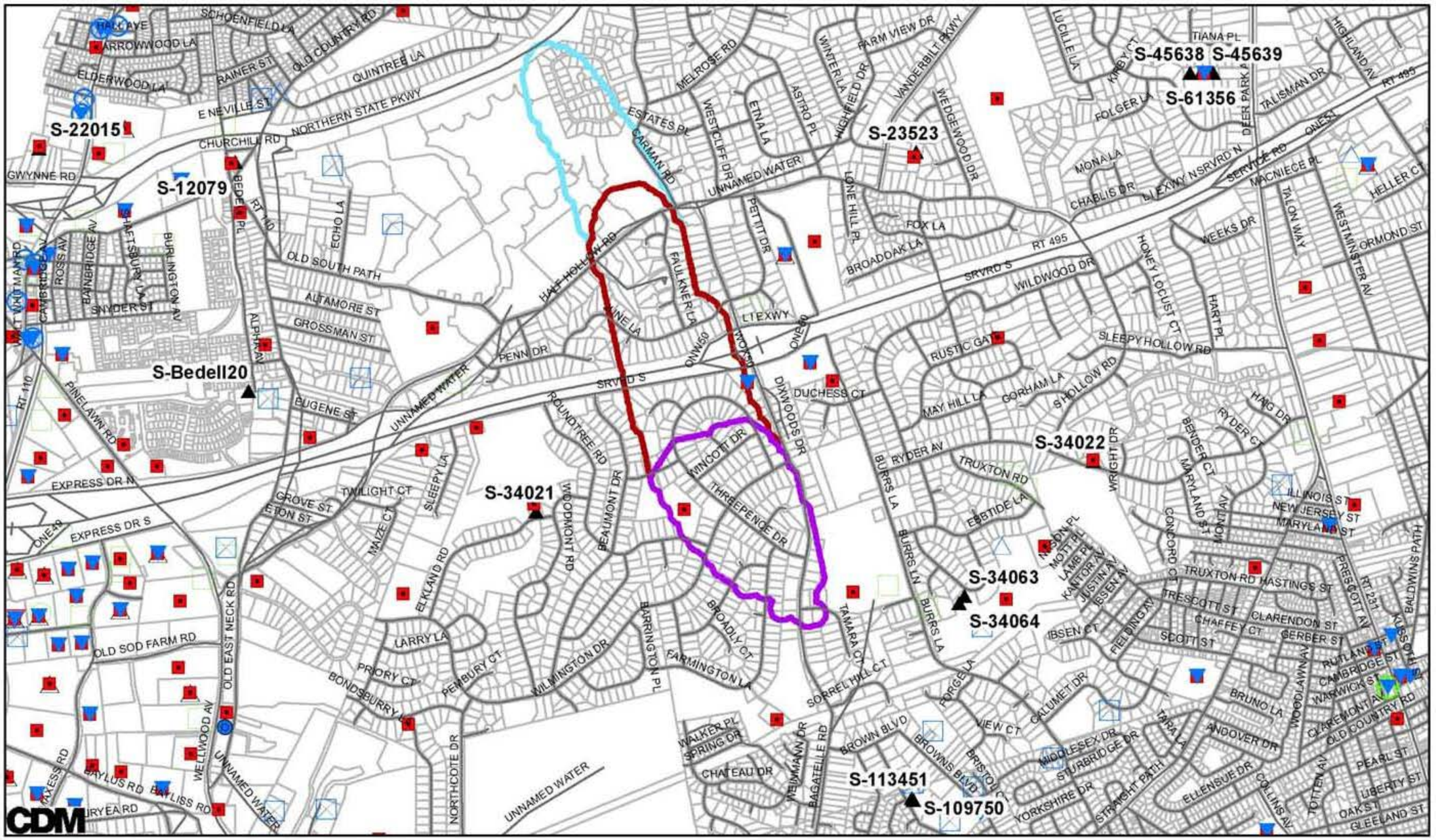
Contributing area to well number S-113451

- Lot Lines
- ▲ Public Supply Wells

N W E S

740 0 740 Feet

Map Date January 12, 2009



Travel Time (Years)

- 0 to 2
- 2 to 5
- 5 to 25
- 25 to 50
- 50 to 75
- 75 to 100

Potential Point Sources

- PBSF Facility
- Chemical Bulk Storage Facility
- CERCLA Facility
- Drycleaning Facility
- Hazardous Waste Site
- Landfill
- MOSF
- Salt Storage
- CLEARS Site
- PCS Facility
- RCRA Facility
- SPDES / Denit Facility
- Spill Site
- Gas Station

Contributing area to well number S-113451

- Lot Lines
- Public Supply Wells

930 0 930 Feet

N W E S

Map Date April 14, 2009

Table S-109750-1B: Land Use Summary

Land Use Type	Land Use Parcels in Time Of Travel					
	2	5	25	50	75	100
Institutional Unsewered					4-260-1-1.011, 4-272-2-6.000, 4-272-3-40.000, 4-273-3-1.032	4-260-1-1.011, 4-272-2-6.000, 4-272-3-40.000, 4-273-3-1.032
Low Density Residential Unsewered				4-272-3-114.000, 4-272-3-115.000, 4-272-3-116.000, 4-272-3-117.000, 4-272-3-122.000, 4-272-3-123.000, 4-272-3-124.000, 4-272-3-46.000, 4-272-3-47.000, 4-272-3-49.000, 4-272-3-50.000, 4-272-3-81.000, 4-272-3-99.000, 4-272-4-11.005, 4-272-4-11.006, 4-272-5-	4-260-2-48.008, 4-260-2-48.009, 4-260-2-49.000, 4-260-2-50.001, 4-260-2-50.002, 4-260-2-51.000, 4-260-2-52.001, 4-260-2-52.004, 4-260-2-52.006, 4-260-2-53.001, 4-260-2-53.003, 4-260-2-53.004, 4-260-2-53.005, 4-260-2-53.006, 4-260-2-53.007, 4-260-2-53.009,	4-260-2-48.008, 4-260-2-48.009, 4-260-2-49.000, 4-260-2-50.001, 4-260-2-50.002, 4-260-2-51.000, 4-260-2-52.001, 4-260-2-52.004, 4-260-2-52.006, 4-260-2-53.001, 4-260-2-53.003, 4-260-2-53.004, 4-260-2-53.005, 4-260-2-53.006, 4-260-2-53.007, 4-260-2-53.009,
Medium Density Residential Unsewered				4-272-3-100.000, 4-272-3-101.000, 4-272-3-102.000, 4-272-3-103.000, 4-272-3-104.000, 4-272-3-105.000, 4-272-3-106.000, 4-272-3-107.000, 4-272-3-108.000, 4-272-3-109.000, 4-272-3-110.000, 4-272-3-111.000, 4-272-3-112.000, 4-272-3-113.000, 4-272-3-118.000,	4-260-2-53.008, 4-260-2-55.003, 4-260-2-55.004, 4-260-2-55.007, 4-260-2-55.008, 4-260-2-55.010, 4-260-2-55.011, 4-260-2-55.012, 4-260-2-55.016, 4-260-2-57.001, 4-260-2-59.000, 4-260-2-68.000, 4-260-2-69.000, 4-260-2-71.000, 4-260-2-78.000, 4-260-2-80.000,	4-243-5-19.000, 4-243-5-20.000, 4-243-5-21.000, 4-243-5-22.000, 4-243-5-23.000, 4-243-5-24.000, 4-243-5-25.000, 4-243-5-26.000, 4-243-5-27.000, 4-243-5-28.000, 4-243-5-29.000, 4-243-5-30.000, 4-243-5-31.000, 4-243-5-32.000, 4-243-5-33.000, 4-243-5-34.000,
Open Space					4-260-1-1.010, 4-260-1-1.020, 4-272-5-72.000, 4-272-5-73.000, 4-272-5-81.000	4-243-7-1.004, 4-243-7-1.005, 4-260-1-1.010, 4-260-1-1.018, 4-260-1-1.020, 4-272-5-72.000, 4-272-5-73.000, 4-272-5-81.000
Transportation				4-272-3-18.000, 4-273-1-77.000, 4-273-3-1.031	4-260-2-55.002, 4-260-2-65.000, 4-260-2-81.000, 4-272-3-1.000, 4-272-3-18.000, 4-273-1-77.000, 4-273-3-1.031	4-243-2-25.000, 4-243-3-1.000, 4-243-5-76.000, 4-260-2-55.002, 4-260-2-65.000, 4-260-2-81.000, 4-272-3-1.000, 4-272-3-18.000, 4-273-1-77.000, 4-273-3-1.031

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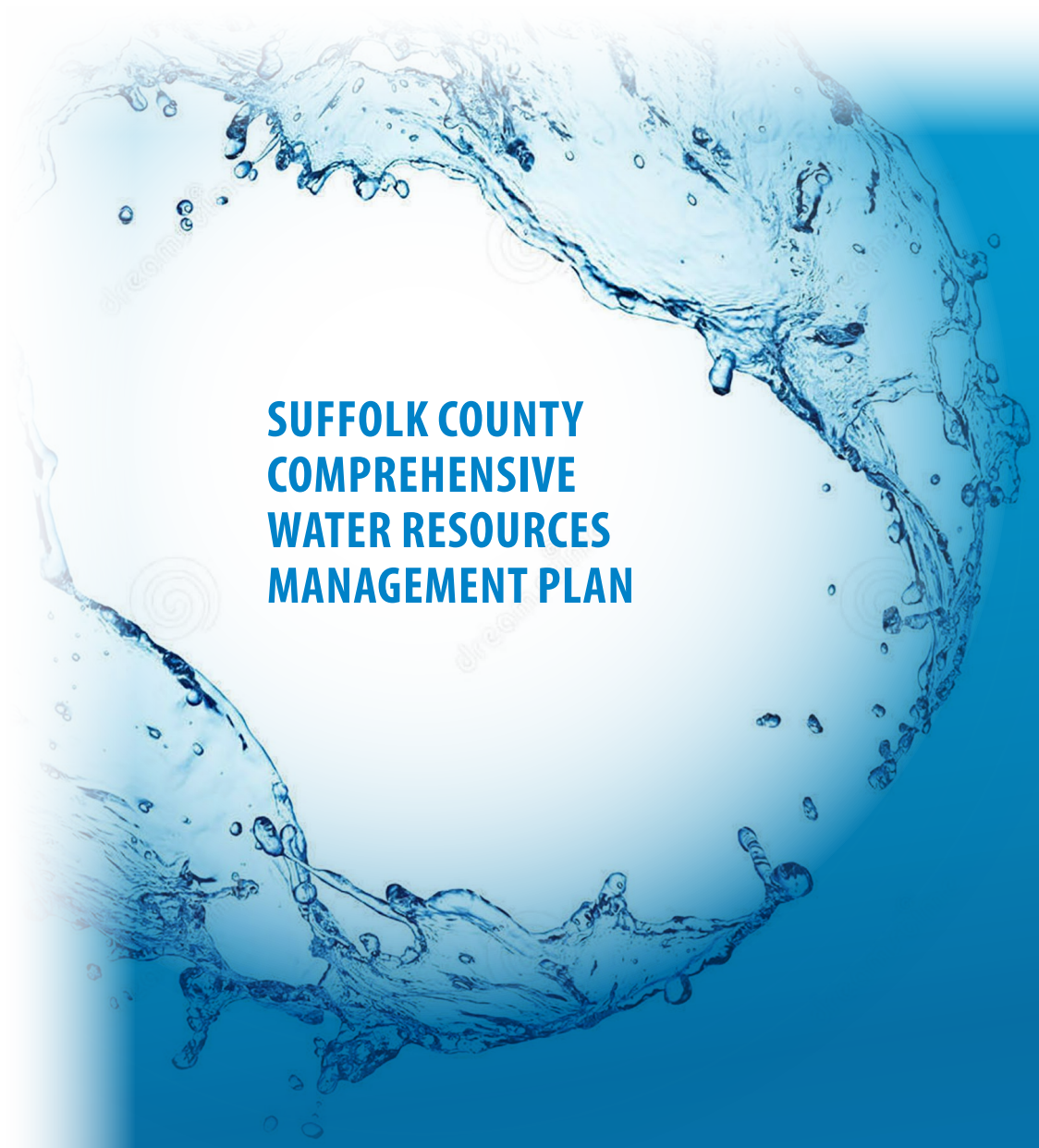
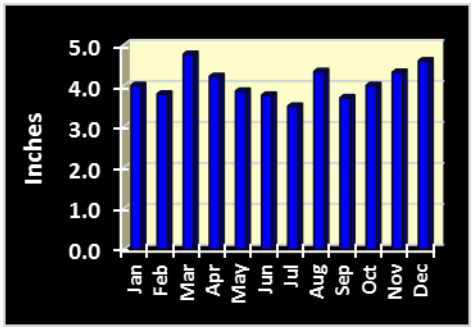


SUFFOLK COUNTY
COMPREHENSIVE
WATER RESOURCES
MANAGEMENT PLAN

Section 4
DRINKING WATER SUPPLY

Section 4
Drinking Water Supply

The fact that Suffolk County's extensive and productive aquifer system provides the sole source of potable water supply for the County's 1.5 million residents[31] has been documented for decades. All of the County's groundwater originates as precipitation that recharges the island - the County is fortunate to receive an annual average of almost 49 inches of precipitation[32], relatively evenly distributed throughout the year. While the amount of precipitation that recharges the aquifer varies by season and location throughout the County, on average, it is estimated to provide approximately 1,367 million gallons of recharge each day to the aquifer system County-wide.



Average Monthly Precipitation: 1949-2014 (from Brookhaven National Laboratory)

Natural groundwater throughout most of the County is of very high quality. In fact, the **1987 Comp Plan** identified only four inorganic constituents – chlorides, sulfate, iron and manganese – that exceed drinking water standards in native groundwater in some parts of the aquifer system. Over the years, groundwater quality has, however, been impacted by materials used, stored or disposed of at the ground surface that may be carried by recharging precipitation down to contaminate the aquifer system. The sands, silts, gravels and clays that make up the unsaturated zone and the aquifer system function as a large sand filter that has helped to protect the resource from many of these contaminants.

The combined efforts of programs at the Federal, State, County and Town levels to protect the aquifer system have been reasonably successful in controlling the impacts of development on groundwater - although groundwater quality data indicate that additional efforts are required. Consequently, compared to many sources of supply throughout the country, Suffolk County's groundwater supply remains for the most part, a high quality source of potable water, despite the impacts of the 1.5 million people who live in the watershed.

4.1 Problem Identification

Several potential issues of concern that affect residents' access to a reliable and safe supply of water have been identified. Drinking water supply issues have been identified and described in more detail in the Task 4 and Task 7

[31] With the exception of the approximately 2500 residents of Fishers Island who utilize a combination of wells and surface water.

[32] Based on precipitation data collected at Brookhaven National Laboratory since 1949.

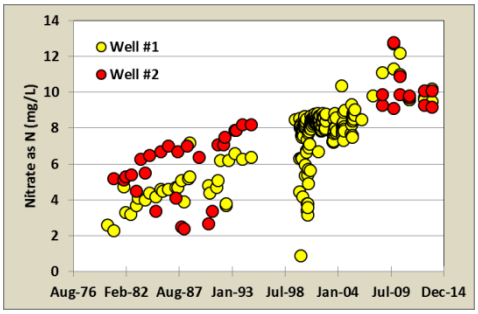
memoranda. Both environmental and infrastructure constraints impact access to a reliable potable supply in some areas of the County; both types of potential constraints are briefly summarized below.

Water supply issues relating to the aquifer's ability to yield sufficient potable supply include:

- Water quality – contamination from anthropogenic (e.g., nitrate and pesticides) and natural (e.g., iron, manganese, chlorides) sources;
- Localized impacts of water supply pumping on surface water features, such as streams, ponds and wetland areas;
- Localized impacts of water supply pumping on saltwater interfaces.

Water supply issues resulting from infrastructure limitations include:

- Potential reliability and water quality concerns associated with non-community and private supplies; and
- The impacts of increasing peak demands on existing water supply infrastructure.



Nitrate as nitrogen concentrations from Church Street – Northport Wellfield (SCWA)

4.1.1 Resource Limitations

4.1.1.1 Groundwater Quality Limitations

Most untreated groundwater in Suffolk County complies with existing drinking water Maximum Contaminant Levels (MCLs) and community supplies are treated to remove the low levels of volatile organic compounds (VOCs) or other contamination that may be detected. The presence of high levels of nitrate or chlorides, and any detections of pesticides are, however, more problematic to address from a potable water supply perspective, due to the complexity and cost associated with treatment.

South Spur Drive – Ion exchange process removes nitrate (SCWA)

Two areas of the County where existing groundwater quality has affected the ability to utilize the existing groundwater supply have been identified during this study:

- Northport and East Northport, where nitrate levels measured in untreated water from existing Suffolk County Water Authority (SCWA) Magothy wells have ranged from 8 mg/L to 12 mg/L, and
- Southold, where the extent of the shallow aquifer is limited by underlying and surrounding saltwater, and where agricultural contaminants such as nitrates and pesticides have caused widespread groundwater contamination.

4.1.1.2 Groundwater Quantity Limitations

From a County-wide water quantity perspective, Suffolk County's aquifers can readily provide the 314.5 million gallons per day (mgd) required to satisfy the projected future demand for water supply in 2030. Based upon conceptual water balances prepared for the Main Body of the island, the North and South Forks and Shelter Island, County-wide recharge amounts to an average of approximately 1,367 mgd (**Task 4.3 - Hydrology,** CDM**,** 2006). However, in localized coastal areas, projected water supply demands do exceed the capacity of the limited shallow fresh water aquifer present. In addition, the effects of water supply pumping on groundwater-fed streams, ponds and wetlands areas must also be considered.

Projected community water supply demands in the year 2030 summarized on **Table 4-1** were developed in 2010 based on population projections provided by the Suffolk County Department of Economic Development and Planning (at the time, Suffolk County Planning Department, **Task 3 – Land Available for Development and Population Analysis Western Suffolk County**, 2009, and **1999 Existing Land Use Inventory – Eastern Suffolk County**), and the assumption that community supply will be provided to all residents currently obtaining supply from private wells. Incorporating peak water supply pumping demands that are based on currently observed peak demand factors, the 2030 projections indicate that additional wells will be required in Brookhaven, East Hampton, Huntington, Smithtown and Southold. In fact, over one hundred new supply wells would be required in the County based upon projection of peak water demand patterns and typical well capacities.

As the need for additional wells is identified and new wells are sited, the potential impacts of water supply pumping on surface water features such as ponds, streams and wetland areas must be considered on a site-specific basis. In general, wells screened within the Magothy aquifer are not anticipated to cause significant impacts to surface water features, although impacts are possible on a localized basis. The potential for water supply pumping to affect surface waters and wetland features is one factor affecting the well permitting process. If new supply wells are required in areas where freshwater is unavailable in the Magothy aquifer (e.g., on the North Fork), potential impacts on groundwater baseflow to streams and surface water features will need to be considered on a site-specific basis.

The USEPA Lists Six Basic Steps for Private Well Owners

(from USEPA, 2002):

- Identify potential problem sources.
- Talk with "local experts" (Health Department).
- Have your water tested periodically - annually for total coliform, nitrate, TDS, pH and any other suspected contaminants
- Have the test results interpreted and explained clearly.
- Set a regular maintenance schedule for your well, do the scheduled maintenance, keep accurate and up-to-date records.
- Remedy any problems.

Table 4-1 Projected Average 2030 Water Community Water Supply Pumpage

Town	2013 Pumpage (mgd)[1]	Projected (2030[2]) Pumpage (mgd)
Babylon	27.6	29.1
Brookhaven	65.7	81.9
East Hampton	6.4	11.5
Huntington	38.8	41.4
Islip	41.6	43.8
Riverhead	7.6	12.7
Shelter Island	0.1	1.8
Smithtown	22.7	24.9
Southampton	15	17.2
Southold	2.8	4.6
Total	228.3	268.8

1. Source of community supply pumpage data: major water purveyors (SCWA, South Huntington, Dix Hills, Greenlawn, Riverhead, Hampton Bays, Northport VA Hospital, Shelter Island Heights, West Neck Water Supply, Dering Harbor); NYSDEC (Saltaire, West Gilgo Beach)
2. Assumes all private wells on community supply by 2030.

Similarly, the potential for water supply pumping on the forks, Shelter Island and in coastal areas to cause saltwater intrusion or upconing must be carefully evaluated considering well locations, depths and pumping rates.

4.1.2 Infrastructure Limitations

Community supplies currently provide potable water to more than 87 percent of Suffolk County residents; approximately 80 percent of the population is served by the Suffolk County Water Authority (SCWA). Community supplies (identified in Appendix H) are generally acknowledged to be the most reliable means of providing a dependable, safe supply of potable water that complies with all applicable drinking water criteria or MCLs.

The Suffolk County Department of Health Services (SCDHS) has summarized the established benefits of community supplies as follows:

- Community supplies must meet rigorous federal and state quality standards and are routinely tested for purity, whereas non-community wells are tested for fewer parameters at reduced frequencies, and private wells are only required to be tested once - for approval of new construction. Due to the existence of treatment and disinfection systems, professional operations, and the routine

maintenance performed on community systems, compliance with MCLs is more reliable.

- Community supply wells are generally deeper and less prone to contamination than private wells and non-community wells.
- During power outages, public water continues to be available, whereas private well owners are left without water for drinking and sanitary purposes.
- Public water hydrants protect life and property by providing greater fire protection as a continuing available water source for firefighting activities, and often reduce fire insurance costs for homeowners.

Nevertheless, for a variety of reasons, in many parts of the County, non-community systems and private wells continue to provide potable supplies.

4.1.2.1 Non-Community Supply Limitations

The number of non-community systems has declined in recent decades, from 725 in 1984 as documented in the ***1987 Comp Plan***, down to 273 in 2008 (**Task 7.4 – Non Community Supplies**; CDM, 2008) to 192 in 2014 (personal communication, SCDHS). Most remaining non-community systems are transient systems, such as parks, convenience stores and restaurants. Non-transient non-community water systems include schools, large businesses and government run facilities with over 25 employees. Approximately 75 percent of non-community systems are supplied by a single well, and the majority of the non-community systems do not provide any treatment.

New York State Department of Health (NYSDOH) requires that non-community systems be monitored for microbials quarterly (monthly if the system has a disinfection waiver) and for nitrates annually (quarterly if nitrates exceed 5 mg/L), while VOCs and pesticides are monitored at state discretion. SCDHS inspects all non-community systems on an annual basis. Since 2003, the SCDHS has tested non-community wells for VOCs and pesticides annually. Monitoring of community supplies occurs more frequently, providing a greater level of safety.

4.1.2.2 Private Well Limitations

A Geographic Information Systems (GIS) analysis of Suffolk County Department of Economic Development and Planning (SCDEDP, formerly Suffolk County Planning Department), SCWA and other water supplier data that was completed as part of this study concluded that approximately 47,000 private wells continued to provide potable supply to Suffolk County residents (**Task 7.5 – Private Water Supply Wells**, CDM, 2009); the SCDHS estimates

that this number has declined to approximately 45,000 as of 2015. Private wells are very susceptible to contamination from near-surface activities and from sources such as on-site wastewater disposal systems, spills, fertilizers and pesticides, because they are generally screened at very shallow depths, typically 40 feet into the water table. While the majority of the private wells are located in the towns of Brookhaven, East Hampton, Shelter Island, Southampton and Southold, thousands are also used in the western towns. Nitrate exceeded the drinking water standard of 10 mg/L in approximately seven percent of the private wells sampled by SCDHS between 2007 and 2013. VOCs exceeded the 5 µg/L threshold in 19 percent of the private wells sampled by SCDHS between 1997 and 2013.

NYSDOH recommends annual testing of private wells for total coliform. USEPA and the National Groundwater Association (NGWA) also recommend annual testing of private wells for, at a minimum, total coliform, nitrate, total dissolved solids and pH. SCDHS provides a private well water quality testing program that analyzes for a much wider range of potential contaminants, including semi-volatile chemicals, pharmaceuticals, and pesticide compounds and their breakdown products, for a sampling fee of $100, which is much lower than the cost of analyses performed by commercial laboratory testing. In 2012 and 2013, fewer than 600 private well owners requested water quality testing under SCDHS's private well water quality testing program; this is less than 1 percent of the private wells existing in the County. Suffolk County resolutions 245-2000 and 1009-2000 require that when a home with a private well is purchased, the well must be tested prior to closing on the home purchase.

For new construction on individual parcels, the SCDHS requires whole house (point of entry or POE) treatment systems for removal of iron, manganese, chloride, VOCs, and aldicarb residues where well water quality is unsatisfactory and public water is not available. However there are thousands of older residences relying on private wells that have not been tested.

4.1.2.3 Peak Water Supply Demands

Over the past 20 years, the increase in the use of automated irrigation systems has caused a large increase in per capita water usage during summer months, as shown on **Figure 4-1**. Peak pumping occurs during the early morning hours when automated sprinkling systems typically operate, as shown by **Figure 4-2**. During 2008, the peak day for water demand in the County required that SCWA pump very close to capacity while utilizing water in storage**.** Peak water demands that approach the capacity of the existing infrastructure have also been reported by other water suppliers such as the Riverhead Water District. If the trend of increasing summer irrigation continues, stress on the existing infrastructure will also increase.

Figure 4-1 – Summer water supply pumping associated with increased outdoor water use and automated irrigation systems has significantly increased in recent years

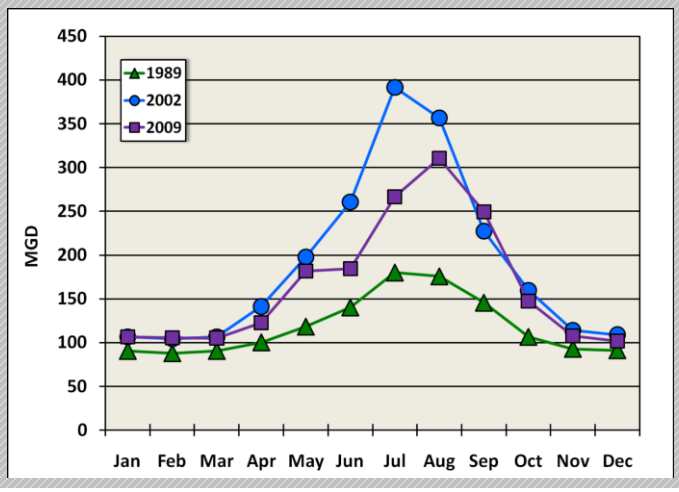
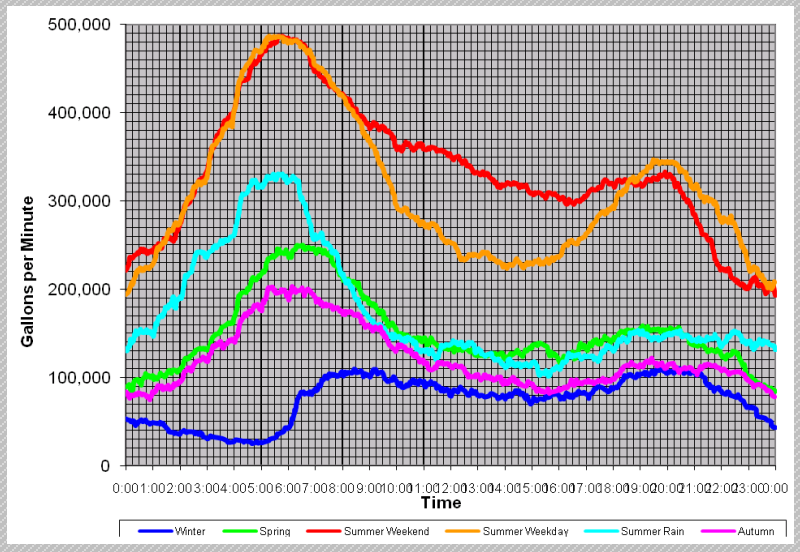


Figure 4-2- Peak SCWA Demand in 2008

Summer pumping rates, shown by the red and orange lines, are significantly greater than winter pumping rates, shown in blue. The early-morning peak demand results from automated irrigation systems.



4.2 Drinking Water Supply Goals and Objectives

Working together with the SCDHS, SCWA, and the Suffolk County Comprehensive Water Resources Management Plan Steering Committee, three drinking water supply management goals were identified, along with more detailed and measurable objectives. These goals and objectives are targeted to provide a healthy and safe supply of potable water to County residents through 2030. Although it is acknowledged that full achievement of these goals within the next fifteen years may not be realized, the recommendations presented in this document provide the framework for provision of a reliable, high quality potable supply for future generations.

The goals and objectives are consistent with County policy declarations that are articulated in Article 4 of the Suffolk County Sanitary Code:

760-401: " ... the policy of the County of Suffolk is to protect the groundwater to insure the availability of an adequate and safe source of water supply for generations to come by: enforcing the local, state and federal laws regulating water supply; promoting the extension of public water supply to all areas of the County; maintaining a process of groundwater planning; carrying out research and development in the field of alternatives to community water supply; and by promoting education and acceptance of the importance of groundwater management and protection."

The goals reflect SCDHS philosophy that all Suffolk County residents are entitled to safe potable water, and that the availability of a community water supply is the most reliable way to assure the population of a reliable supply of high quality potable water. They also recognize that an increasing portion of the groundwater that is pumped from the aquifer system is used for landscape irrigation. This increased discretionary use of the resource has stressed the capacity of existing water supply infrastructure in some areas. If landscape irrigation trends continue through the planning period, they will continue to stress the aquifer system in coastal areas such as the North Fork and will require significant investment in additional infrastructure.

Drinking water supply goals, and the supporting objectives, are summarized in **Table 4-2**. The first management goal and supporting objectives are consistent with the Groundwater Resource Management goals and objectives described in Section 3. Hence, implementation of the Groundwater Resource Management recommendations will also result in progress in achieving the first drinking water supply goal; those recommendations are not repeated here.

Table 4-2 Drinking Water Supply Goals and Objectives

Drinking Water Supply Goals and Objectives

GOAL 1: All County residents should have access to safe potable water that is in compliance with drinking water MCLs, USEPA health advisories and New York State guidance levels.

OBJECTIVES:

1. All drinking water should comply with MCLs and USEPA and New York State health advisories.
2. All areas within 50-year capture zones to community supply wells should be subject to the most stringent practicable pollution control measures.
3. Source water protection (e.g., pollution prevention) is preferred to wellhead treatment.
4. The Pine Barrens Core Preservation Area should continue to be preserved for future water supply.

GOAL 2: A community public water supply should be available to all Suffolk County residents.

OBJECTIVES:

1. The infrastructure necessary to supply and convey potable water to all Suffolk County residents should be identified.
2. The infrastructure necessary to supply and convey potable water to all Suffolk County residents should be constructed.

GOAL 3: Residential and commercial irrigation should be managed to reduce peak demands on water supply infrastructure.

OBJECTIVE:

1. Within three years, Suffolk County should adopt regulations to manage residential and commercial irrigation.

4.3 Recommendations to Address Drinking Water Supply

4.3.1 Introduction

Working together with project stakeholders, a variety of recommendations have been identified to guide drinking water supply management through the planning period, in accordance with the drinking water supply goals and objectives. Additional recommendations that address the first goal ***(All County residents should have access to safe potable water that is in compliance with drinking water MCLs, USEPA health advisories and New York State guidance levels)*** by protecting the groundwater resource itself via land use and/or management controls, source water protection or wastewater management are described in Section 3 and Section 8 of this Plan. The recommendations presented in this section of the Plan focus upon the new infrastructure and institutional alternatives associated with responding to goals number two ***(A community public water supply should be available to all Suffolk County residents)*** and number three ***(Residential and commercial irrigation should be managed to reduce peak demands)***.

4.3.2 Extension of Community Supplies

Provision of a community water supply has been identified as the recommended approach to provide a reliable, safe supply of potable water that complies with all applicable drinking water criteria or MCLs. SCDHS Office of Drinking Water has identified several existing community supplies that should be incorporated into a SCWA service area or other effectively managed municipal water district, based upon aging infrastructure and/or the small population serviced. These community water suppliers are listed on **Table 4-3**.

Distribution systems serving developments such as condominiums, apartments, townhomes or home owner associations should also be owned and maintained by the community water supplier, to assure that the system is operated and maintained, and that adequate pressure is maintained for fire protection.

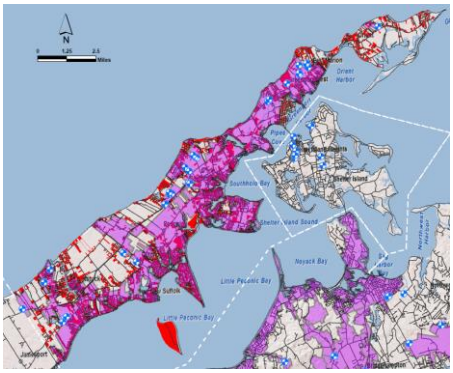
Residents using private wells should be encouraged to connect to public (community supply) wherever it is possible. In general, although water mains exist throughout most of the western towns (Huntington, Babylon, Smithtown, Islip and Brookhaven), some residents continue to utilize private wells for potable supply. Because the private wells are more susceptible to contamination than public supplies and there are no continuing monitoring requirements, connection to the community supply is recommended whenever available.

Table 4-3 Community Water Supplies That Could be Improved by SCWA Takeover

Water System Name	Population Served (2008)	Number of Wells
Bridgeford Colony	16	1
Dougherty Water Company	34	1
Kings Cabins [1]	7	1
Maidstone Park Cottages	20	1
McCarren Water Supply	30	1
McCrodden Water Company	33	1
Shelter Island Chalets [1]	15	1
Wolfies Tavern	10	1

(1) SCWA does not currently provide water on Shelter Island; if, in the future, SCWA does have a presence on the island, the service areas of these supplies should be incorporated.

SCDHS private well standards should be amended to require new single family residences to connect to a public water supply if one is available within 500 feet of the parcel being developed. Public water should be available to vacant or developed properties that can potentially be subdivided into lots with areas less than 40,000 square feet in compliance with the density requirements of Article 6 of the Suffolk County Sanitary Code and in accordance with town zoning. Previously subdivided, undeveloped parcels with densities equivalent to or less than one dwelling unit per acre should be designated to be served with a public water supply system.



Residential land use in Southold (red) and SCWA distribution zones (purple)

Additional area-specific recommendations are summarized in the following sections.

4.3.2.1 North Fork

Background

Currently, SCWA, non-community suppliers and private wells all provide water to different parts of the Town of Southold. Because the quality of the shallow aquifer has been compromised by widespread contamination from agricultural contaminants such as nitrates and pesticides, provision of a community supply for all residents is recommended. Several alternatives have been considered to supply Southold residents with a water supply that complies with drinking water criteria.

The ***1987 Comp Plan*** recommended establishment of water quality districts for some areas of the North Fork. The experience gained from the SCWA satellite system at Browns Hills Association in Orient has shown that a

treatment district can be problematic, even for a small scale district with a centralized water supply. In Browns Hills, where the nitrate concentration of water from the two public supply wells operated by the SCWA exceeds the 10 mg/L MCL, individual under-sink treatment units were installed to provide potable water at acceptable nitrate concentrations to a single tap in each home (Point of Use or POU system). SCWA personnel access to these units for monitoring and filter maintenance has been problematic and the staffing costs have been significant. SCWA proposed to supply the homes at Browns Hills by extending a water main from its distribution system in East Marion to eliminate the need for the POU systems. This would provide water that complies with the nitrate MCL at all taps for every service connection. In addition to protection of Browns Hills residents, this approach would make potable water available to residents with contaminated private wells in Orient and provide for increased fire protection. To date, no water main extension has been installed.

SCDHS and SCWA viewed the Browns Hills POU experience as a "best-case" pilot project with the advantages of an experienced water supplier, a small community (25 homes) contained within a limited area, and identical treatment systems for nitrate reduction at single household taps. The establishment of a treatment district over a broader area to address the varied water quality problems identified in North Fork wells (e.g. nitrate, VOCs, iron, pesticides, MTBE), requiring different types and sizes of treatment technologies and varied monitoring requirements for each parameter, would provide more challenges to effective operations.

Therefore, extension of SCWA service to all Southold Town residents, and to non-community systems with documented contamination (e.g., SCDHS sampling of the non-community water supply system serving the ***Cross Sound Ferry*** has consistently revealed a variety of compounds, including Atrazine degradates, Simazine, DEET and Tebuthiuron), is recommended to protect public health.

SCDHS Recommendations

Historical SCDHS water quality data obtained from sampling private water supply wells was used to identify priority areas for water main extensions to areas impacted by contaminants, such as nitrates exceeding 6 mg/L, and pesticide and VOC contamination. For Southold Township, the SCDHS has made recommendations to the Town and SCWA that public water be extended to specific areas in Laurel, Mattituck, Cutchogue, Southold, East Marion and Orient, based upon contamination of existing private wells as summarized below.

Laurel - Aldrich Lane extending south from Sound Avenue to interconnect with the Main Road water main, due to high levels of nitrate and detections of parent pesticides or metabolites/degradates of Aldicarb, Alachlor, Metolachlor, and perchlorate.

Mattituck - Wickham Avenue, and Mill Lane, due to high levels of nitrate and detections of Aldicarb degradates, Metolachlor, and perchlorate, and Soundview Avenue, where elevated concentrations of nitrates, Aldicarb degradates, VOCs and perchlorate were observed.

Cutchogue - Duck Pond Roads, Vista Place, and portions of Depot Lane, Oregon Road, between Mill Lane and Depot Road, and Digman's Road, Route 48, between Alvah's Lane and Horseshoe Drive, and along the southern portion of Alvah's Lane, tapped from Route 25 and Bridge Lane, due to elevated nitrates, parent pesticides or metabolites/degradates of Aldicarb, Metolachlor, Metalaxyl, Dinoseb, Dacthal metabolites, and Imidacloprid.

GAC System for VOC Removal (SCWA)

Southold - Ruch Lane, Bayview Avenue and Colony Road, due to detections of MTBE.

East Marion - Stars and Rocky Point Roads, Aquaview Drive and Southern Boulevard between Cedar Drive and Rocky Point Road due to detections of parent pesticides or metabolites/degradates of Aldicarb, Dacthal and elevated nitrates.

Orient - Kings Street, Village Lane, Orchard Street, Oyster Pond Lane, Navy Street, Old Farm and Douglas Harbor Roads, Willow-Terrace Lane, Major Pond Road, and Narrow River Road due to significant detections of numerous contaminants, including Alachlor, parent pesticides or metabolites/degradates of Aldicarb, Dacthal metabolites, nitrates, and MTBE. Also, existing properties north of Main Road, between Ryder Farm Lane, Park View Lane and Three Waters Lane, due to detections of Alachlor and Metolachlor, and properties located between Greenway Drive West and Greenway Drive East, as they do not meet the density requirements of Article 6.

Evaluation of Alternative Approaches to Provide Community Supply

At the time of the draft 2010 Comp Plan, SCWA had an installed capacity of approximately 10,000 gallons per minute (gpm) in Southold, which included potential capacity from the storage tank at Moore's Lane. As older wells have been replaced with lower capacity wells in recognition of site-specific aquifer characteristics, this installed capacity has since been reduced. Based on current water demand rates and SCDEDP population projections, and assuming that all residents choose to connect to an available public supply, by 2030, a total of 14,526 gpm will be required to satisfy the peak water supply

pumping rate. Therefore, approximately 6,100 gpm of additional capacity is projected to be required (excluding the storage tank at Moore's Lane). Using the average 164 gpm capacity of existing wells in Southold, 38 new wells would be required to meet the projected 2030 demands, if no conservation measures targeting outdoor water use are implemented.

If a conservation program is successful in reducing peak outdoor use during the summer months, it is recommended that an additional 3 wells be added so that an adequate supply remains if the largest wellfield in eastern Southold is removed from service for any reason.

Several alternative approaches to provide this projected water supply demands were evaluated (**Task 8.3 Water Transmission Costs,** SCWA 2010 and **Task 9.1/9.2 Water Supply Recommendations**, CDM, 2010), including:

- Development of new wells in Southold;
- Development of new wells in Riverhead and transmission of the water eastward to Southold; and
- Development of new wells in the Pine Barrens, and transmission of the water eastward to Southold.

Three primary concerns with developing the additional capacity from wells sited within Southold were identified:

- The ability of the shallow aquifer to sustain the additional capacity without salt-water upconing/intrusion or without causing a water table decline that could impact wetlands and surface water bodies;
- Identification and acquisition of available land for well sites and potential treatment facilities; and
- The cost associated with construction of the additional wells, transmission mains and treatment facilities.

In order to evaluate the capability of the shallow aquifer to sustain the additional projected water supply demands, a transient groundwater model simulation was developed using the dual-density North Fork Model (CDM, 2003). Because the additional required infrastructure is driven by peak demand, a 20-year transient model simulation was developed based on SCWA 2008 pumping rates, including peak pumping rates experienced during the summer months. Several of the options that were simulated are presented here:

Option #1: Provision of future projected needs from new wells in Riverhead and Southold (higher capacity wells in Riverhead),

Option #2: Provision of future projected needs from new wells in Southold, and

Option #3: Use of existing and new wells in Southold to provide reduced future water supply needs based on implementation of a successful conservation program.

The transient model simulations incorporated average 2008 water supply pumping rates for the non-growing season (September-May). During the growing season, the model simulations used average 2008 water supply pumping rates for the 18 hour period from 10 AM to 4 AM and a peak pumping rate (approximately 4.53 times the average pumping rate) for the four hour period from 4 AM to 10 AM, mimicking peak water demand patterns identified by SCWA (please see **Figure 4-2**).

The first sets of model evaluations simulated projected water supply pumping based on current peak water demand rates that did not include conservation. Option 1 would supply all projected future needs by the addition of nine new wells, five of which were assumed to be located in Southold and pumping at the current average capacity of the existing wells (200 gpm), and four of which were assumed to be located in Riverhead, where higher capacity wells of up to 1,000 gpm can typically be sited (SCWA, personal communication). As shown on **Figure 4-3**, the five new Southold wells were assumed to be located within the 5 foot water table contour (referenced to mean sea level) in the Cutchogue area and in western Southold/eastern Riverhead near Laurel and Jamesport; two new 1000 gpm wells were simulated between Church Lane and Northville Turnpike in Riverhead, and two new 500 gpm capacity wells were simulated in eastern Riverhead, within the 8-foot water table contour. The simulated new well locations are hypothetical, and were identified based solely on the current water table elevation and well screen intervals that are consistent with those of other area supply wells. In addition to the nine new wells, Sound Avenue wells 1A and 1B, Evergreen Drive #2, and North Road (Greenport #2), all of which were installed but were not yet operational in 2008, were also included in the simulation.

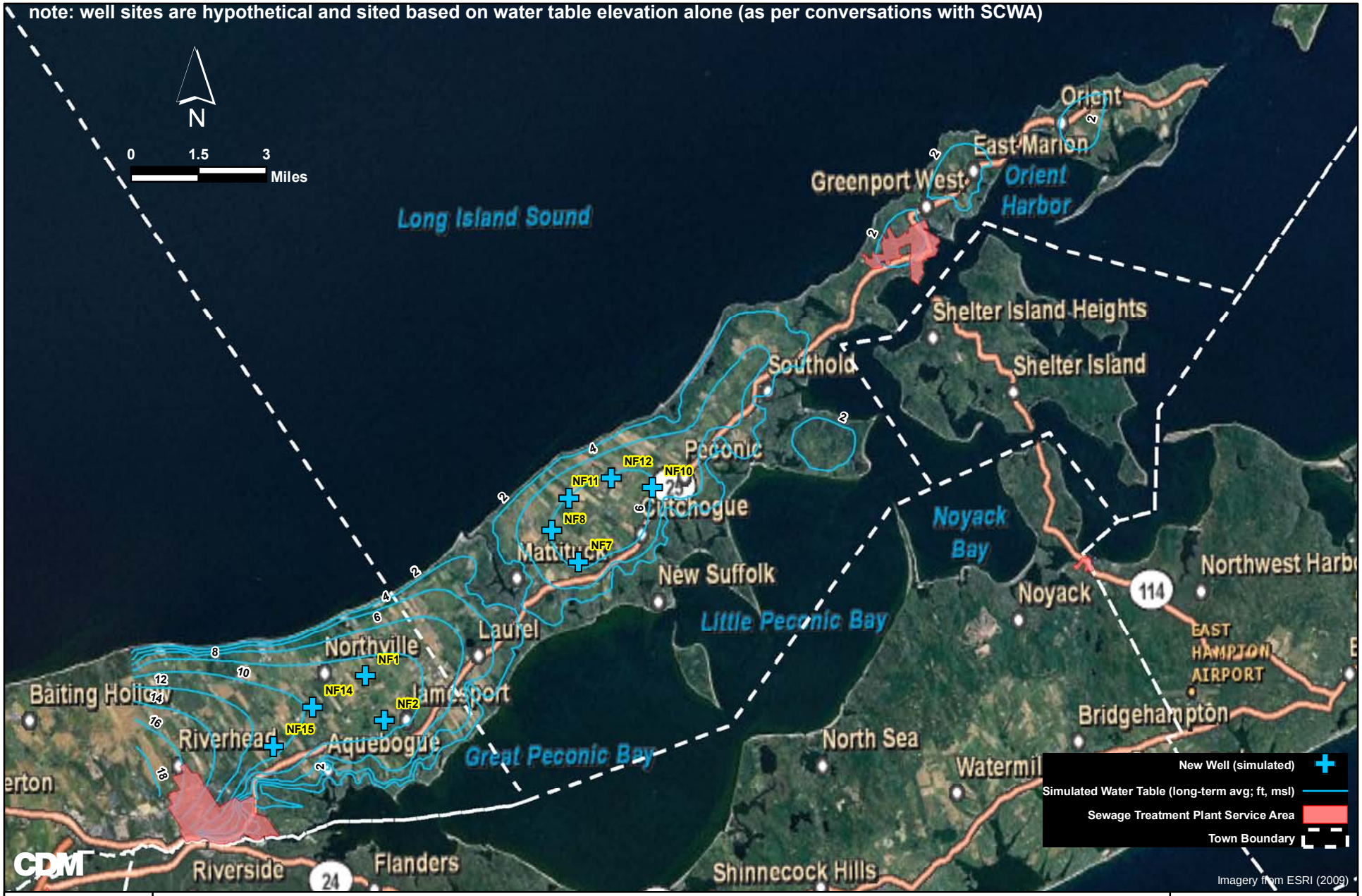
Differences in the position of the saltwater/fresh water interface from baseline conditions after 20 years are shown on **Figure 4-4.** The position of the saltwater interface is simulated to rise by between 15 and 50 feet in the area of interest and reach a new steady-state position within 20 years. Although the elevation of the interface is predicted to rise, the simulated position of the interface is projected to remain well below the elevation of any of the well

screens, so that the quality of the water would not be impacted by saltwater. Only minor changes in the interface elevation are observed in Southold (approximately 15 feet). Impacts to the position of the saltwater interface are more apparent in Riverhead, where the elevation of the interface is simulated to rise by approximately 50 feet (see **Figure 4-4**). Please note that these changes to the saltwater interface location are based on the increased water supply pumping alone, and do not consider the impacts of projected sea level rise further in the future.

Although the 2030 pumping projections are not simulated to cause either saltwater intrusion or upconing affecting the supply wells, it is anticipated that all wells would require treatment for nitrate removal, and potentially for iron/manganese, VOC and/or pesticide removal. In addition, permitting the new wells may be problematic as simulated water table declines from existing conditions may potentially impact freshwater wetlands. As shown on **Figure 4-5**, the simulated decline in the water table from a base of existing conditions approaches 0.5 feet in some wetlands in Riverhead. A greater change in head is observed in Riverhead than in Southold as a result of greater pumping, and because the area is being served by a sanitary sewer system that discharges treated effluent to surface water.

The second option assessed the potential to site all new supply wells within the Town of Southold. Due to the limited freshwater thickness on the North Fork, it is assumed that the new wells could only be located within the 5 foot water table contour, (located generally in the Cutchogue area and just east of the Riverhead/Southold town boundary) and that the capacity of the wells would be limited to 200 gpm. The simulated "new" wells are shown on **Figure 4-6** (locations are represented as wellfields in which more than one well is installed at a given site). As shown on **Figure 4-7**, the elevation of the saltwater interface is simulated to increase in Southold by approximately 40 feet. Although the interface does not intersect the screens of any wells, the water table decline intersects freshwater wetlands (**Figure 4-8**) which may affect the potential to permit new wells in this area.

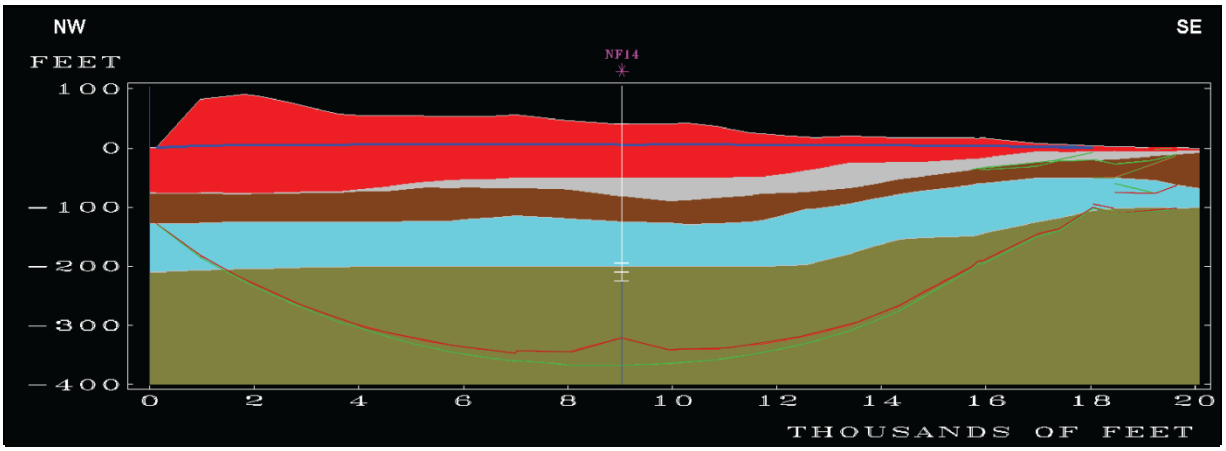
Finally, an additional simulation assuming successful implementation of a conservation program targeting peak outdoor water use was also performed. Under this scenario, Option 3, three additional wells would be recommended. Should conservation measures be put in place to reduce the peaking factor from the existing 4.5 down to 3.0, the peak demand for Southold would be reduced to 9,642 gpm. Preliminary model simulations indicated that while the 2008 network of supply wells pumping at or near capacity would be sufficient to meet demands, installing three or four new wells to replace wells located closer to the coastline may be more sustainable.

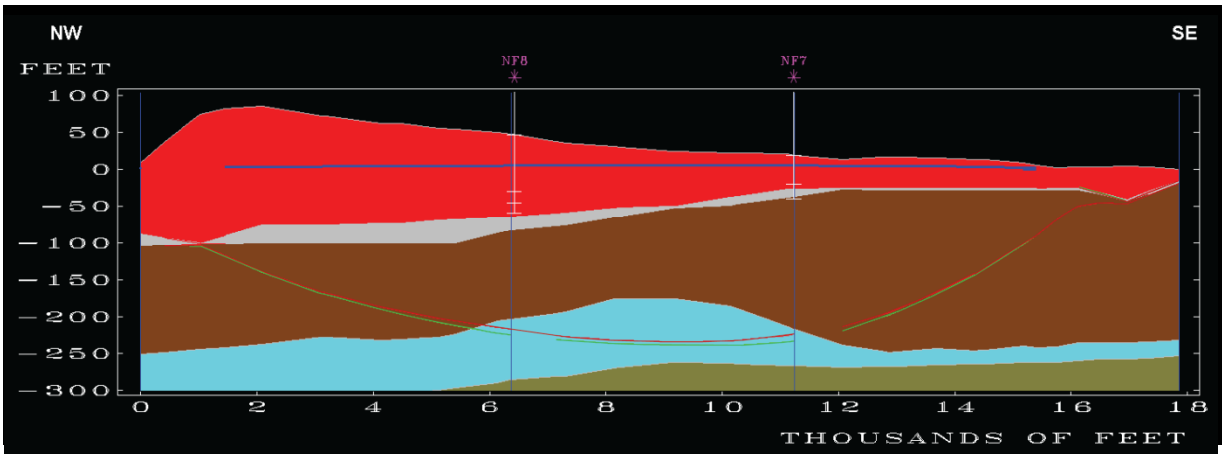


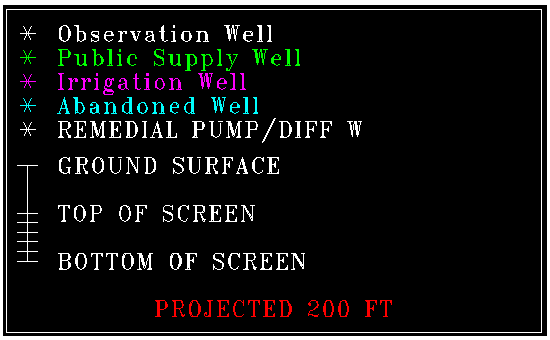
Potential New Supply Wells in Southold for 2030 Water Demand with No Conservation

Suffolk County Comprehensive Water Resources Management Plan

Figure 4-3







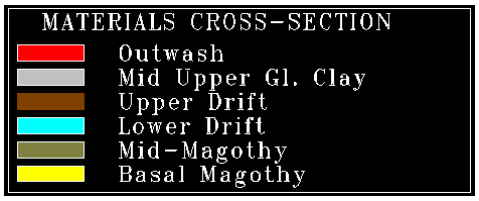
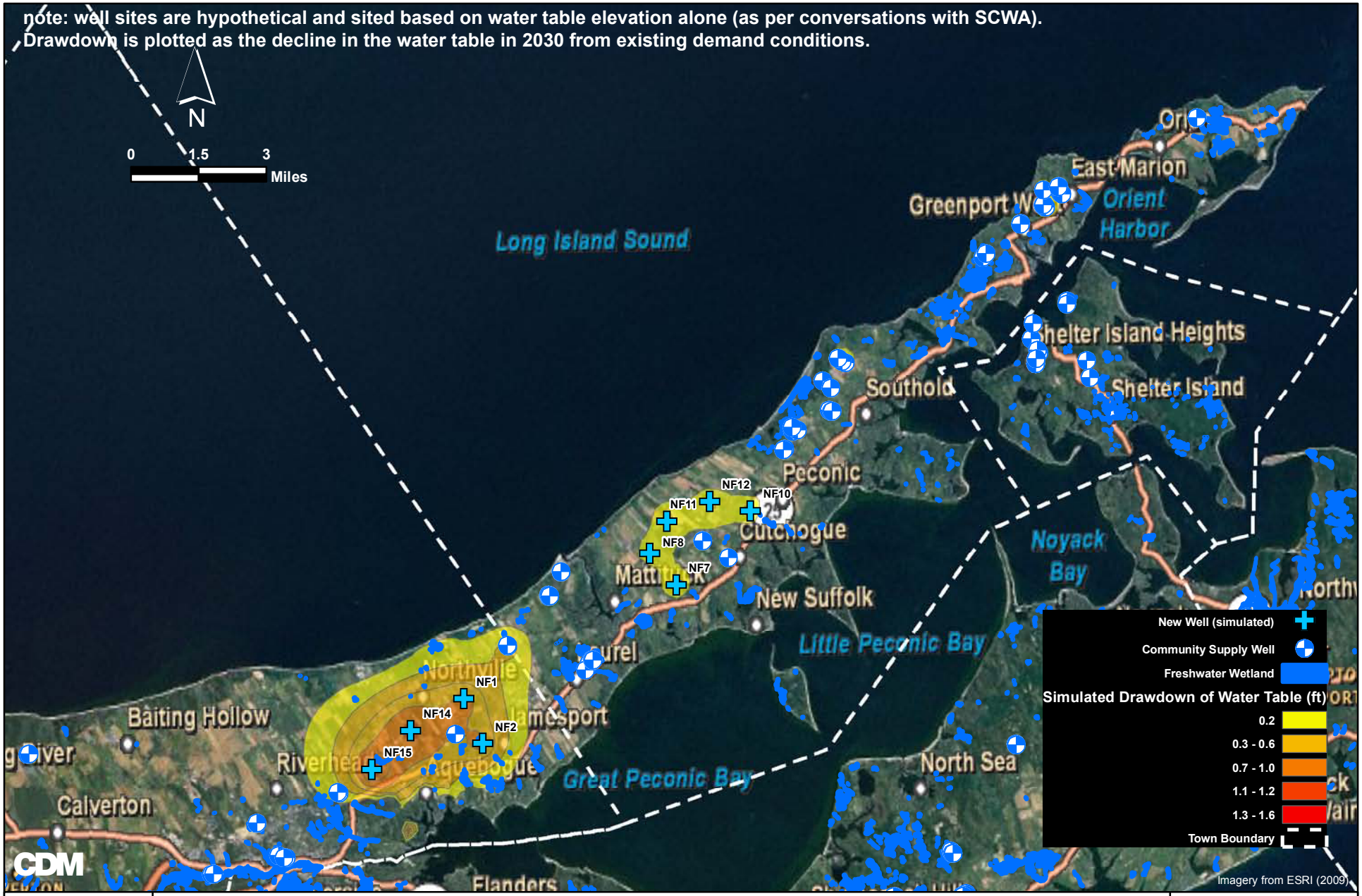


Figure 4- 4 Change in Saltwater Interface Elevation in 2030 with No Conservation

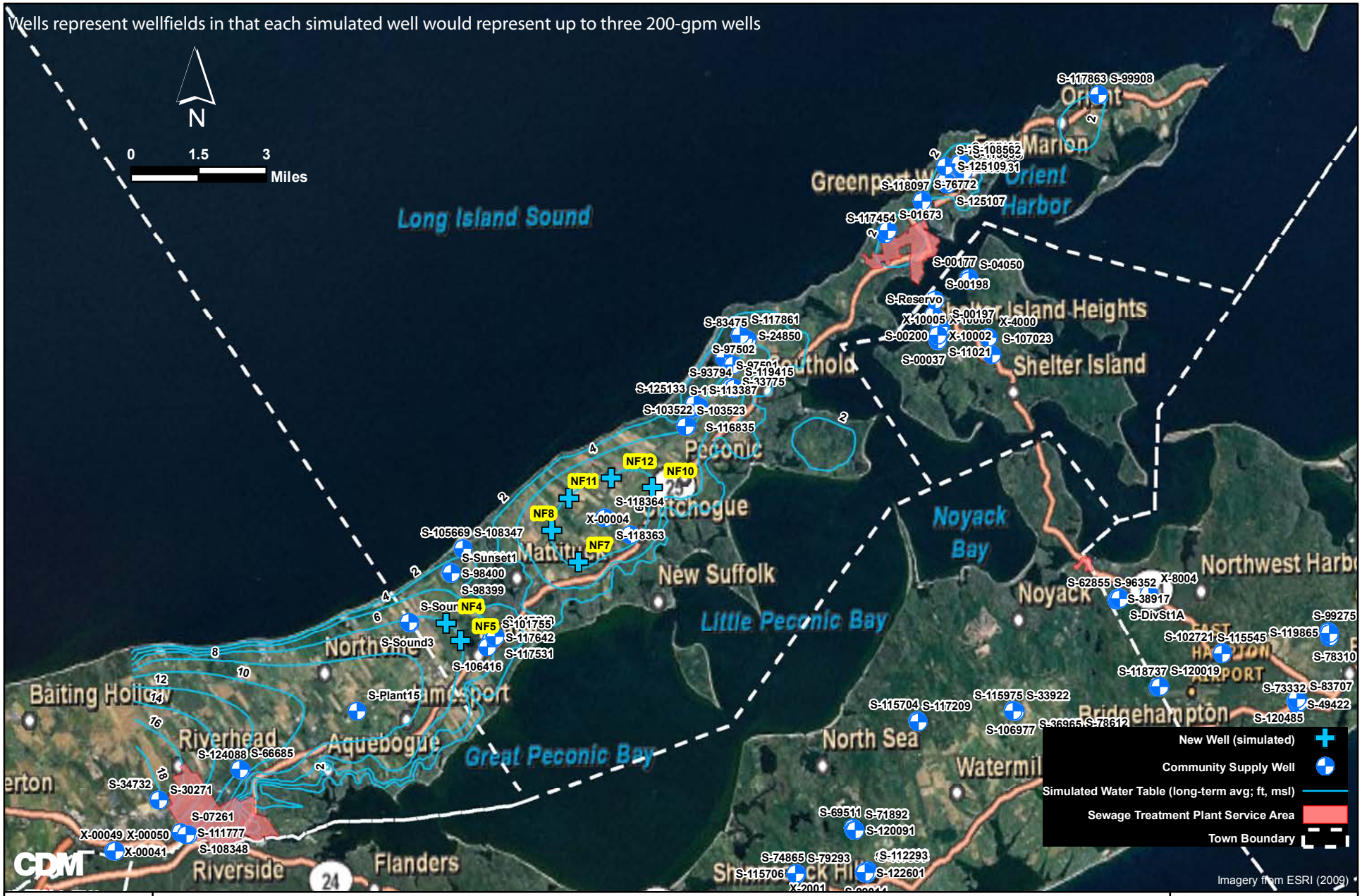
(Existing Conditions (green) and Projected Southold Water Demand Conditions (red). Northwest-Southeast Cross-section in Riverhead Shown on (a) and Southold on (b))



Simulated Water Table Drawdown in Southold and Riverhead in 2030, with No Conservation.

Suffolk County Comprehensive Water Resources Management Plan

Figure 4-5



Potential New Supply Wells in Southold in 2030, with No Conservation

Suffolk County Comprehensive Water Resources Management Plan

Figure 4-6

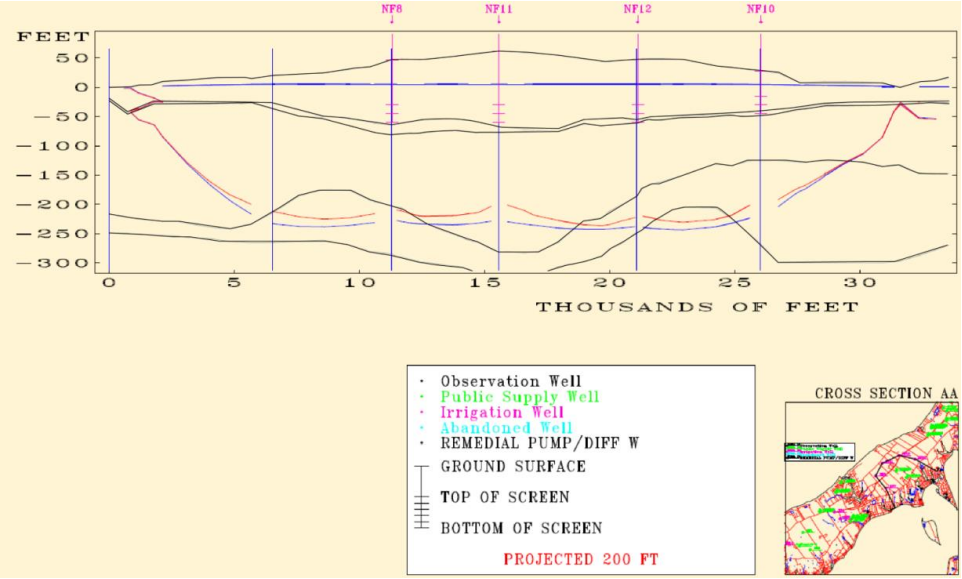
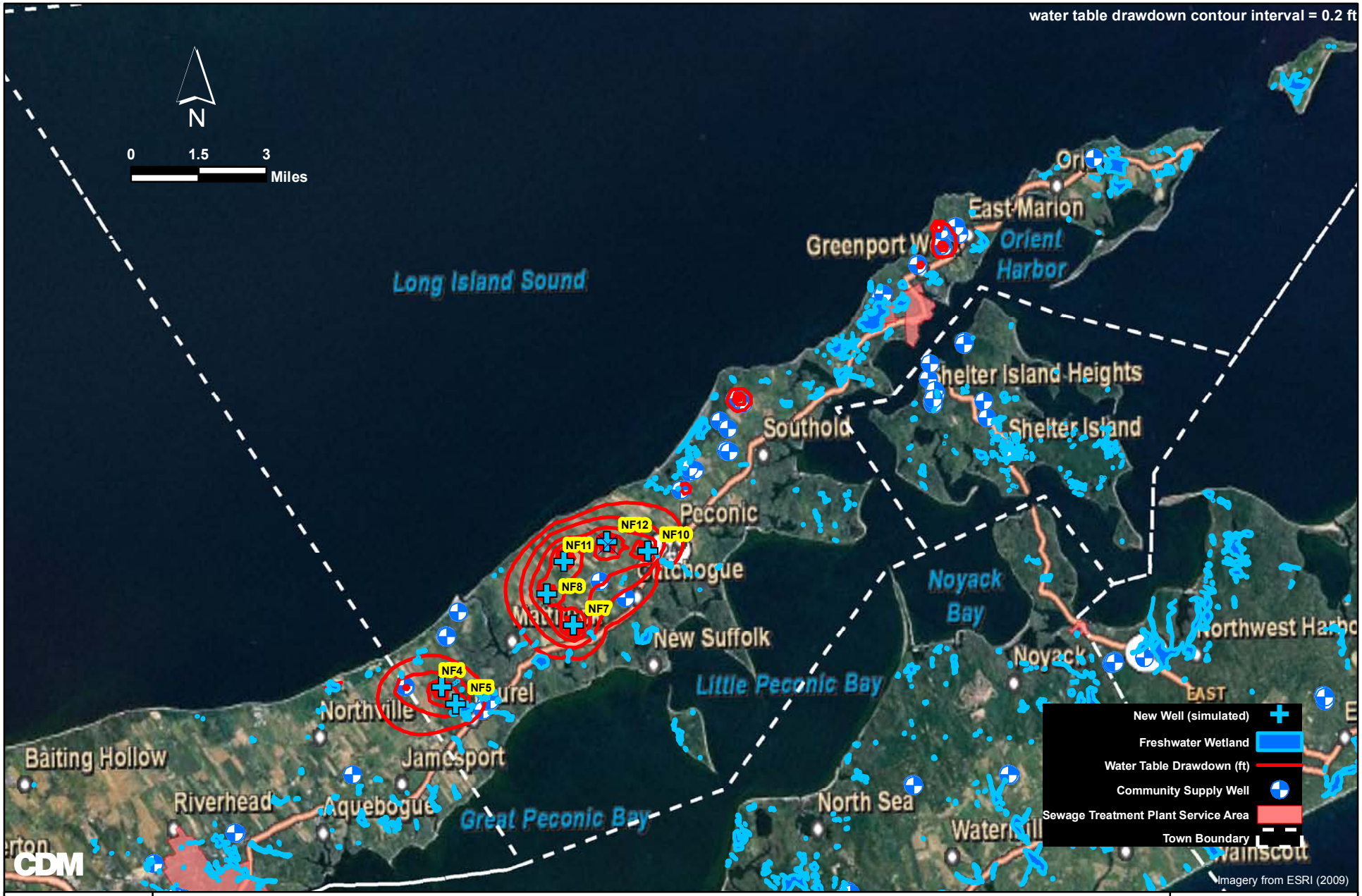


Figure 4-7 Simulated Position of the Saltwater Interface in Southold at 2030 under Existing Pumping Conditions (blue) and 2030 Pumping Conditions (red).

In this simulation, 980 gpm of peak pumping was moved from existing wells S-105669, S-108347, S-101755, S-127039, S-127226, and S-126076 to four hypothetical new wells (two new wells in Southold and two new wells in Riverhead). An additional 600 gpm was simulated to be pumped from three new wells located in Southold during peak summer periods. Use of all of these wells during periods of peak demand results in a peaking factor of 3.2. This configuration would give the SCWA more operating flexibility, should the conservation measures fall short of their target (a summer peaking factor of 3.0). Results are shown on **Figure 4-9.**

Simulation results show limited drawdown relative to existing peak conditions; a number of combinations of new wells and pumping rates (assuming the same total peak rate) would have yielded similar results; that is, only a slight decline in the water table elevation from existing conditions is predicted to result from water supply pumping.

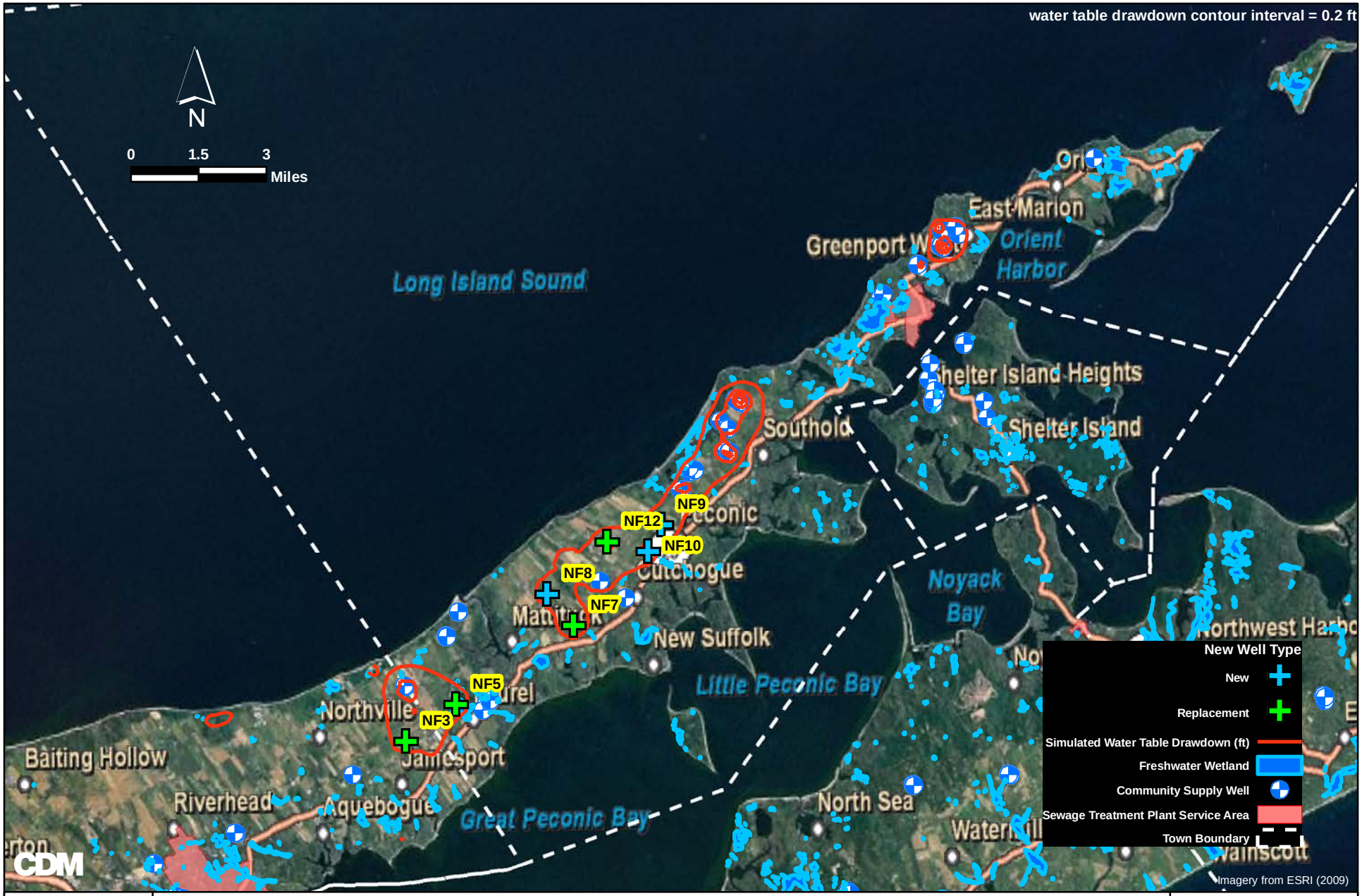
Well-specific treatment requirements for contaminants such as nitrate or pesticides that are found in North Fork groundwater have not been defined for these wells, however, the reduced number of additional wells required as a result of conservation makes Option 3 a more implementable approach. The replacement wells may also not be required should the coastal wells remain in



Simulated Water Table Drawdown (from existing pumping conditions) in Southold in 2030 with No Conservation

Suffolk County Comprehensive Water Resources Management Plan

Figure 4-8



Simulated Drawdown from Southold Water Demand
From Baseline (existing) with Conservation
Suffolk County Comprehensive Water Resources Management Plan

Figure 4-9

Due to the difficulty in siting high capacity wells on the North Fork, and the poor water quality that has resulted in many areas from historical agricultural practices, SCWA has also considered the possibility of installing several new wells in the Pine Barrens, and transmitting the water approximately 32 miles to Southold.

The potential to site new high capacity wells in Riverhead and transmit the potable water to Southold was also evaluated on a preliminary basis.

Conceptual cost estimates for these options were documented in the Task 8.3 Memorandum prepared by SCWA (2010), and are also summarized on Table 4-4.

Should any of these alternatives be identified for implementation, costs in 2010 dollars would be escalated to the mid-point of construction. Estimates of the relative ranking of alternative costs remain applicable regardless of the year of construction.

service. In addition, the much smaller predicted decline in the water table should be more favorable from a permitting standpoint.

Conceptual Capital Cost

Based on cost information provided by SCWA, preliminary conceptual capital cost estimates were developed in 2010 dollars for each of the options considered. More detailed costs, based upon the site-specific locations, capacities and treatment requirements associated with each new well would be required as the alternatives are further developed. Land acquisition costs have not been included, due to the site-specific nature of the investment. The cost estimates shown do not include escalation, as the schedule of construction has not been defined.

Table 4-4 summarizes the preliminary conceptual capital costs of each scenario, including the expansion of the distribution system to all residential properties in areas that are currently outside of the SCWA pressure zones 30 and 35. These costs are preliminary conceptual estimates because wells have not been sited, and well-specific treatment needs based on site-specific water quality data have not been defined.

Table 4-4 Conceptual Capital Cost Estimates for Southold Water Demand Alternatives

Option	Name	Conceptual Capital Cost ($ millions, 2010 dollars)				
		Wells	Transmission Main	Treatment	Expansion of Distribution System	Total
1	Riverhead Transmission Main with Supplemental Southold Wells	$ 12.32	$ 7.50	$ 4.97	$ 96.00	**$ 120.79**
2	Expand Existing System in Southold	$ 12.72	$ -	$ 15.93	$ 96.00	**$ 124.65**
3	Existing System with Conservation	$ 5.91	$ -	$ 3.38	$ 96.00	**$ 105.29**
4	Wells in Pine Barrens, run transmission main from Pine Barrens to Southold	$ 4.84	$ 48.00	$ -	$ 96.00	**$ 148.84**
5	Riverhead Transmission Main	$ 6.05	$ 7.50	$ -	$ 96.00	**$ 109.55**

Note: Costs in 2010 $ would be escalated to the mid-point of construction; information on the relative ranking of costs remains applicable regardless of the year of construction.

For these estimates, treatment costs have been presumed as described below:

- Option 1: Assumes that a centralized nitrate removal plant is required for new wells in Southold only. Cost assumes a 1,000 gpm plant, treating 600 gpm at a capital construction cost of $2,000,000. In addition, the cost includes a Granular Activated Carbon (GAC) facility at $500,000. A 24,700 foot raw water transmission main to the centralized facility is estimated at $100 per linear foot.

- Option 2: Assumes nitrate removal for a total flow of 3,000 gpm from the Southold wells, GAC treatment for all wells (centralized

plant in Southold) and 63,400 feet of raw water transmission main to centralized plants.

- Option 3: Assumes centralized nitrate and VOC removal plant for 1,000 gpm and 15,000 feet of raw water transmission main.

The cost of the distribution system extension was calculated using GIS, assuming that distribution pipelines would follow the existing road network in Southold. The length of all roads in Southold outside of SCWA Zones 30 and 35 was estimated to be approximately 960,000 linear feet. Using a distribution system construction cost of $100 per linear foot (SCWA, 2010), the total cost of the distribution system extensions was approximated at $96M. This should be considered a very preliminary cost estimate, because the actual length of distribution mains will vary based on factors such as final alignment, topography, sensitive environmental features, and because the unit cost of $100 per linear foot will vary depending on factors such as pipe size, market price of material, the ability to utilize public right-of-ways or the need to repave, etc. In addition, depending on development patterns in 2030, additional roadways are likely to be constructed which would increase project costs.

These costs were described in more detail in the Task 9 memorandum (**Drinking Water Supply Recommendations**, CDM, 2010) and are based on costs documented by SCWA in the Task 8 memoranda (**Water Production Costs, Water Treatment Costs** and **Water Transmission Costs** (SCWA, 2009 and 2010). The cost estimates assume that groundwater pumped from Riverhead only requires routine disinfection and corrosion control; any additional treatment required (iron removal, GAC, nitrate removal, etc.), would further increase the costs shown. Estimated treatment costs for nitrate removal at a centralized treatment facility for water withdrawn from the new wells in Southold are included, based on water quality data. Finally, SCWA has not historically provided centralized treatment facilities; the cost of pumping water from the wellhead to the treatment facility, and then to distribution would be an additional consideration.

The Engineering News Record (ENR) Construction Cost Index (CCI), which is based on a twenty city average of costs for common labor, steel, concrete and labor, is widely used to estimate the impacts of escalation. As of December 2014, the ENR CCI was 2.7%. Each of the conceptual capital cost estimates presented in this document could be escalated to the projected mid-point of construction using this escalation rate to provide a more up-to-date assessment of actual anticipated implementation costs. As the objective of this example is to compare the estimated capital cost associated with each alternative, the relative differences between alternative costs would remain the

same. For these estimates, treatment costs have been assumed as described below.

All of the potential alternatives identified to provide a safe and adequate supply of potable water to Southold are significant construction projects that are only described conceptually here. Assuming that the peak pumping rate can be reduced through a successful conservation program targeting outdoor water use, installation of three additional wells in Southold would be the most cost effective approach to provide a safe and reliable supply to North Fork residents, assuming that limited treatment will be required. Siting new wells in Riverhead, and transmitting the water east to Southold appears to be the most cost effective approach to satisfy the 2030 water demand on the North Fork if a conservation program is not implemented. This option requires the fewest new wells and, based on available water quality data, potentially the least required treatment of the North Fork alternatives. However, after potentially suitable well sites are selected, additional analyses will be required to evaluate treatment requirements, the potential site-specific water table drawdown, and any potential impacts to freshwater wetlands.

Although considerably more costly at an estimated $148M (2010 dollars), the Pine Barrens alternative may prove to be the most feasible from a water resources perspective depending upon the projected water table drawdown in area wetlands resulting from siting new wells in Riverhead. These potential impacts will need to be assessed based on the locations selected for the new wells. Similarly, the impacts of potential new wells located within the Pine Barrens upon local wetlands would also require evaluation. Finally, if additional new wells required to respond to the projected increased demand in the Riverhead Water District are sited in the eastern part of the town, the ability to withdraw additional water in Riverhead for transmission to Southold would be reduced.

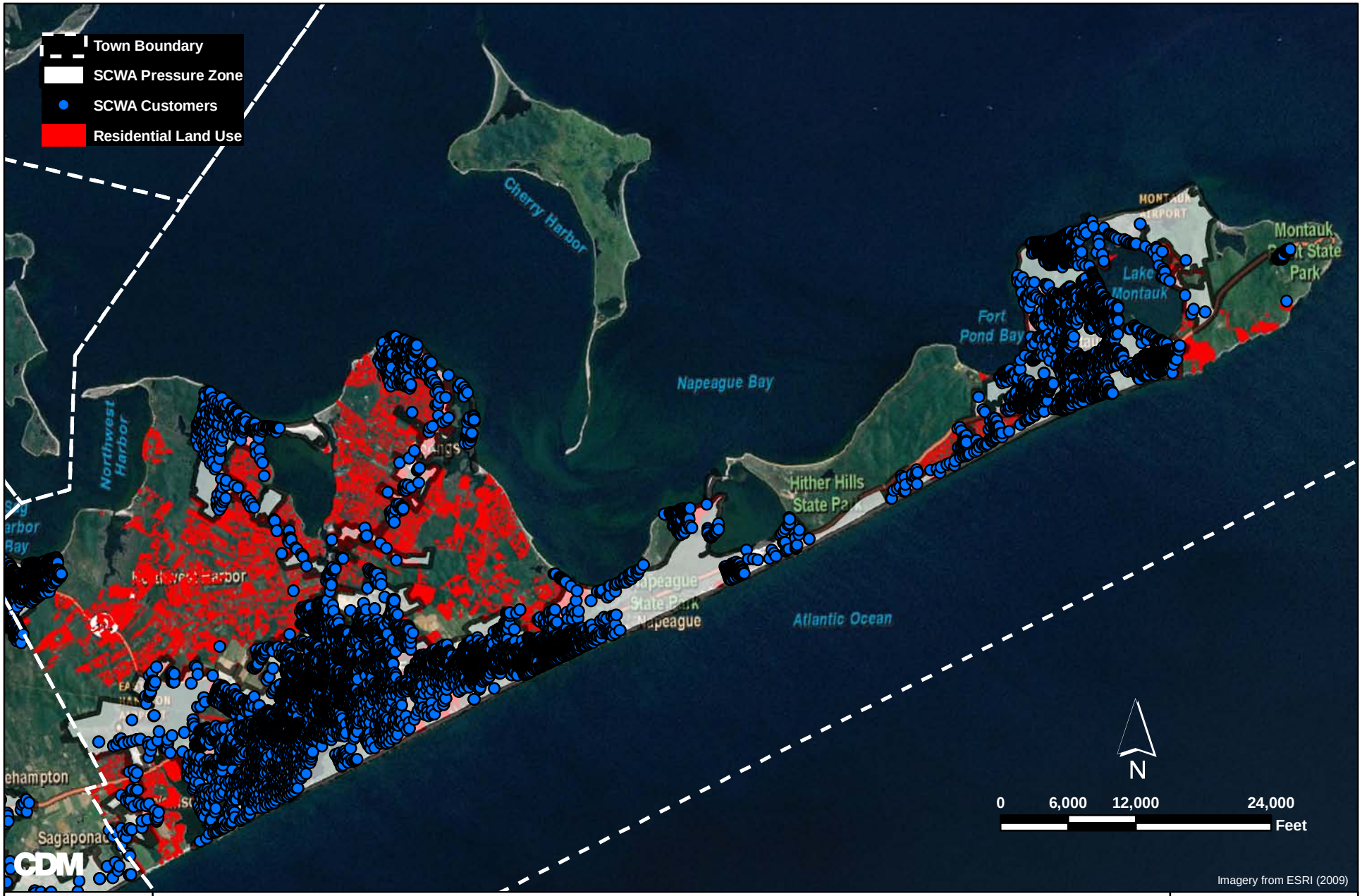
4.3.2.2 South Fork

There are also a number of areas on the South Fork where access to community supply is not yet available, including two large regions within East Hampton that currently do not have public water; the northwestern region of the town between Southampton and just west of Three Mile Harbor, and the eastern region of the town east of Three Mile Harbor and within the vicinity of Dennistown Bell Park, as shown on **Figures 4-10** and **4-11**. Although SCWA and Hampton Bays Water District have significantly expanded service areas in Southampton since the ***1987 Comp Plan*** was published, some areas continue to remain on private wells as shown on **Figure 4-11**. Expansion of the SCWA should continue in Southampton, particularly in southern regions with upgradient agricultural land uses and existing elevated nitrate levels, such as in Sagaponack and Watermill.

Existing SCWA distribution areas should be extended throughout Southampton and East Hampton. While the evaluation of future water supply needs based upon historical water use did not identify the need for additional wells to meet projected 2030 demands in Southampton (the need for additional booster pumps/stations was identified and the need for additional wells was identified in East Hampton, which shares distribution zone 23 with Southampton), SCWA has identified the need for additional capacity, based upon summer 2010 pumping demands. In an effort to resolve the low distribution pressure problems that were common in the Westhampton, Southampton, and East Hampton areas during the summer of 2010, the SCWA has applied to the NYSDEC for permits to increase its overall withdrawal capacity. The SCWA is mindful of the fact that in this portion of eastern Suffolk County, increases in capacity have the potential to induce contaminants and/or saltwater into a given well. For this reason, SCWA has developed a regional planning approach to address this problem.

The majority of the overall increase in supply for this area will come from small, incremental increases in the permitted capacities of existing wells in the area and addition of higher capacity pumps and associated infrastructure. Part of the overall increase in withdrawal is to come from new wells constructed in areas where water quality is known to be excellent, and where computer modeling has identified minimal negative impacts from increased pumping. New wells are planned for existing wellfields in Bridgehampton and Westhampton. A new well that will be screened in a productive area of the Magothy aquifer will be accompanied by a deeper monitoring well to provide early warning of saltwater upconing. In addition, new wells are being planned to replace existing wells that are prone to high iron and manganese, and contamination from documented releases. Finally, a new wellfield would be added in Bridgehampton. The SCWA's regional planning approach, balancing environmental and economic impacts, will result in a total planned increased capacity of 4,300 gpm.

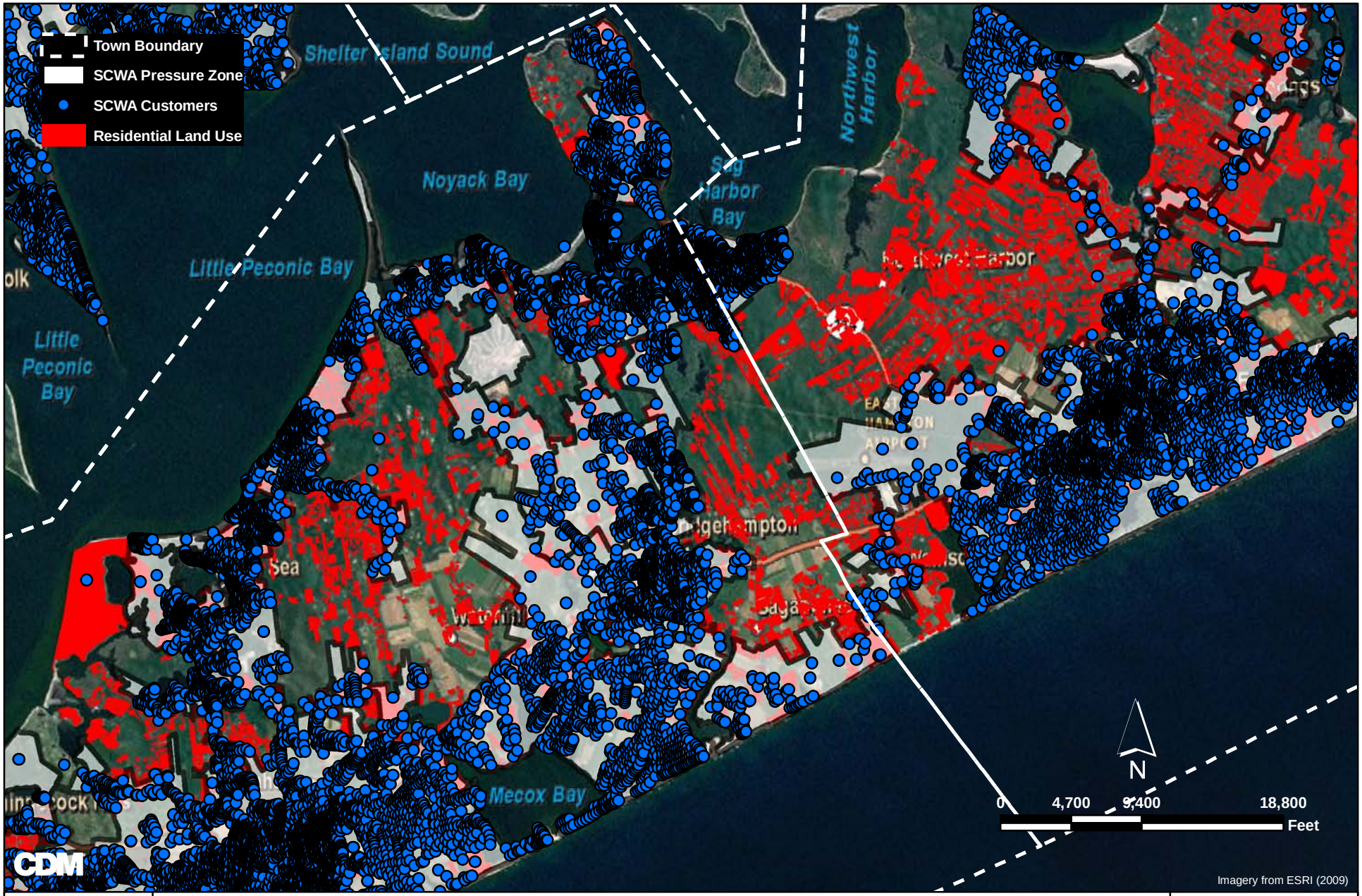
Additional supply needs, including up to 29 new wells, are projected for East Hampton to provide community supply to all residents on private wells and to meet projected new demands in 2030, unless conservation is successfully implemented to reduce outdoor use during the period of peak demand. SCWA has recently been granted easements on a number of properties that Suffolk County has acquired under the County's Drinking Water Protection Program, including properties in East Hampton as shown on **Figure 4-12**. These, and existing SCWA properties should be used for the new wellfields, depending upon the location(s) of additional demand.



Western Residential Areas in East Hampton Not Served by Public Supply

Suffolk County Comprehensive Water Resources Management Plan

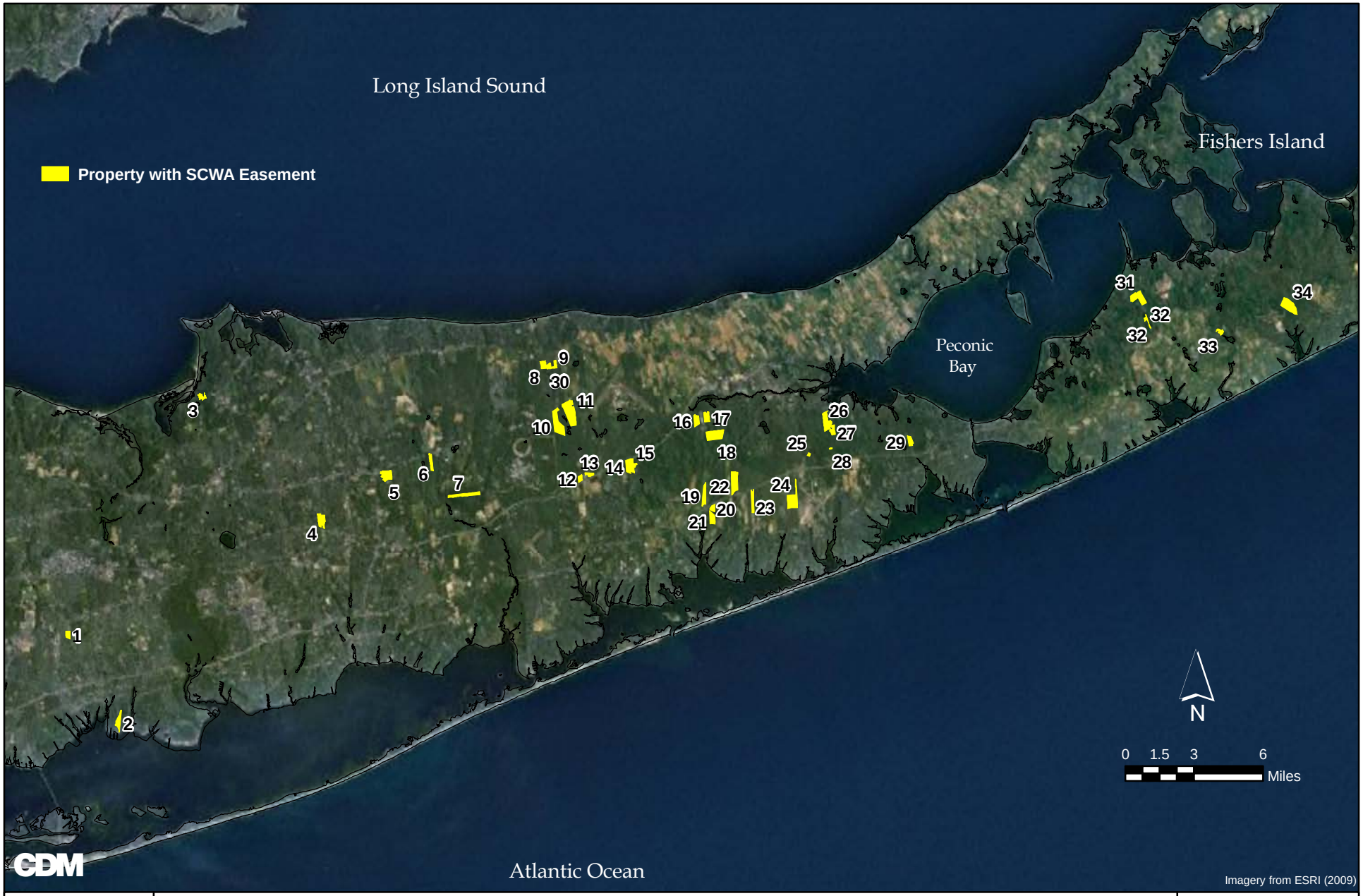
Figure 4-10



Eastern Areas in Southampton Not Served by Public Supply

Suffolk County Comprehensive Water Resources Management Plan

Figure 4-11



Suffolk County Comprehensive Water Resources Management Plan
Properties with Suffolk County Water Authority Easements
(from, SCWA, 2010)

Figure 4-12

4.3.2.3 Eastern Brookhaven

Based on population projections and current peak water supply pumping rates, an additional ten to eleven new wells will also be required in the Town of Brookhaven:

- Zone 18: Two wells at 1,200 gpm each;
- Zone 20: Seven wells at 900 gpm each;
- Outside of the existing SCWA distribution area, depending on the distribution system configuration, one additional well may be needed at 900 gpm, and
- Depending upon the areas of additional demand, and the sites selected for new wells, additional booster pumps/stations may also be required.

SCWA has a number of properties in the town of Brookhaven, including the easements recently granted from properties acquired under the County's Drinking Water Protection Program (**Figure 4-12**). These properties could be used for the new wellfields, depending upon the location(s) of additional demand and raw water quality.

4.3.2.4 Northport

SCWA has evaluated the potential to replace nitrate-impacted wells in the Northport area with water obtained from new wells to be located in the Pine Barrens (**Task 8.3 Water Transmission Costs**, SCWA 2010). A water supply project of this scope would include the following components:

- Nine new wells in the Pine Barrens, providing 12,000 gpm;
- Two to three new pump stations, and;
- A 28 mile transmission main running along the Long Island Expressway west from Exit 70 to Exit 52, where it would join the proposed Northport transmission main.

SCWA has developed a total preliminary cost estimate of over $51M for this option and has noted that additional costs are likely to be associated with booster pumps along the route of the new main.

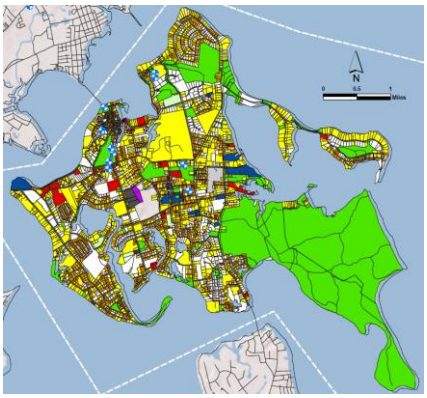
SCWA continues to explore other alternatives. Consideration is being given to siting a new wellfield at several potential alternative locations in southeastern Huntington/southwestern Smithtown where water quality data appears to indicate that lower levels of nitrogen are present, such as West Hills County

Park in Huntington. This would reduce transmission costs from the Pine Barrens alternative considerably. Site-specific costs, including well station, treatment, transmission, and any additional pump stations will be dependent upon the location selected.

SCWA had also explored the possibility of utilizing a new Lloyd well for blending. A Lloyd well would be sited within the area of northern Huntington where the USGS hydrologic framework indicates that the Magothy formation is not present. The 1986 amendment to New York State's Environmental Conservation Law established a moratorium on new Lloyd wells in areas that are not coastal communities. Coastal communities were defined as areas where the Magothy aquifer is either not present, or is contaminated with chlorides. If this option were to be approved, improved water quality could be provided by blending water from newly constructed Lloyd wells with water from the existing Magothy wells, thereby eliminating the need for costly nitrate treatment or long distance transmission. Additional detailed evaluation of the impacts of using Lloyd water is warranted.

4.3.2.5 Shelter Island

Community, non-community and private supply wells currently provide potable supply to Shelter Island residents. Because there is no industry and very little commercial and agricultural land use on Shelter Island, the potential to introduce contaminants such as VOCs and pesticides to the aquifer is lower than elsewhere in the County, and the shallow private wells are therefore not as susceptible to contamination. Nevertheless, SCDHS has documented the presence of contaminants such as nitrate and ibuprofen in the groundwater, which are most likely introduced by on-site wastewater disposal systems, along with MTBE, presumably from stormwater runoff and previous spills/discharges of gasoline containing MTBE.



Land Use on Shelter Island (Suffolk County Department of Economic Development and Planning)

Provision of a community supply to all of Shelter Island requires additional detailed study, due to the hydrogeologic characteristics of the local aquifer system. Siting of up to seven supply wells that would be required to meet projected 2030 demands could be challenging, given the limited extent of the freshwater system, and the low productivity of much of the formation. In the past, the SCWA has considered development of a transmission main from North Haven (SR 114) to provide water from the South Fork to Shelter Island residents. SCWA has developed a preliminary estimate of $2.3M for directional drilling of 2,500 feet of 24-inch high density polyethylene (HDPE) pipe from North Haven to Shelter Island. A total project cost to provide public supply would also include the cost for new wells, and distribution lines throughout the Town.

In the meantime, it is recommended that private wells undergo a comprehensive water quality analysis every three years to confirm that the potable supplies remain in compliance with MCLs (EPA recommendations of annual sampling for total coliform, nitrate, pH and other suspected contaminants should also be implemented).

4.3.3 Additional Recommendations Pertaining to Private Wells

In general, safe potable water that is in compliance with drinking water MCLs, USEPA health advisories and New York State guidance levels can most reliably be provided by a community water supply. It is recognized however that extension of public supplies to areas currently served by private wells will not occur overnight; the considerable planning, siting, permitting, design and construction required to extend a community supply, particularly on the East End, will take years. The following recommendations have been identified to provide additional protections for residents that continue to utilize private wells in the interim, in accordance with Suffolk County's philosophy that access to a safe potable supply in compliance with applicable drinking water criteria should be available to all.

- SCDHS Division of Environmental Quality (DEQ) Office of Water Resources (OWR) should develop a private well database including well location, date of installation, sampling dates, treatment units installed and any water quality problems. Wells that have not been sampled within the last 10 years should be targeted for sampling and analysis. SCWA has developed a GIS database of their customer base, which was utilized during the private well analysis (Task 7.5 Private Wells, CDM, 2009). Continued updates from water purveyor databases should be utilized (particularly the larger suppliers such as SCWA, South Huntington, Dix Hills, Greenlawn, Riverhead and Hampton Bays) to build the private well database.

- SCDHS OWR should consider requiring all private wells to undergo a comprehensive water quality analysis, including testing for bacteria and nitrate, every three years, to confirm that the water supplied complies with MCLs.

- Suffolk County should consider additional outreach about the water quality testing program for private wells to inform residents that the program exists, and the benefits and safeguards provided by proper testing. Outreach can be in the form of a mailer targeted to parcels that are not already served by public supply and/or highlighted on the County's website. Additional staffing (samplers and laboratory

technicians) will be required to collect and analyze additional samples, should the program be more highly utilized.

- The existing SCDHS fee for private well sampling and analysis is $100, but an exemption can be filed for households that have a cumulative family income of less than $25,000. However, based on a New York State minimum wage of $8.75 per hour (2015), a three person household of minimum wage earners would have an annual household income of $54,600. The exemption should be updated to more contemporary minimum wage assessments; SCDHS DEQ should consider increasing the cumulative family income for the water quality exemption to $55,000.

- Option B of Section 406.4-12(b) of the SCDHS well standards should be revised to include additional specifications for double casing of the test well through an aquiclude or confining layer to prevent poorer quality water from the shallow aquifer from migrating to deeper portions of the aquifer that may be locally hydraulically separated by the aquiclude/clay layer.

- Suffolk County should require a variance for private well installation in areas where the saltwater interface is <40 feet below the water table, so that they have the opportunity to review all pertinent information including the saltwater interface location (induction log) and proposed well screen depth.

- SCDHS OWR should revise the Suffolk County Private Water System Standards to be consistent with the more stringent New York State Standards requiring a minimum distance of 200 feet between a private well to a cesspool (or leaching pool), where property sizes allow.

4.3.4 County-wide Peak Pumping Demands

Conservation is described in depth in the **1987 Comp Plan**. At that time, total community supply pumpage in the County was estimated at 146 mgd, and it was assumed that a 5 percent reduction in pumpage could be achieved by implementation of a conservation program. In fact, while the Suffolk County population has increased by approximately 14 percent, from 1,284,231 in 1980 to 1,499,738 in 2013 (http://quickfacts.census.gov), average daily community water supply pumping during that same time increased by 56 percent, from 146 mgd to 228 mgd. Approximately 80 percent of groundwater withdrawn in Suffolk County for all purposes is pumped by community water suppliers. Community supply pumping during the winter months has only increased by approximately 15 mgd since 1987/1988, while pumping during the summer has

increased by 100 mgd or more. Much of this increase is attributed to the installation and use of automatic irrigation systems.

Per capita water use varies significantly by town, as summarized on **Table 4-5.** Some of this apparent variation is due to the fact that more commercial and industrial water users exist in Babylon, for example, as compared to Shelter Island. In addition, landscape irrigation practices and seasonal population increases on the East End have a significant impact.

Review of average monthly pumping from the Greenlawn Water District, Riverhead Water District, SCWA, and the South Huntington Water District reveals that the demand on community supply systems increases significantly during the summer months. **Figure 4-13**, average monthly pumping in SCWA Distribution Zone 1, illustrates the pattern observed in many areas of the County. In fact, approximately 42 percent of the total average annual withdrawal from SCWA between 2006 and 2009 exceeded the baseline water supply pumpage and is presumed to supply outdoor water uses, including irrigation.

Table 4-5 Per Capita Water Usage by Town

Town	Gallons per Capita per Day (2008)
Shelter Island	92
Islip	116
Southampton	117
Southold	118
Brookhaven	141
Huntington	166
Smithtown	198
Babylon	199
East Hampton	230
Riverhead	253

Review of current (2013) pumpage by Town indicated similar patterns for most west end towns. Recent changes to per capita water use in the east end towns

were not readily discernible, due to the impacts of seasonal population changes.

Average Monthly Pumping from SCWA Distribution Area 1

Average monthly pumping from the Greenlawn, Riverhead and South Huntington Water Districts shows similar patterns, in that approximately 40 percent of total average annual water supply pumping appears to be utilized for outdoor water use during the growing season.

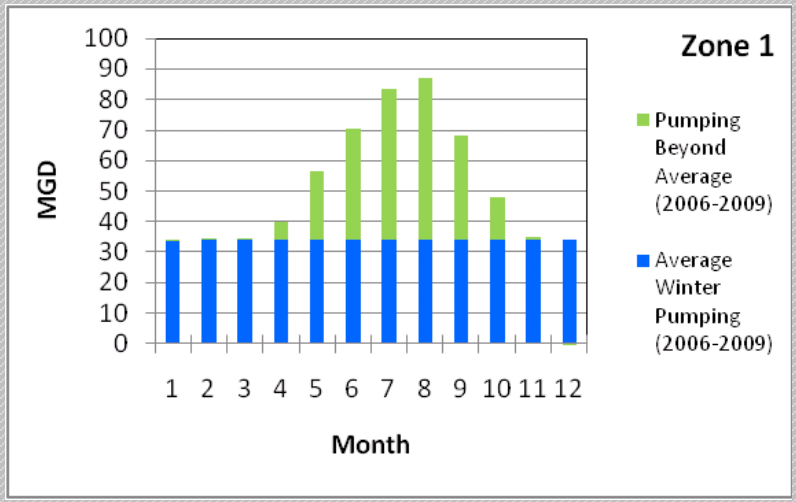


Figure 4-13 Average Monthly Pumping from SCWA Distribution Area 1

Previous estimates have concluded that approximately 30 percent of SCWA pumpage is utilized exclusively for lawn irrigation (Munster, 2004). Almost 60 percent of the total annual pumpage in Riverhead has recently been estimated to be attributed to outdoor use.

While there are adequate groundwater supplies to meet all potable needs within the County, existing infrastructure is not adequate to respond to the increased water supply demand during hot, dry summer periods, in particular the increased use of automatic irrigation systems during the early morning hours, as exemplified during the summer of 2010. For example, thirteen wells provided potable water supply for the Riverhead Water District in 2010. From November through March; operation of just four of those wells was usually sufficient to meet the water demands of Riverhead residents. However, during hot dry summer days, pumping of all thirteen wells was not enough to meet the increased demand. The Town estimates that during the summer months, eighty percent of the water pumped is used to water lawns, and that seventy percent of residents have irrigation systems. In fact, per capita water use in Riverhead was the highest of any town in the County. Since 2010, the Riverhead Water District has installed five new public water supply wells to address the increased demands.

Therefore, the Suffolk County water conservation program should focus upon outdoor water use. The increased demand resulting from the use of automatic sprinkling systems should be specifically addressed to reduce the summer time pumping peaks, and to reduce the amount of additional infrastructure required to extend community supply to areas of need, such as the North Fork, where fresh water supplies are more limited. In recognition of the more limited supply of fresh water available, Shelter Island has already addressed the need to reduce lawn irrigation; new underground sprinkler systems are prohibited, and existing underground irrigation systems must be removed by September 2013 under Shelter Island Town Code, section 82-5.

Outdoor conservation measures that have been implemented elsewhere are summarized on **Table 4-6**.

Table 4-6 Potential Outdoor Conservation Measures

Potential Outdoor Conservation Measures
Irrigation restrictions (e.g., odd/even)
Irrigation controller rebates
Rain sensor regulations
Landscape requirements
Turf removal programs
Landscape professional/contractor education programs
Xeriscape workshops/education
Landscape contractor certification program
Soil moisture sensor rebate
Gray water system education
Water waste prohibition
Rain barrel catchment
Swimming pool and spa covers
Irrigation audits of large turf areas
Reclaimed water for large turf areas
Conservation Rates
System Water Audits
Leak Detection
Distribution system pressure regulation
Irrigation controller rebates

Measures that have been effective at reducing outdoor water use and reducing peak pumping needs include:

- Developing customer education programs;

- Modifying rate structures;
- Implementation and enforcement of outdoor water use ordinances and
- Implementation of incentives or ordinances for low water demand landscapes.

It is recommended that a County-wide conservation program consisting of the following four components be developed to reduce peak summertime pumpage in Suffolk County:

1. A County law mandating rain sensors to shut sprinkler systems off when it is raining should be enacted.
- SCDHS should develop and implement a conservation program to address all suppliers in the County.
- Water suppliers in the County should consider implementing an increasing block rate structure for seasonal use.
- A County law mandating odd-even lawn watering days should be promulgated by the Suffolk County legislature.

Each of these recommendations is discussed in more detail below.

4.3.4.1 Rain Sensor Shut-off Devices

While the public has become increasingly aware that both water and money can be saved by turning off in-ground sprinkler systems during precipitation events, casual observation indicates that sprinkler systems on a number of properties continue to operate even during rain events.

A local law should be established to require that all new in-ground sprinkler systems incorporate a rain sensor that would turn the system off when a pre-specified amount of precipitation is detected. Although installation of rain sensors will not reduce the peak pumping rates that occur during hot, dry periods, they will reduce demand on the water supply system during the summer months, as well as reduce power consumption, potable supply treatment costs and run-off.

4.3.4.2 Conservation Program

Article 4 of the Suffolk County Sanitary Code addresses conservation as summarized on the following page:

760-433 Conservation

- Owners of public water supply systems shall be responsible to take water conservation measures to control the quantity of water being utilized.

- The Department may require the owner of a public water system to submit documentation that an adequate water conservation program is in place.

It is recommended that Suffolk County, in collaboration with the water suppliers, establish a County-wide conservation program to educate residents and commercial and industrial water users on the benefits and opportunities associated with water conservation, to track the success of the outdoor irrigation reduction recommendations and to enforce compliance with the requirements. Since the time that the ***1987 Comp Plan*** was prepared, an increasing number of utilities throughout the country have implemented very successful water conservation programs. Both United Water New York (UWNY) and the Massachusetts Water Resources Authority (MWRA) have implemented extensive and comprehensive water conservation programs – per capita use in both supplier service areas is less than 100 gallons per capita per day (gpcd). In Suffolk County, only Shelter Island has a per capita use rate of less than 100 gpcd.

In Suffolk County, basic conservation measures such as metering, publication of voluntary water conservation measures on supplier websites, billing inserts and the annual drinking water quality reports are already in place. However, participation in programs focused on reducing peak outdoor water demand is voluntary in most towns, with the exception of Shelter Island. Additional information about the SCWA (and other suppliers') customer bases is required in order to develop a comprehensive conservation program, as commercial and industrial customers have different demands and opportunities for conservation than residential customers. To date, this type of information has not been available.

SCDHS OWR should work with County water suppliers to support the development of a comprehensive conservation program. The basic steps and components of a potential program are outlined below:

- The water suppliers should compile data on water demand per sector (residential, commercial, industrial) by season, to assess impacts on peak demand and help to guide conservation efforts;

- Specific peak demand reductions should be targeted, perhaps by supplier or by Town;

- Water suppliers should provide data on daily and peak pumping rates to OWR to assess the effectiveness of proposed conservation measures in reducing peak demands, and to identify any potential need for increased conservation measures;

- If implementation of the recommended conservation measures (e.g., alternate day watering, automatic rain shut-off, conservation rates) does not reduce the peak demands as anticipated, customer surveys should be conducted to further understand sector water demands, compliance with conservation measures, and the effectiveness of proposed measures;

- SCDHS OWR should consider working with Cornell Cooperative Extension to monitor evapotranspiration rates, and to post evapotranspiration data on the County website to guide lawn watering decisions;

- SCDHS OWR should work together with Cornell Cooperative Extension and the water suppliers to advance xeriscaping principles throughout the County; and

- Conservation measures should be incorporated into the public education initiatives described in the Task 10 memoranda.

4.3.4.3 Seasonal Rate Structure

Empirical studies have shown that outdoor water use is more responsive to price than indoor use, especially during the summer months when outdoor use is greatest. Since outdoor use tends to be more discretionary than indoor water use, people are more willing to reduce outdoor water use as prices increase. Because outdoor water use occurs mainly in the peak summer months, the costs of providing outdoor peak demand can be increased; outdoor use should be priced at a higher rate during peak periods of the year, both to help to recover the incremental cost of providing water during peak periods and as an inducement to conserve water because of seasonally limited supplies. The American Water Works Association (AWWA) reports that "conservation rates have proven to be an effective tool for reducing peak season demand" (AWWA, 1997) and a recent Water Environment Federation (WEF, 2010) study reported that saving money was the most frequently identified factor motivating conservation. AWWA has documented that only 1 out of 3 water suppliers continue to use uniform rates.

Conservation-based rate structures have been used successfully to reduce water demands in arid regions (Albuquerque, NM and Phoenix, AZ), in rapidly developing areas (Cary, NC), and in nearby suburban areas with similar

household characteristics (Rockland County, NY, northern New Jersey). Conservation-based rate structures can include inclining rate blocks, seasonal rates, and excess use charges. Developing the appropriate rates and definition of 'excessive water use' is one challenge that water suppliers face when establishing rate structures to motivate conservation. Several Suffolk County water suppliers have already established increasing block rates.

Establishment of an increasing block structure, an excessive use rate structure, water budget based rate structure, or seasonal rates from April through September are all options to reduce peak summertime usage. The increasing block (also known as inclining block) rate structure increases the unit cost for water as water use increases; today this is the most common rate structure used by water utilities. Increasing block rate structures typically have two to three tiers, although some water suppliers have implemented rate structures with a greater number of tiers. The first tier establishes a reasonable minimal cost based on minimum water use for a typical household in the service area, and the next tier(s) are priced significantly (e.g., more than 50 percent) higher for additional water use. The Alliance for Water Efficiency (www.allianceforwaterefficiency.org, 2009) reports that the increasing block tier structure is considered to be the most effective rate structure to motivate conservation. Excessive use rates establish a significantly higher rate for "excess use"; this type structure requires definition of excess water, which is not always straightforward. Water budget- based rate structures are the most complex, data-intensive rate structures, although they are also very effective in prompting conservation, and are fair, as they are based on individual household needs. Based upon the number of people per household and the square footage of landscape, base water usage is established for each residence, and rates increase according to established tiers as the baseline water use is exceeded. This approach requires significant work to establish the baseline water use, as well as more complicated tracking and billing procedures. Finally, seasonal rates can be established during the peak summer use period. In some areas, this may be three months (from June through August), in others it is the six month period from May through October.

Because conservation in Suffolk County is targeted to reduce summer time peak water use, implementation of a seasonal rate structure may be the simplest and most effective rate structure to prompt reduced outdoor water use. SCWA has already implemented a monthly meter reading/billing program for large accounts. Monthly billing has been shown to be more effective than quarterly billing in providing timely feedback to water customers in terms of how much water they are using, and the associated costs. The feedback provided by quarterly billing is not as timely; hence residents cannot respond to increased charges resulting from increased water use as promptly.

4.3.4.4 Odd/Even Watering Restrictions

Cornell Cooperative Extension and others have determined that in general, landscaping requires one inch of water each week to thrive. In fact, long term average precipitation records show that Suffolk County receives approximately 4 inches of precipitation per month throughout an average year. During lower than average precipitation months during the growing season, or when precipitation is not distributed consistently throughout the month, supplemental water may be required. However, automatic irrigation systems that water lawns each day, including rainy days (see **Figure 4-13**), can often exceed the targeted one inch of precipitation per week. Although the amount of water delivered to a lawn by a sprinkler system varies depending upon the distribution system pressure, the sprinkler setting and the duration of sprinkling, it is estimated that about an inch of water is provided by an hour of sprinkling (United Water Suez).

Therefore, watering a lawn for just 15 minutes each day would provide almost twice as much water as the lawn requires, even if there were no precipitation events during that week. In fact, an assessment of precipitation at 15 Suffolk County precipitation gages during the 'growing season months' of April through September during the 1960s drought of record showed that the growing season irrigation need ranged from just 8.6 inches in 1963 to 10.3 inches in 1964.

Some Suffolk County suppliers (e.g., Dix Hills) already have established mandatory odd/even irrigation requirements with fines for non-compliance. SCWA, the largest water supplier in the County, does not have a formal conservation program in place. While information provided on the SCWA website identifies odd/even irrigation as a recommended conservation measure, they currently have no formal conservation enforcement program. Therefore, establishment of a local law restricting lawn watering to odd/even days based upon house number, should be established by Suffolk County to reduce unnecessary landscape irrigation throughout the County.

While additional information is required to more accurately estimate the reduction in peak pumping demand that would result from enactment of this legislation, on a preliminary basis it is assumed that the peak demand on the system could be expected to be reduced by twenty-five percent (reducing the peaking factor to about 3).

4.3.5 Supply and Pumpage Monitoring

The Suffolk County water supply is monitored by both the SCDHS and by water suppliers themselves to assess water quality. Public health is protected by existing monitoring programs that analyze for more parameters and at

greater frequencies than is required by federal and state regulations, in most cases. SCDHS continues to administer a multi-tiered monitoring program that includes the County's aquifer system (source water), community, non-community and private supply wells, and targeted groundwater investigations.

Additional water quantity and water quality monitoring is recommended, to protect public health, to provide the information necessary to better identify and respond to aquifer system stresses such as drought conditions, and to support management functions. Recommended quantity and quality monitoring of the County's aquifer is described in Section 3 of this document. Water supply monitoring recommendations are summarized below.

Water quantity monitoring recommendations include:

- All non-residential private wells (e.g., agricultural, commercial, industrial, non-community) should be metered. Well locations and depths should be reported to SCDHS OWR for incorporation into a new database. Pumpage for all non-residential wells should be reported on an annual basis to SCDHS OWR. A comprehensive database of all of the water supply withdrawals will help the SCDHS to better assess the demands on the aquifer system, in particular during times of drought, and the potential for saltwater intrusion. Perhaps even more significantly, knowledge of pumping centers and approximate rates will provide the SCDHS with the information necessary to assess the potential migration of any contaminants in the local aquifer system, and will also allow them to notify water users of any potential threats to the quality of their water supply. Finally, an assessment of private well pumpage will assist the SCWA in siting and managing supply wells, particularly on the North Fork where large capacity agricultural wells can have a significant impact on the water table.

- SCDHS OWR should maintain the database of well locations and pumpage, and incorporate this information into their facility review procedures and response procedures as appropriate.

Drinking water supply recommendations are summarized in **Table 4-7**.

Table 4-7 Drinking Water Supply Recommendations

Table 4-7
Drinking Water Supply Recommendations

Provision of Community Supply

Extension of community supply to all Suffolk County residents is recommended, in particular to areas of documented aquifer contamination in Southold Town and southern Southampton, as well as to areas served by non-community systems with documented contamination.

Residences using private wells should be encouraged to connect to public (community) supply wherever it is available.

Existing community supplies with aging infrastructure should be incorporated into the SCWA (or other municipal) service area. Water distribution systems serving developments such as condominiums, apartments, townhomes or home owners associations should be owned and maintained by the community supplier.

Conservation

It is recommended that a County-wide conservation program, including the following four components, be developed to reduce peak summertime pumpage in Suffolk County:

1. A County law mandating rain sensors to shut sprinkler systems off when it is raining should be enacted by the Suffolk County legislature.
2. SCDHS should develop and implement a conservation program to address all suppliers in the County.
3. Water suppliers in the County should consider implementing an increasing block rate structure for seasonal use.
4. A County law mandating odd-even lawn watering days should be enacted by the Suffolk County legislature.

Table 4-7 (continued)
Drinking Water Supply Recommendations

Private Wells

SCDHS DEQ OWR should develop a private well database including well location, date of installation, last sample date, treatment units installed and any water quality problems. Wells that have not been sampled within the last 10 years should be targeted for sampling for standard parameters.

SCDHS DEQ OWR should consider additional outreach about the water quality testing program for private wells to inform residents that the program exists, and the benefits and safeguards of proper testing.

SCDHS DEQ OWR should consider requiring all private wells to undergo a comprehensive water quality analysis, including testing for bacteria and nitrate, every three years, to determine compliance with MCLs.

SCDHS DEQ should consider increasing the cumulative family income for the private well testing fee exemption to $50,000.

Option B of Section 406.4-12(b) of the SCDHS well standards should be revised to include additional specifications for double casing of the test well through an aquiclude or confining layer so that poorer quality water from the shallow aquifer is not introduced to deeper portions of the aquifer that may be locally hydraulically separated by the aquiclude/clay layer.

SCDHS DEQ should require a variance for private well installation in areas where the saltwater interface is <40 feet below the water table, so that they have the opportunity to review all pertinent information including the saltwater interface location (induction log) and proposed well screen depth. New residences should be required to connect to public water if a main is located within 500 feet.

SCDHS DEQ should revise the Suffolk County Private Water System Standards to be consistent with the more stringent New York State Standards requiring a minimum distance of 200 feet between a private well and septic system leaching pool where property sizes allow.

Table 4-7 (continued)
Drinking Water Supply Recommendations

Monitoring

Additional monitoring and data management is recommended to protect public health, to better identify, understand and respond to aquifer system stresses and to support management functions.

All non-residential private wells (e.g., agricultural, industrial, commercial, non-community, geothermal) should be metered. Well locations and depths should be reported to SCDHS OWR for incorporation into a new database. Pumpage for all non-residential wells should be reported on an annual basis to SCDHS OWR. SCDHS DEQ should maintain the database of well locations and pumpage, and incorporate this information into their facility review procedures and response procedures as appropriate.

Existing analytical methods should be expanded to increase the number of PPCPs analyzed, including cotinine, diltiazem, hydrochlorothiazide, meprobamate, metropolol, naproxen, 4-nonylphenol, phenobarbital, sulfamethoxazole, tramadol, tributyl phosphate (TBP), Triphenyl phosphate (TPP), Tri (2-botoxy-ethyl) phosphate (TBEP), Tri (2-chloro-ethyl) phosphate (TCEP), Tri (2-dichlorisopropyl)phosphate and the Ames test.

Perchlorate should be added to the additional parameters note for Table 5 in Section 406.4-13. Nitrite, sodium, hardness, alkalinity and turbidity should be added to the parameter list (Table 5).

Outpost wells to monitor saltwater intrusion and upconing should be sited and constructed for all new wellfields located in coastal areas and the North and South Forks.

Assess potential impacts of water supply pumping on the Lloyd aquifer.

4.4 Implementation

4.4.1 Implementation Framework

A complete set of recommendations, including the framework for implementation of the drinking water supply recommendations is described in Section 9. Recommendations to improve groundwater quality and recommendations for data collection and management will also support the ability to provide a safe and reliable potable supply to Suffolk County residents. The implementation framework identifies the "owner", or entity responsible for implementation of each recommendation, other collaborators whose participation will be required and the time frame for implementation. Implementation of each recommendation is subject to funding availability, as well as other variables that will influence the timing of implementation, or even whether the recommendation can be fully implemented (e.g., community support). Most of the key activities associated with provision of extending community supply so that a safe and reliable potable source is available to all residents have already been initiated.

4.4.1.1 Extension of Community Water Supplies

The cost to extend community supply to County residents is significant; nevertheless, a conceptual cost benefit accounting analysis documented as part of Task 12.1 (CDM, 2010) which assessed the recommendation to extend public water supply to Southold on the North Fork concluded that based on the calculated benefit/cost ration, the public health and environmental benefits exceed the costs of the conceptual program. While a full cost benefit accounting of this recommendation would require more research to support the estimates of costs and benefits than can be accomplished as part of this project, it did provide a good example of the usefulness of this approach, and some guidance on the value of the recommendation.

4.4.1.2 Conservation

Groundwater pumpage projections based on 2008 peak demands concluded that over 100 additional wells and associated infrastructure would be required to meet 2030 water demands. Successful implementation of outdoor conservation measures to reduce the peak demand from approximately 4.25 down to 3.0 times the average demand would significantly reduce the number of additional wells needed during the planning period, as summarized on **Table 4-8** below. This is particularly important for East End areas such as the North Fork, where wells have a limited potential capacity due to the possibility of saltwater intrusion, and where the cost of treatment must also be considered given widespread nitrate and pesticide contamination.

Table 4-8 Projected New Supply Wells Required with and without Conservation

Town	Community Supply Pumping (MGD) (2013)	Peaking Factor	Projected Community Supply Pumping (MGD) (2030)	Number of Wells Needed (Existing Factor/Peak Reduced to 3.0)
Babylon	27.6	3.52	29.1	1/1
Brookhaven	65.7	4.14	81.9	11/4
East Hampton	6.4	4.29	11.5	29/6
Huntington	38.8	3.99	41.4	8/2
Islip	41.6	3.61	43.8	0/0
Riverhead	7.6	4.25	12.7	23/13
Shelter Island*	0.1	1.00	1.8	7/7
Smithtown	22.7	4.13	24.9	1/0
Southampton	15.	4.44	17.2	0/0
Southold	2.8	4.53	4.6	38/4

* Peaking factors not applied to Shelter Island. Peak is the increase in summer population.

Well needs are dependent on where actual development occurs

While the cost of developing and promulgating a new local law is not significant, it is assumed that one person with a vehicle will be needed to develop educational materials, monitor and enforce the local law, and, using data reported by the suppliers, monitor and document the effectiveness of the law in reducing the peak pumpage.

By contrast, if conservation is not implemented, as shown on **Table 4-4**, the incremental cost of new wells, transmission and treatment for Southold alone ranges from approximately $5M to $45M (in 2010 dollars), without including the cost for land for the new facilities. Annual pumping and treatment costs would also need to be considered on an area or site-specific basis, as described above for Southold. Implementation of conservation is clearly more cost-effective than construction of additional wells, and also provides additional environmental benefits.

It can be concluded that the cost of providing and operating additional infrastructure to satisfy lawn watering demands is significantly greater than the cost to establish new local laws mandating odd/even water restrictions and rain sensor shut-off devices. However, capital investment and annual operational costs must also be considered within the context of the anticipated revenue gained by the suppliers while meeting the peak demand. For example, again considering the Town of Southold, and assuming that the peak demand is sustained for five hours each day during 30 summer days, the SCWA would realize additional gross annual revenue of over $200,000 that year, based on

the higher peak pumpage rates and using the current $1.67/1000 gallon SCWA rate. At a rate of $200,000 year, it would take at least several decades to recoup the investment in additional infrastructure, based upon successful implementation of the least costly alternative considered.

4.4.1.3 Monitoring, Data Management, Evaluation and Coordination

As a minimum, all drinking water, ground water quality and quantity and surface water quality and quantity information should be entered into a new integrated database. Field data should be entered via portable hand held devices (e.g.; tablet such as an iPad or other mobile device) to reduce the time needed for transcription, data entry and data availability. Field and laboratory data should be regularly reviewed after routine uploading. SCDHS DEQ OWR should be responsible for maintaining this database. This database would comprise a portion of the proposed Capital Project 4081, the Environmental Health Information Management System (EHIMS) described by SCDHS that would encompass all of the Environmental Health programs. In addition to the groundwater, surface water and drinking water supply data, the database would incorporate data currently located within 30 different databases, including:

- Community, Non-Community and Bottled Water Supply Plant Inspections
- Private Well Inspection and Sampling
- Groundwater Pollution Investigations and Sampling
- Community Water Supply Plan Review
- Bathing Beaches
- Individual Water and Sewer Construction Plan Review
- Reality Subdivision Water and Sewer Plan Review
- State Pollutant Discharge Elimination System (SPDES)
- Sewage Treatment Plant Monitoring
- Petroleum Bulk Storage Tank Plan Review Inspection and Registration
- Enforcing Toxic and Hazardous Materials Storage regulations, which involve plan review, inspection and permitting of commercial and industrial facilities

- Sampling of Marine and Surface Waters for Chemical, Bacteriological and Algal Quality
- Environmental Remediation
- Public and Environmental Health Laboratory (PEHL) Laboratory Information Management System data integration with water quality databases
- State Environmental Quality Review (SEQR) Reviews

Integration of all of the existing databases addressing water quality and water quantity, as well as the factors affecting water quality and water quantity (e.g., facilities, spills, etc.) into a single database that could be viewed using a GIS interface would provide a number of benefits. For example, all of the datasets could be accessed by any user, instead of limiting access to an individual or group with access to and knowledge of a particular type of software; information currently residing within different databases could be mapped simultaneously to help assess water resource implications, and the data back-up would protect against the impacts of any hardware malfunctions (e.g., individual personal computer failure) or facility disaster (e.g., paper records).

Alternatively, it could be part of a larger, comprehensive Countywide database as recommended by IBM's Smarter Cities Challenge Report. The data would be readily available to all departments within the County to help to identify public health concerns and water resources issues, to identify appropriate management actions, to assess priorities and guide decision making. This data would be readily accessible so that queries relating to ground or surface water quality or data trends can be readily answered, issues can be rapidly and appropriately addressed, and the County can have the information to develop responses to long range concerns such as sea level rise. Finally, the data should be made available to other stakeholders outside the County such as SCWA, NYSDEC, the estuary programs, etc., so that timely decisions can be made based on the best available information.

It is recommended that SCDHS prepare a concise annual report summarizing the results of the countywide groundwater and surface water quality and quantity monitoring.

The report should contain, at a minimum, the following information:

- Background information on precipitation over the sampling period;
- Water supply pumping from each of the major water use categories, and monthly pumping from community supplies;

- Mapping of ground water levels, and figures depicting baseflow and stream flow; figures showing groundwater baseflow as a percentage of total stream flow;
- "Dot plot" type graphics depicting countywide water quality within each aquifer for each parameter of concern (e.g., nitrates, most often detected VOCs, pesticides, PPCPs);
- Statistics on water quality comparing annual water quality with baseline (1987, 2005 and 2013) years (baseline year dependent upon parameter of concern);
- Trend graphs of contaminants of concern for selected indicator wells, as well as trends in the minimum, mean, and maximum concentrations from all the wells;
- Water level graphs of selected indicator wells showing trends;
- Saltwater interface monitoring results depicting chloride concentrations with time;
- Results of nitrogen and pesticide analyses in monitoring wells characterizing agricultural areas;
- Identification of any newly observed contaminants of concern for future targeting;
- Tables summarizing surface water quality data identifying any contaminants of concern identified;
- Figures depicting trends in nitrate concentrations at sampling stations in the Long Island Sound, Peconic Estuary and South Shore Estuary; and
- Tables summarizing water quality data at the estuary program sampling locations and figures showing time histories of nitrogen and dissolved oxygen at key estuary program sampling locations.

In addition, each document should identify the apparent most significant issues affecting the resource and identify any additional priorities for monitoring and/or research.

Over the years, new monitoring tools and improved analytical capabilities have facilitated the identification of increasing numbers of contaminants in the environment, and the presence of these constituents can be detected at lower and lower concentrations. In addition, new tools and more powerful computer

capabilities have facilitated the synthesis of various types of data and information (e.g., GIS information, groundwater modeling output and groundwater quality data for example) and are conducive to presentation of data and results in comprehensive graphical representations, which are more robust and much faster to produce than in years past. The need to utilize and enhance the ability to use, analyze and share data within a GIS framework has previously been documented in the draft 2010 Comprehensive Water Resource Management Plan and supporting task memoranda going back as far as 2008.

As appropriate, the data should be used to update the groundwater models, and for model application to:

- Support site investigations;
- Evaluate impacts of changing conditions (e.g., simulation of the impacts of sea level rise on the water levels and the saltwater interface, simulation of the impact of drought on water levels, stream base flows and saltwater interfaces);
- Evaluate remedial alternatives;
- Delineate source water areas for new or proposed wells;
- Assess the impacts of proposed developments on downgradient water quality, in accordance with the procedure documented in the Task 5.2 memorandum (**Future Land Use Impacts**, CDM 2008).

It is presumed that the County would assign a groundwater model caretaker (SCDHS DEQ OWR) who would also review the modeling section of any reports (e.g., remedial investigations/feasibility studies, remedial design reports, etc.) submitted for County review. A single individual would fulfill both the model caretaker function and would support other on-going County programs. A brief summary of the model revisions and subsequent verification of the model calibration should be prepared for incorporation into the annual groundwater and surface water quality report. The monitoring report should be distributed to other County agencies, NYSDEC, SCWA and water suppliers to support their resource management efforts and should also be made available electronically via the Suffolk County website.

4.4.2 Implementation Responsibilities

Responsibilities for many of the drinking water supply activities identified in the Plan are currently shared by a number of agencies, on the federal, regional, state, county, town and local levels as previously documented in the Task 2.1, 2.2, 2.3 memorandum. Suffolk County has the authority to implement many of the drinking water supply recommendations identified in Section 9 and

most of the drinking water supply recommendations would be implemented by SCWA, SCDHS, and the other community suppliers operating within Suffolk County. Other collaborators who will support implementation efforts include USEPA, USGS, NYSDOH, NYSDEC, Towns, Estuary programs and Cornell Cooperative Extension of Suffolk County.

Defined roles and responsibilities will help to ensure that the work is completed as required to protect the County's drinking water supply. SCDHS has an established framework for groundwater monitoring and data collection, regulatory authority to monitor drinking water supplies and potential point sources of contamination, and the capability of using powerful tools such as computer models and GIS to evaluate most contemporary water resources issues.

Nearly all of the proposed drinking water supply management recommendations are targeted to begin implementation in the short term; e.g., within five years. In fact, SCDHS and SCWA have initiated key actions (e.g., prioritize areas where the availability of public supply should be provided) associated with high priority recommendations (e.g., to the extent that is practical, extend community supply to all residents). Full implementation of the recommendation to extend community supplies to all County residents is likely to take decades, and will also be contingent upon community support.

4.4.3 Assessment Monitoring

Implementation monitoring has two objectives:

- To monitor implementation of the plan recommendations, and
- To monitor the effectiveness of the plan recommendations in achieving the plan goals and objectives.

The effectiveness of these recommendations in achieving the drinking water supply goals and objectives will be assessed according to key performance indicators, summarized in **Appendix K**. The recommended approach for monitoring implementation progress has been developed specifically to minimize costs, by tracking implementation and progress using readily available information to the extent possible.

Much of the information needed to assess implementation of the Plan recommendations is already routinely collected and much of the information needed to assess the success of the Plan recommendations in achieving the stated goals and objectives will be collected, if the recommended data collection and database development programs are implemented. Monitoring should be conducted and documented annually.

Specific drinking water supply recommendations generally fall into one of several categories:

- Extension of Community Supplies to All Residents
- Conservation to Reduce Peak Summer Pumping
- Monitoring
- Private Wells

It is important to monitor the effectiveness of the Plan recommendations in achieving the stated goals and objectives, focusing on measures of progress that are quantifiable; the USEPA has reported that if indicators cannot be measured, then it is not possible to identify progress towards achieving goals.

Full implementation of some of these recommendations may take years, under the best of circumstances. For example, development of a comprehensive database will require planning, funding, database design and development, a process that is likely to take several years before the recommendation is fully implemented. Other recommendations, such as requiring that rain or moisture sensors be included with all new sprinkler system installations, could likely be implemented within a year. For all of the recommendations, it is important however that clear, consistent progress towards implementing the recommendations be observed. If the recommendations are not being implemented, this will be readily apparent so that corrective actions can be taken.

Achievement of the goals and objectives articulated in this Plan is likewise anticipated to take years, and likely decades, in some cases. For example, the planning, design, permitting and construction of extension of community water supply to all areas of the County may take decades. Achievement of other goals and objectives should be relatively straightforward (e.g., reduction of peak summertime irrigation pumping rates) and can be implemented within the shorter time frame that is targeted in the Plan Implementation Framework. Annual monitoring of Plan effectiveness and early assessments of Plan effectiveness will allow the County to modify the Plan and make improvements as necessary – ineffective components should be discarded and those recommendations that are most effective can be further enhanced.

The measures that are recommended to assess the effectiveness of the Plan in achieving the drinking water supply recommendations are primarily based upon data that is already routinely collected. The effectiveness of Plan recommendations in improving groundwater quality, for instance, can be readily assessed by compiling and reviewing the groundwater quality data that

is collected by SCWA and other suppliers, and by SCDHS. SCDHS already compiles much of the data that should be used to assess progress (e.g., number of private wells sampled, etc.); this data should also be noted on the spreadsheet. Assuming that a comprehensive database is established and populated as recommended, the assessment of Plan effectiveness will be straightforward, and readily accomplished within a couple of days. Data entered into a new user-friendly comprehensive database described in previous task memoranda can be readily accessed and evaluated; it will be very straightforward to assess trends and changes in water quality indicators such as nitrates, VOCs, pesticides and PPCPs.

Additional monitoring of the effectiveness of specific alternatives, for example, conservation, can also be conducted by the water suppliers themselves. Existing programs such as EPA's WaterSense program provide guidance and a framework for water supplier partners.

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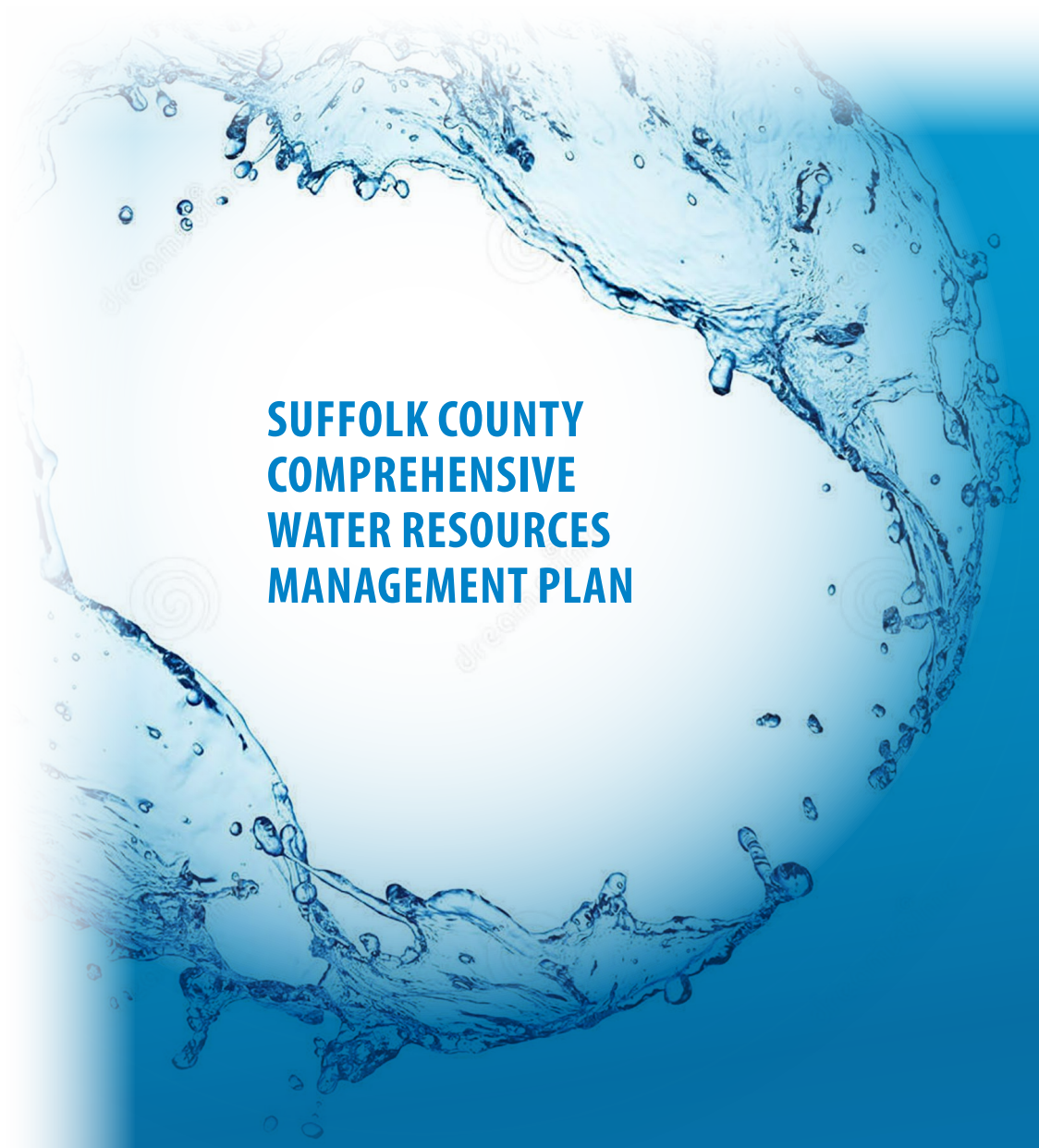

SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Section 5
SURFACE WATER RESOURCES

Section 5
Surface Water Resources

Suffolk County's fresh and marine surface water resources are diverse and abundant; coastal waters form the County's boundaries to the north, east and south. In fact, the County's surface water features largely define the County's identity as a desirable location to live, work and play. Both the Long Island Sound and the Peconic Estuary have been designated as estuaries of national significance. The Long Island Sound (LIS) Comprehensive Conservation and Management Plan (CCMP) Summary reports that "Long Island Sound is a national treasure, to be prized for its beauty, abundant and diverse resources, and recreational and commercial opportunities." On the south shore, Coopers Beach in Southampton was named #1 in the nation by Dr. Stephen Leatherman (also known as Dr. Beach, Director of Florida International University's Laboratory for Coastal Research) on the 2010 list of the top ten beaches in the United States, and Main Beach in East Hampton was also identified as a National Winner. The County's harbors and estuaries also have great ecological value and significance; Great South Bay, part of the South Shore Estuary Reserve, is the largest shallow estuarine bay in New York State.

The 1987 Comp Plan enumerated and described the County's fresh surface waters and wetlands; that information is not reproduced here. The Long Island Sound, Peconic Estuary and South Shore Estuary Reserve have been the subjects of focused studies for years as documented extensively by the LIS and Peconic Estuary programs. The LIS CCMP, the Peconic Estuary CCMP and the South Shore Estuary Reserve (SSER) Comprehensive Management Plan (CMP) all identify a number of strategies and recommendations to improve water quality, reduce use impairments and protect/restore habitat and ecosystems in those marine systems, as well as the fresh surface waters that feed them. The surface water issues identified by the estuary programs, and the hundreds of recommendations incorporated into the estuary management plans are not repeated here, but are discussed in more detail in Section 6 of this document. Rather, this study evaluated the water quality of the County's fresh surface water features, particularly as it was impacted by the quality of groundwater baseflow, and reviewed trends in nitrogen levels in coastal water bodies. The status of implementation of the recommendations to protect and improve estuary water quality developed during previous studies was also assessed.

These reviews formed the basis for identification of recommendations that can reduce groundwater contamination; hence the quality of the groundwater

discharging to the surface waters will be improved, which will ultimately result in improved surface water quality.

In general, the recommendations for open space preservation, improved sanitary wastewater management, reduced fertilization, reduced stormwater impacts and enhanced public participation programs described in Section 3 of this Plan are all consistent with previous estuary program recommendations.

5.1 Problem Identification

5.1.1 Fresh Surface Water Resources

Suffolk County's fresh surface water resources are abundant and generally of sufficient quality to support multiple uses. Within the County, New York State has classified more than 200 freshwater streams and ponds and regulates over 1,050 freshwater wetlands covering nearly 24,000 acres (NYSDEC, 2006). The New York State Natural Heritage Program has identified over 50 coastal plain ponds in the County, distinguished by their rare ecological community type that supports rare and unusual plant species.

Many of the significant freshwater streams in the County are located along the County's south shore within the Southwest Sewer District (SWSD); however, some of the largest freshwater streams such as the Nissequogue, Connetquot, and Peconic Rivers are outside of the SWSD and the Flow Augmentation Needs (FANS) study area.

Suffolk County surface waters are regularly monitored, and their quality is assessed as part of other on-going programs, including New York State's identification of Impaired Waters under Section 303(d), the Long Island Sound Study (LISS), PEP and SSER programs (Task 6.1 - Freshwater Streams, Ponds and Wetlands, CDM, 2006; Task 6.2 - Coastal Marine Resources, CDM, 2007; and Task 6.3 - Estuary Study Recommendations, CDM 2008). Between 1966 and 2005, when staffing reductions forced a temporary reduction of the surface water monitoring program, SCDHS collected and compiled water quality data from over 113 streams. Thirteen streams were sampled by SCDHS in 2013/2014.

Table 5-1 lists the freshwater streams, segments and ponds identified in Suffolk County, along with their New York State use classification. The Suffolk County's water bodies on New York State 2014 303(d) list of impaired waters are highlighted on **Table 5-1,** along with the presumed cause(s) of the use impairments identified. NYSDEC has identified pathogens, metals, dissolved oxygen, phosphorus, ammonia, pesticides and silt/sediment as the primary contaminants causing impairment of the fresh surface waters, and storm water runoff as the source of these contaminants.

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source
1	LIS-P 378	Great Pond		Q-30sw	A	A		
2	(MW6.1d) GB.GPB-P 495	Mattituck or Marratooka Pond (1701 - 0129)[4]		R-29ne	A	A	Oxygen Demand & Phosphorous	Urban/Storm Runoff
3	GPB-P 496	Laurel Pond		R-29ne	A	A(T)		
4	Fishers Island-P 1100	Middle Farm Pond	Pond on Fishers Island.	P-32sw	A	A		
5	Barlow Pond	Fishers Island-P 1108		P-32sw	A	A		
6	LIS-61 portion including P 274, P 275	Sunken Meadow Creek	From Fort Salonga Road to source.	R-26ne	B	B		
7	(MW7.7) AO-GSB-193..P304	Lake Ronkonkoma (1701-0020)		R-27sw R-27se	B	B	Pathogens & Phosphorus	Urban/Storm Runoff
8	(MW7.5) AO-GSB-185-P889	Caanan (1701-0018)			B	B(T)	Phosphorus, Silt/Sediment	Urban/Storm Runoff
9	GSB-189-P 896 to P 898	Sans Souci Lakes		S-27ne R-27se	B	B		
10	GSB-193 portion	Connetquot River	From Montauk Highway to north boundary of Connetquot State Park.	S-27nw R-27sw	B	B(TS)		
11	GSB-193-2 portion and P 902	Trib. of Connetquot River	From Montauk Highway to source.	S-27nw	B	B(T)		
12	GSB-193-3	Rattlesnake Brook		R-27sw S-27nw	B	B(TS)		
13	GSB-208-P 950	Geiger Memorial Park		R-26se	B	B		
14	LIS-P 362	Hollocks Pond	Camp Carey, Boys Club of New York camp.	R-29ne	B	B		
15	GB-137-P 726-1 and P 726a	Tribs. of Alewife Pond		Q-31sw	B	B		
16	GB-139	Tanbark Creek	Fresh water portion extends to approximately 1.0 mile south of Threemile Harbor.	R-31nw	B	B		
17	SIS-134 portion	Trib. of Shelter Island Sound	Fresh water portion.	R-30ne Q-30se	B	B		
18	SIS-134-1	Subtrib. of Shelter Island Sound		R-30ne Q-30se	B	B		
19	(MW6.3c) GB..LPB-123-1-P 661, P662	Big/Little Fresh Ponds (1701-0125)		R-30nw	B	B	Phosphorous	Urban/Storm Runoff
20	(MW7.1b) AO-P790-2-2P793, P794	Mill and Seven Ponds (1701-0113)			B	B	Phosphorous	Urban/Storm Runoff
21	BIS-141 portion	Trib. of Block Island Sound	Fresh water portion.	R-31ne R-31nw	B	B		
22	BIS-P 755	Fort Pond		Q-32sw	B	B		
23	BIS-P 763	Big Reed Pond		Q-32sw	B	B		
24	----	Spring Pond/Lake (1701-0157)			B		Chlordane	Contam. Sediment
25	CSH-50 portion	Trib. of Cold Spring Harbor	Mouth to trib. 1a within Suffolk County.	R-26sw	C	C(T)		
26	CSH-50 portion	Trib. of Cold Spring Harbor	From trib. 1a to source.	R-26sw	C	C		
27	CSH-50-P 158, P 159	Subtribs. of Cold Spring Harbor	Within Suffolk County.	R-26sw	C	C(T)		
28	CSH-P 200	Trib. of Cold Spring Harbor		R-26sw	C	C		
29	CSH-P 202, P 203, P 203a	Tribs. of Cold Spring Harbor		R-26nw	C	C		
30	CSH-52-1 including P 207	Subtrib. of Cold Spring Harbor		R-26nw	C	C		
31	HB-P 210	Trib. of Huntington Bay		R-26nw	C	C		
32	HB-HH-55	Trib. of Huntington Harbor		R-26nw	C	C		
33	HB-HH-55-P 221	Subtrib. of Huntington Harbor		R-26nw	C	C		
34	HB-HH-P 221a	Trib. of Huntington Harbor		R-26nw	C	C		

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source
35	HB-P 220, P 226, P 227, P 238, P 238a, P 239, P 242, P 243, P 247, P 248, P 248a, P 249	Unnamed ponds		R-26nw R-26sw	C	C		
36	HB-NB-CH-56a-P 240a	Subtrib. of Centerport Harbor		R-26nw	C	C		
37	HB-NB-CH-P 240	Trib. of Centerport Harbor		R-26ne	C	C		
38	HB-NB-NH-57	Trib. of Northport Harbor		R-26ne	C	C		
39	HB-NB-NH-57-P 257, P 258	Subtribs. of Northport Harbor		R-26ne	C	C		
40	LIS-P 270	Unnamed pond		R-26ne	C	C		
41	LIS-P 270a, P 270b	Unnamed ponds		R-26ne	C	C		
42	From trib. 1 to source.	Crab Meadow Brook	LIS-59 portion and trib. 1	R-26ne	C	C		
43	LIS-P 271a	Unnamed pond		R-26ne	C	C		
44	LIS-P 271b	Unnamed pond		R-26ne	C	C		
45	LIS-61 portion	Sunken Meadow Creek	Freshwater portion to Fort Salonga Road.	R-26ne	C	C		
46	LIS-P 281	Unnamed pond		R-27nw	C	C		
47	LIS-62 portion	Nissequogue River	From P 288 to P 292.	R-27sw	C	C(TS)		
48	LIS-62 portion	Nissequogue River	From P 292 to source.	R-27sw	C	C(T)		
49	LIS-62-1 including P 282	Trib. of Nissequogue River		R-27nw	C	C		
50	LIS-62-2-P 283	Subtrib. of Nissequogue River		R-27nw	C	C		
51	LIS-62-2a	Trib. of Nissequogue River		R-27sw	C	C(T)		
52	LIS-62-2a-P 287b, P 287a	Subtribs. of Nissequogue River		R-27sw	C	C(T)		
53	LIS-62-P 288	Philips Mill Pond		R-27sw	C	C(T)		
54	LIS-62-P 290, P 291a, 4	Tribs. of Nissequogue River		R-27sw	C	C(T)		
55	LIS-62-4-P 291 and trib. 1	Webster Pond		R-27sw	C	C(T)		
56	LIS-62-4-P 289	Willow Pond		R-27sw	C	C(T)		
57	LIS-62-P 292	New Mill Pond		R-27sw	C	C(T)		
58	LIS-62-P 292-1 including P 296, P 296a, P 297, P 297a	Trib. of New Mill Pond (Millers Pond (1701-0013)		R-27sw	C	C	Oxygen Demand & Phosphorus	Urban/Storm Runoff
59	LIS-62-P 292-2 including P 326	Trib. of New Mill Pond		R-27sw	C	C(T)		
60	LIS-62-P 292-3 including P 329	Trib. of New Mill Pond		R-27sw	C	C(TS)		
61	LIS-62-P 292-4 including P 292a	Trib. of New Mill Pond		R-27sw	C	C		
62	LIS-P 304-1	Trib. of Lake Ronkonkoma		R-27sw	C	C		
63	LIS-P 304a, P 312, P 319, P 323, P 331, P 331a, P 331b, P 333, P 333a, P 334, P 335	Unnamed ponds		R-27se R-27ne R-27nw	C	C		
64	LIS-P 305, P 306, P 319a	Unnamed ponds		R-27sw R-27se	C	C		
65	SB-SBH-63	Trib. of Stony Brook Harbor		R-27nw	C	C		
66	SB-SBH-63-P 336	Mill Pond		R-27nw	C	C(T)		
67	SB-SBH-63-P 338	Unnamed pond		R-27nw	C	C(T)		
68	SB-SBH-64-1	Trib. of West Meadow Creek		R-27nw	C	C		
69	LIS-PJH-CB-66 portion	Trib. of Conscience Bay	From inlet of P 340a to source.	R-27ne	C	C		
70	LIS-PJH-CB-P 340a	Trib. of Conscience Bay		R-27ne	C	C		
71	LIS-P 343	Unnamed pond		R-27ne	C	C		
72	LIS-P 346, P 349	Unnamed ponds		R-27ne	C	C		

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source
73	LIS-MSH-67a	Trib. of Mount Sinai Harbor		R-27ne	C	C		
74	(MW7.5) AO-GSB-178	Beaverdam Creek and tribs (1701-0104)	River		C(TS)	NA	Ammonia	Urban/Storm Runoff
75	(MW7.5) AO-GSB-179	Motts Creek, Upper, and tribs (1701-0325)3			NA	C	Aquatic Toxicity	Urban/Storm Runoff
76	GSB-189 portion	Brown Creek	From inlet of Sayville Mill Pond to source.	S-27ne R-27se	C	C		
77	GSB-189-2 portion	West Branch Brown Creek	From mouth to Sayville Mill Pond (P 893).	S-27ne	C	C		
78	GSB-189-2 portion	West Branch Brown Creek	From Sayville Mill Pond to source.	S-27ne R-27se	C	C(TS)		
79	GSB-189-2-P 893	Sayville Mill Pond		S-27ne	C	C(T)		
80	GSB-189-P 895	Lotus Lake		S-27ne	C	C		
81	GSB-190 portion and P 899a	Green Creek	From Montauk Highway to source.	S-27ne	C	C(T)		
82	GSB-191-P 900	Trib. of Indian Creek		S-27ne	C	C		
83	GSB-193 portion	Connetquot River	From Connetquot State Park north boundary to source.	R-27sw	C	C(T)		
84	GSB-193-2-P 903	West Brook Pond		S-27nw R-27sw	C	C(T)		
85	GSB-193-3-1,2 including P 904, P 905, P 905a	Tribs. of Rattlesnake Brook		R-27sw S-27nw	C	C(TS)		
86	GSB-193-P 906	Main Pond		S-27nw R-27sw	C	C(T)		
87	GSB-193-P 907	Lower Pond		S-27nw R-27sw	C	C(T)		
88	GSB-193-P 908, P 909	Tribs. of Connetquot Brook		R-27sw	C	C(T)		
89	GSB-P 911a	Unnamed pond		S-27nw	C	C		
90	(MW7.8) AO-GSB-194	Champlin Creek, Upper and tribs (1701-0019)	From inlet of P 910 to source.	S-27nw	C	C(TS)	Thermal Changes	Urban/Storm Runoff
91	GSB-194-1GSB-194-1	Trib. of Champlin Creek		S-27nw	C	C		
92	GSB-194-P 910, P 911	Unnamed ponds		S-27nw	C	C		
93	GSB-194-P 912	Knapp's Lake		S-27nw	C	C(T)		
94	GSB-194-P 912-1	Trib. of Knapp's Lake	Enters from the east.	S-27nw	C	C		
95	GSB-P 910a	Unnamed pond		S-27nw	C	C		
96	(MW7.8) AO-GSB-196 portion	Orowoc Creek	From Montauk Highway to source.	S-27nw	C	C(T)	Aquatic Toxicity	Urban/Storm Runoff
97	(MW7.8) AO-GSB-196-1 including P 915, P 915b	Trib. of Orowoc Creek		S-27nw	C	C(T)		
98	(MW7.8) AOGSB-196-1-P 915a	Subtrib. of Orowoc Creek		S-27nw	C	C		
99	(MW7.8) AO-GSB-196-P 916	Trib. of Orowoc Creek		S-27nw	C	C(T)		
100	(MW7.8) AO-GSB-197	Awixa Creek, Upper, and tribs (1701-0093)		S-27nw	C	C	Aquatic Toxicity	Urban/Storm Runoff
101	(MW7.8) AO-GSB-198	Penataquit Creek, Upper, and tribs (1701-0090)[3]		S-27nw	C	C	Aquatic Toxicity	Urban/Storm Runoff
102	GSB-200-P 922, P 923, P 923a	Tribs. of Lawrence Creek		S-26ne	C	C		
103	GSB-201-P 924	Cascade Lake		S-26ne	C	C		
104	GSB-201-P 925	Mirror Lake		S-26ne	C	C		
105	GSB-201-P 925a	Nosreka Lake		S-26ne	C	C		
106	GSB-201-P 925b	Lagoon		S-26ne	C	C		
107	GSB-202-P 927, P 928, P 929	Tribs. of Thorn Canal		S-26ne	C	C		
108	GSB-203 portion	Thompsons Creek	From Montauk Highway to source.	S-26ne	C	C		

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source
109	GSB-204 portion including P 930, P 931, P 932	Trues Creek	From Montauk Highway to source.	S-26ne	C	C		
110	GSB-P 933a	Unnamed pond		S-26ne	C	C		
111	GSB-205 portion	Willets Creek	From Montauk Highway to source.	S-26ne	C	C		
112	(MW7.8) AO-GSB-205-P 934	Lake Capri (1701-0175)		S-26ne	C	C	Cadmium/Chlordane	Cont. Sed, Land.Disp.
113	(MW7.8) AO-GSB-207	Sampawams Creek	From Montauk Highway to source.	S-26ne	C	C(T)	Aquatic Toxicity	Urban/Storm Runoff
114	(MW7.8) AO-GSB-207-P 936	Trib. of Sampawams Creek		S-26ne	C	C		
115	(MW7.8) AO-GSB-207-P 937, P 938, P 939	Tribs. of Sampawams Creek		S-26ne	C	C		
116	(MW7.8) AO-GSB-207-P 940	Trib. of Sampawams Creek		S-26ne	C	C(T)		
117	GSB-208 portion	Carlls River	From Montauk Highway to Railroad Avenue.	S-26ne	C	C		
118	GSB-208 portion	Carlls River	From Railroad Avenue to source.	S-26ne R-26se	C	C(T)		
119	GSB-208-1a- P 941, P 942, P 942a	Subtribs. of Carlls River		S-26ne	C	C		
120	GSB-208-P 943	Memorial Pond		S-26ne	C	C		
121	GSB-208-P 946	Southards Pond		S-26ne	C	C(T)		
122	GSB-208-3	Trib. of Carlls River		S-26ne	C	C(T)		
123	GSB-208-3-P 946a	Subtrib. of Carlls River		S-26ne	C	C		
124	GSB-208-3-P 947	Elda Lake		S-26ne	C	C		
125	GSB-208-3-P 947-1, 2	Tribs. of Elda Lake		S-26ne	C	C(T)		
126	GSB-208-P 949	Belmont Lake		S-26ne	C	C	*Delisted in 2006*	
127	GSB-208-P 950-1	Trib. of Geiger Memorial Park		R-26se	C	C		
128	GSB-208-4	Trib. of Carlls River		S-26ne	C	C(T)		
129	GSB-209-P 954	Unnamed pond		S-26ne	C	C		
130	GSB-210 portion and trib. 1	Santapogue Creek	From Montauk Highway to source.	S-26ne	C	C(T)		
131	GSB-210-P 959a	Trib. of Santapogue Creek		S-26ne	C	C		
132	GSB-211 portion including P 959c, P 959h	Neguntatogue Creek	From Montauk Highway to source.	S-26ne	C	C		
133	GSB-212 portion and trib. 1	Trib. of Great South Bay	From Montauk Highway to source.	S-26nw S-26ne	C	C		
134	GSB-213 portion including P 959d	Trib. of Great South Bay	From Montauk Highway to source.	S-26nw	C	C(T)		
135	GSB-215 portion	Woods Creek	From Merrick Road to source.	S-26nw	C	C		
136	GSB-216 portion including P 960, P 961a	Amityville Creek	From Merrick Road to source.	S-26nw	C	C(T)		
137	GSB-216-P 961	Avon Lake		S-26nw	C	C(T)		
138	GSB-P 969a, P 969b	Unnamed ponds		S-26nw	C	C		
139	LIS-P 362a, P 363, P 364, P 365	Tribs. of Long Island Sound		R-29ne	C	C		
140	LIS-71-1 portion	Trib. of Mattituck Creek	Fresh water portion.	Q-29se R-29ne	C	C		
141	LIS-71-2,4,5	Tribs. of Mattituck Creek		Q-29se R-29ne	C	C		
142	LIS-P 367	Wolf Pit Pond		Q-29se	C	C		
143	LIS-P 375	Trib. of Long Island Sound	Isolated pond located just south of Goldsmith Inlet.	Q-30sw	C	C		
144	LIS-P 379, P 380	Tribs. of Long Island Sound	Lily Pond (P 379).	Q-30sw	C	C		
145	GB-P 393	Trib. of Gardiners Bay		Q-30ne	C	C		

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source
146	GB-P 440, P 441, P 441b, P 443, P 443a, P 444, P 445, P 446, P 448, P 449	Tribs. of Gardiners Bay		Q-30se	C	C		
147	GB-137	Trib. of Gardiners Bay	Fresh water portion.	Q-31sw	C	C		
148	BG-P 726b	Trib. of Gardiners Bay		Q-31sw	C	C		
149	SIS-SI-P 432	Unnamed pond		Q-30se	C	C		
150	SIS-SI-P 433	Wecks Pond		Q-30se	C	C		
151	SIS-SI-2a-P 435	Subtrib. of Shelter Island Sound		Q-30se	C	C		
152	SIS-SI-P 437 P 438	Tribs. of Shelter Island Sound		Q-30se	C	C		
153	(MW7.2a) GS-SIS-SI-WNH-P 458	Fresh Pond (1701-0241)		Q-30se	C	C	Phosphorous	Urban/Storm Runoff
154	SIS-SI-P 461a, P 465	Tribs. of Shelter Island Sound	On Westmoreland Farms property.	Q-30se	C	C		
155	SIS-79-1 portion	Trib. of Shelter Island Sound	Fresh water portion.	Q-30sw	C	C		
156	SIS-79-1-P 409	Subtrib. of Shelter Island Sound		Q-30sw	C	C		
157	SIS-79-2 portion	Moores Drain	Fresh water portion.	Q-30sw	C	C		
158	SIS-79-2-P 402	Silver Lake		Q-30se	C	C		
159	SIS-P 417	Trib. of Shelter Island Sound		Q-30sw	C	C		
160	SIS-P 420a	Trib. of Shelter Island Sound		Q-30sw	C	C		
161	SIS-P 427	Trib. of Shelter Island Sound		Q-30sw	C	C		
162	SIS-P 675	Trib. of Shelter Island Sound		R-30ne	C	C		
163	SIS-P 674a	Trib. of Shelter Island Sound		R-30ne	C	C		
164	SIS-127 including P 676	Mill Creek		R-30ne	C	C		
165	SIS-127-P 677 and tribs. 1, 2	Trout Pond		R-30ne	C	C(T)		
166	SIS-128-2 including P 681, P 682	Subtrib. of Shelter Island Sound		Q-30se	C	C		
167	SIS-P 690, P 691, P 692	Tribs. of Shelter Island Sound		Q-30se	C	C		
168	SIS-P 697a	Mouth to Brick Kiln Road.	Trib. of Shelter Island Sound	R-30ne	C	C		
169	SIS-132 portion	Ligonee Brook	From Brick Kiln Road to source.	R-30ne	C	C		
170	SIS-132-P 698	Round Pond		R-30ne	C	C		
171	SIS-132-P 698a	Subtrib. of Shelter Island Sound		R-30ne	C	C		
172	SIS-132-P 699	Subtrib. of Shelter Island Sound		R-30ne	C	C		
173	SIS-132-P 701	Lily Pond		R-30ne	C	C		
174	SIS-132-P 702	Long Pond		R-30ne	C	C		
175	SIS-132-P 702-P 703, P 704, P 705, P 706	Unnamed ponds		R-30ne	C	C		
176	SIS-132-P 702-P 708	Little Long Pond		R-30ne	C	C		
177	LPB-P 471	Trib. of Little Peconic Bay		Q-30sw	C	C		
178	LPB-P 487, P 488	Tribs. of Little Peconic Bay		R-30nw	C	C		
179	LPB-P 654, P 655	Tribs. of Little Peconic Bay		R-30nw	C	C		
180	LPB-123-1 portion	Trib. of North Sea Harbor	Fresh water portion.	R-30nw	C	C		
181	LPB-124-P 665a	Subtrib. of Little Peconic Bay		R-30nw	C	C		
182	LPB-P 669	Trib. of Little Peconic Bay		R-30ne	C	C		
183	GPB-96-1 portion	Trib. of West Creek	Fresh water portion.	Q-30sw	C	C		
184	GPB-96-1-P 485	Subtrib. of West Creek		Q-30sw	C	C		
185	GPB-97 portion	Downs Creek	Fresh water portion.	Q-30sw R-30nw	C	C		
186	GPB-98 portion	Halls Creek	Fresh water portion.	R-29ne	C	C		

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source
187	GPB-P 489	Trib. of Great Peconic Bay		Q-29se	C	C		
188	GPB-99-P 493	Trib. of Deep Hole Creek		R-29ne	C	C		
189	GPB-100 portion	Trib. of Great Peconic Bay	Fresh water portion.	R-29ne	C	C		
190	GPB-100-P 495a	Subtrib. of Great Peconic Bay		R-29ne	C	C		
191	GPB-101 portion	Trib. of Great Peconic Bay	Fresh water portion.	R-29ne	C	C		
192	GPB-102 portion	Brush Creek	Fresh water portion.	R-29ne	C	C		
193	GPB-104 portion	Trib. of Great Peconic Bay	Fresh water portion.	R-29ne	C	C		
194	GPB-P 507	Trib. of Great Peconic Bay		R-29ne	C	C		
195	GPB-118-1, P 644a	Tribs. of Red Creek Pond		R-29ne	C	C		
196	GPB-P 650, P 650a	Tribs. of Great Peconic Bay		R-30nw	C	C		
197	BIS-P 753	Fresh Pond		Q-31se	C	C		
198	BIS-P 756	Trib. of Block Island Sound		Q-32sw	C	C		
199	BIS-P 761-1, 2 P 761a	Tribs. of Montauk Harbor	Enter Montauk Harbor from southwest and south. Osborne Brook (trib. 1). Dutch Plains Creek (trib. 2).	Q-32sw	C	C		
200	BIS-P 764-1,2	Tribs. of Oyster Pond	Enter Oyster Pond from east and west, respectively.	Q-32sw	C	C		
201	(MW7.2a) AO-MB-170	Terrell River, Upper, and tribs (1701-0103)[3]	River	NA	C(TS)	NA	Aquatic Toxicity	Urban/Storm Runoff
202	AO-P 776	Hook Pond		R-31nw	C	C		
203	AO-P 776-1	Trib. of Hook Pond		R-31nw	C	C		
204	AO-P 778	Town Pond		R-31nw	C	C		
205	AO-P 779	Lily Pond		R-31nw	C	C		
206	AO-P 780-2	Trib. of Georgica Pond	Enters from northwest.	R-31nw	C	C		
207	AO-P 782, P 784	Tribs. of Atlantic Ocean	Wainscott Pond (P 782). Fairfield Pond (P 784).	R-30ne R-31nw	C	C		
208	AO-P 786-1	Trib. of Sagaponack Pond		R-30ne	C	C		
209	AO-P 787	Poxabogue Pond		R-30ne	C	C		
210	AO-P 787, P 787a	Little Poxabogue Pond		R-30ne	C	C		
211	AO-P 786-2	Trib. of Sagaponack Pond		R-30ne	C	C		
212	AO-P 788, P 789	Unnamed ponds		R-30ne	C	C		
213	Gardiners Island-P 732, P 731, P 736, P 737, P 737a, P 738, P 739, 5 including P 741, P 743, P 744, 6 including P 745, P 746, P 746a, 7 including P 747	Tribs. of Gardiners Island	Fresh water portions.	Q-31sw Q-31se	C	C		
214	Fishers Island-P 1089, P 1091, P 1092, P 1093, P 1093a, P 1099, P 1103, P1103a, P 1105, P 1106	Tribs. of Fishers Island	Ponds on Fishers Island.	P-32sw P-31se	C	C		
215	----	Saint James Pond		----	C	C	Chlordane/DDT	Contam. Sediment
216	AO-P 780-1	Trib. of Georgica Pond	Enters from northeast.	R-31nw	D	D		
217	Gardiners Island-1	Trib. of Gardiners Island		Q-31sw	D	D		

Notes from 2014 303d list:

[1] Includes Upper Forge River, which is the trib of primary concern. The Lower Forge River is included in Part 2c - Shellfishing Waters portion of the list.

[2] These listings are a result of impairmaents due to extensive algal blooms (Brown Tide) that are thought to be the result of multiple factors, including elevated nitrogen levels. Further study is necessary to determine the relative contribution of these multiple factors, the role of nitrogen in the Bay, whether a TMDL is the more appropriate management response (and if so, what is the appropriate TMDL target/endpoint). Until these issues regarding causes and pollutants are clarified, Part 3b is the appropriate place to list the waters of the Bay. Other tributary embayments to these waters were also considered for listing, however decisions regarding these additional lists have been deferred pending further study regarding Brown Tide algal blooms.

[3] Although this water is considered to be impaired, poor sampling also influences the biological sampling results that indicate moderate impacted conditions.

Table 5-1
Suffolk County Fresh Surface Water Classifications and Impairments

Item No.	Waters Index Number	Name	Description	Map Ref. No.	Class	Standards	New York State Final 2014 Section 303(d) List Water	
							Cause / Pollutant	Source

[4] This segment had previously been listed in Part 1 of the list (for pathogens), but it has been moved to Part 3c pending the development of the appropriate strategy to address wildlife sources of pathogens.

Key:		
Waters Index Number	**Name of Waters**	**Explanation**
LIS	Long Island Sound	Primary waters identified by abbreviation.
GB	Gardiners Bay	
SIS	Shelter Island Sound	
LPB	Little Peconic Bay	
GPB	Great Peconic Bay	
BIS	Block Island Sound	
AO	Atlantic Ocean	
GPB-96	West Creek	The 96th stream encountered on Long Island proceeding in a clockwise direction around the island from Fort Hamilton (The Narrows).
GPB-96-1	Trib. of West Creek	The first tributary entering West Creek above the mouth.
GPB-P 496	Laurel Pond	The 496th pond or lake encountered in the Conservation Department's report, A Biological Survey of the Fresh Waters of Long Island.
The symbol (T) appearing after any class designation indiactes that the designated waters are trout waters and that the dissolved oxygen specification for trout waters shall apply thereto.		
Shading indicates the water body is included on the Final 2014 New York State 303(d) List of Impaired Waters.		

Source:
www.dec.ny.gov/docs/water_pdf/303dlistfinal2014.pdf

FRESH SURFACE WATERS

§701.6 Class A fresh surface waters

(a) The best usages of Class A waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(b)This classification may be given to those waters that, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to reduce naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug 2,1991 eff. 30 days after filing.

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§701.7 Class B fresh surface waters

The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug. 2,1991 eff. 30 days after filing.

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§701.8 Class C fresh surface waters

The best usage of Class C waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug 2,1991 eff. 30 days after filing.

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§701.9 Class D fresh surface waters

The best usage of Class D waters is fishing. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. These waters shall be suitable for fish survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

SALINE SURFACE WATERS

§701.10 Class SA saline surface waters

The best usages of Class SA waters are shellfishing for market purposes, primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug. 2, 1991 eff. 30 days after filing.

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§701.11 Class SB saline surface waters

The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug. 2, 1991 eff. 30 days after filing.

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§701.12 Class SC saline surface waters

The best usage of Class SC waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug. 2, 1991 eff. 30 days after filing.

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§701.13 Class I saline surface waters

The best usages of Class I waters are secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug. 2, 1991 eff. 30 days after filing.

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§701.14 Class SD saline surface waters

The best usage of Class SD waters is fishing. These waters shall be suitable for fish survival. This classification may be given to those waters that, because of natural or man-made conditions, cannot meet the requirements for primary and secondary contact recreation and fish propagation.

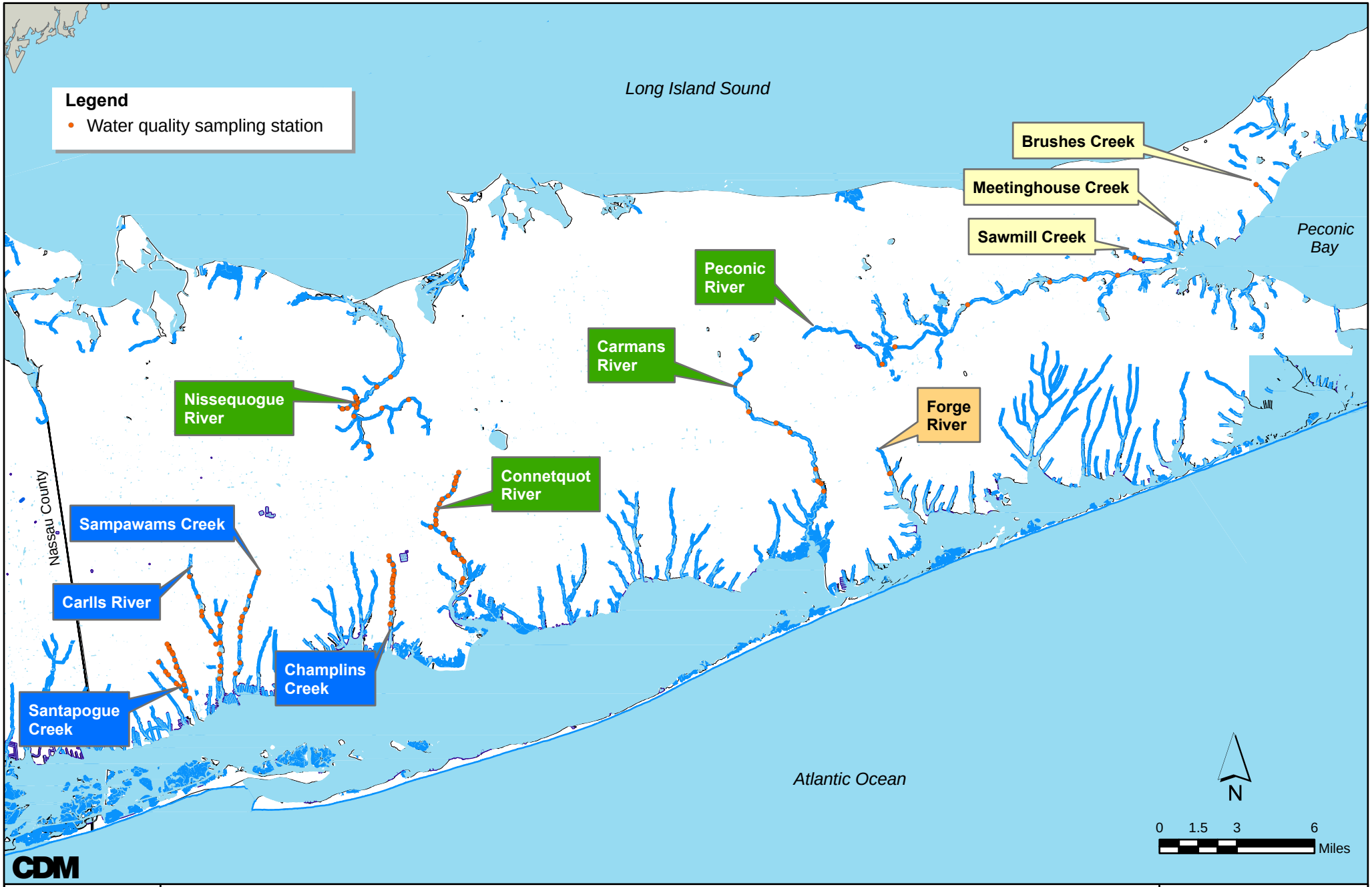
Part 1 of the list identifies individual water body segments with impairments requiring total maximum daily load (TMDL) development. The water bodies identified include lakes (with oxygen demand or phosphorus from urban and stormwater runoff identified as the causes of impairment) and pathogens from urban/stormwater runoff and nitrogen from agricultural lands and onsite wastewater treatment for the estuary segments.

Part 2 of the list identifies multiple water body segments and categorical water body impairments requiring TMDL development. Sediment contaminated with chlordane and cadmium is identified as the issue of concern for the south shore lakes identified in this category. Water bodies with uses impaired by fish consumption advisories (category 2c) are identified in the Long Island Sound, Peconic and south shore estuaries. Pathogens attributed to urban and stormwater runoff have been identified as the water quality concern.

Part 3 of the 303(d) list identifies water bodies for which TMDLs may be deferred pending verification of the impairment, verification of the cause of the impairment or contaminant source, and water bodies awaiting development or evaluation of other restoration measures. Phosphorus from urban/stormwater runoff is identified as the presumed source of impairments to be documented in two lakes.

A review of water quality data characterizing twelve of the larger fresh streams in the County (shown on **Figure 5-1** and described more completely in the Task 6.1 memorandum) revealed that higher levels of Volatile Organic Compounds (VOCs) were detected in streams in the more densely developed western part of the County than in streams located further to the east, and pesticides were primarily detected in streams in the agricultural eastern areas of the County. Both of these observations are consistent with the assessment relating groundwater quality to land use; higher levels of VOCs were detected in wells with industrial, commercial or institutional land uses within the contributing area, while pesticides (except for DEET) were only found in wells with agriculture in the contributing area. The VOCs that were most frequently detected in Suffolk County streams are summarized on **Table 5-2**. MTBE was the most frequently detected VOC, but levels have been declining, probably because sale of gasoline containing MTBE as an additive has been prohibited in New York State since 2004.

The solvents (and breakdown products) detected in groundwater are also the most common group of VOCs detected in surface water. VOCs are found in low concentrations in Suffolk County's surface waters; the percent of samples with solvent detections has declined significantly since the last assessment in 2005. Found in the Nissequogue River at 13 µg/L, tetrachloroethene (PCE) was



FANS Streams | Major Streams

Streams Impacted by Agriculture, Duck Farms, or Golf Courses

Streams with Multiple Causes of Eutrophication

Map of the 12 Selected Streams

Figure 5-1

the VOC detected at the highest concentration in SCDHS sampling conducted from 2013-2014.

Table 5-2 VOCs Most Frequently Detected in Suffolk County Streams, 2013-2014

Compound	Percent of Samples with Detections		
	1981-2005	2005-2014	2013-2014
Methyl-tertiary-butyl-ether	34%	19%	20%
Tetrachloroethene (PCE)	23%	13%	11%
1,1,1-Trichloroethane	21%	2%	2%
Trichloroethene	18%	6%	4%
Carbon disulfide	17%	0%	0%
1,1-Dichloroethene	15%	3%	3%
1,1-Dichloroethane	12%	1%	0%
Methyl sulfide	8%	7%	10%
Freon 113	3%	6%	8%
cis-1,2-Dichloroethene	3%	5%	3%

Numerous pesticides have also been detected in Suffolk County streams in 2013 and the first half of 2014, with 2,6-Dichlorobenzamide being detected most frequently (**Table 5-3**). Brush's Creek in Laurel had the most detections of the streams sampled during this time period.

Table 5-3 Pesticides Detected in Suffolk County Streams, 2013-2014

Compound	Maximum Concentration	Percent of Samples with Detections	
	µg/L	2010-2014	2013-2014
2,6-Dichlorobenzamide	7.4	12.09%	13.08%
Alachlor ESA	0.4	8.79%	10.28%
Metalaxyl	2	2.93%	2.80%
Alachlor OA	Trace (0.1)	2.56%	4.67%
Imidacloprid	0.5	1.83%	3.74%
Dichlobenil	1.3	1.47%	1.87%
Trichlorfon	Trace (0.1)	0.37%	0.93%
Germanium	0.9	0.37%	0.93%
Picaridin	Trace (0.1)	0.37%	0.93%

As shown by **Figure 5-2**, nitrate levels were highest in streams affected by agriculture and duck farming; the installation of sanitary sewers in the southwestern part of the County has resulted in significant reduction in nitrate levels in most streams within the SWSD. Sewering has also resulted in reduced baseflow in those streams located within the SWSD.

Water quality data collected by the SCDHS shows that the sanitary sewering program has helped to reduce nitrate levels in SWSD streams, as summarized on **Table 5-4**, and illustrated for Sampawams Creek by **Figure 5-3**. The observed increase in nitrate levels in Sampawams Creek in recent years is driven by a single 45.5 mg/L sample collected in September 2013; the remainder of the samples were all significantly lower.

Because groundwater continues to provide the majority of County stream baseflow, and as the link between groundwater and surface water quality becomes more established, the County's groundwater models were used to delineate the land surface area contributing groundwater recharge to the County's surface water features. Understanding the land use types within the groundwater contributing areas to a stream can help to identify the sources of any observed contamination, and to help guide identification and evaluation of management options developed to improve water quality. Existing discretization was added to the model grid in the area of the stream corridors, and the models were used to delineate groundwater contributing areas to each stream at time of travel intervals ranging from less than one year to fifty years. These travel time estimates consider advective movement only, and do not consider retardation, decay or other factors that could affect the migration of a specific contaminant.

Figure 5-4 shows the model-predicted groundwater contributing areas to the Carlls River and Sampawams Creek, superimposed on a mapping of current land use types provided by the Suffolk County Planning Department. **Figure 5-5** provides a similar representation superimposed upon a composite orthophotograph of the area.

In decades past, VOCs have been detected in Sampawams Creek twice as often as in the Carlls River; however the most recent data (2013-2014) identifies similar low levels of PCE and MTBE in each. A statistical analysis of the acreage and percentage of land use types within the contributing area for each creek provides some insight into the differences in observed water quality. For Sampawams Creek, medium density residential land (35 percent), transportation (23 percent) and high density residential land (18 percent) comprise three quarters of the land surface area within the contributing area. Less than five percent of the contributing area within a one year travel time to the creek is open space. In the adjacent Carlls River, 25 percent of the land

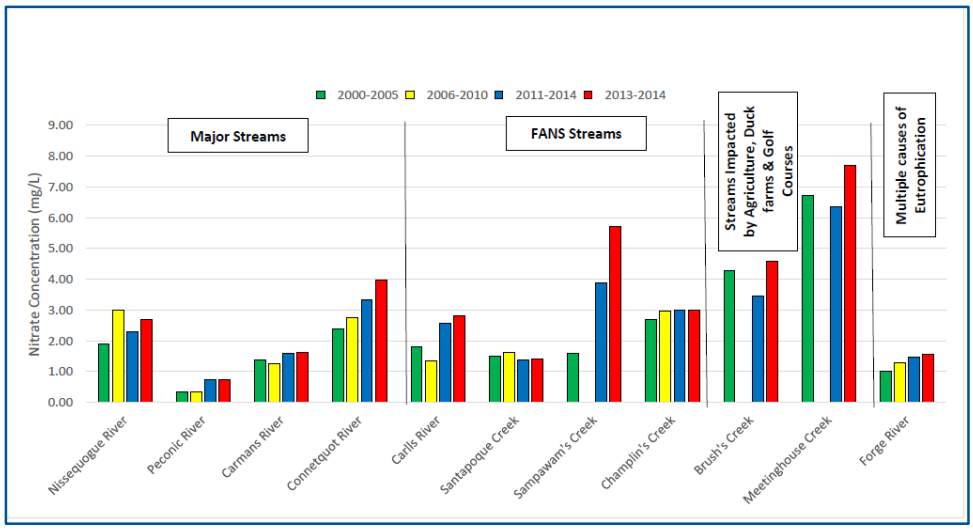


Figure 5-2 Average Nitrate Concentrations in Streams (2000 -2005 and 2013-2014, SCDHS)

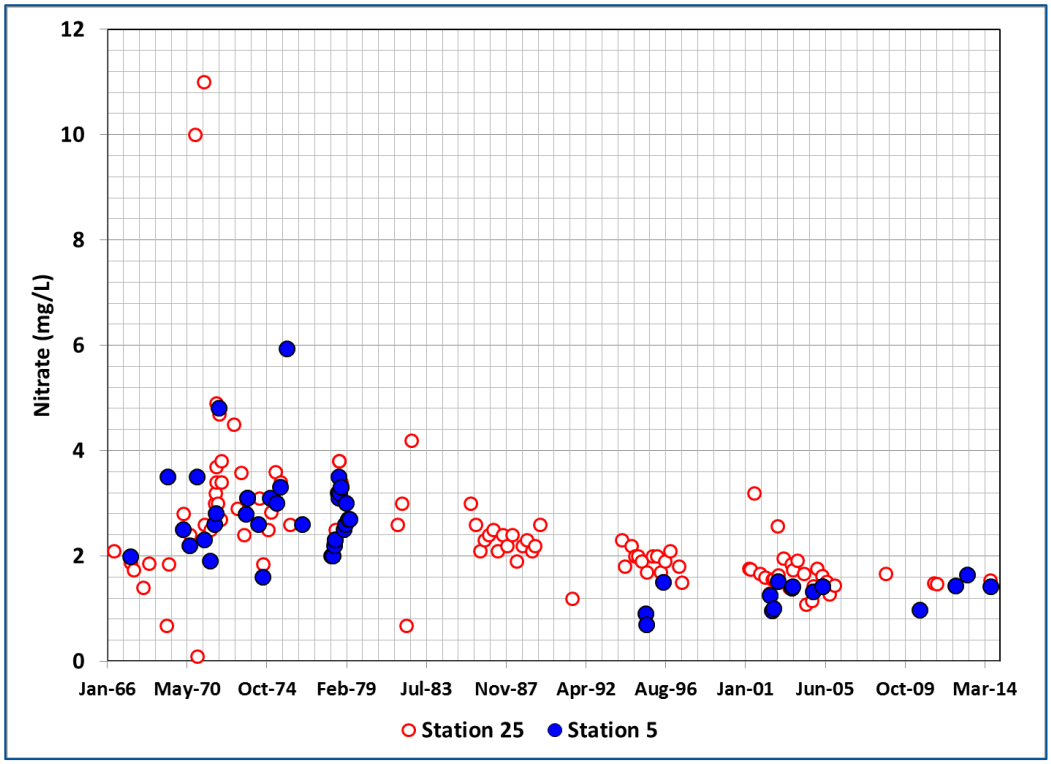


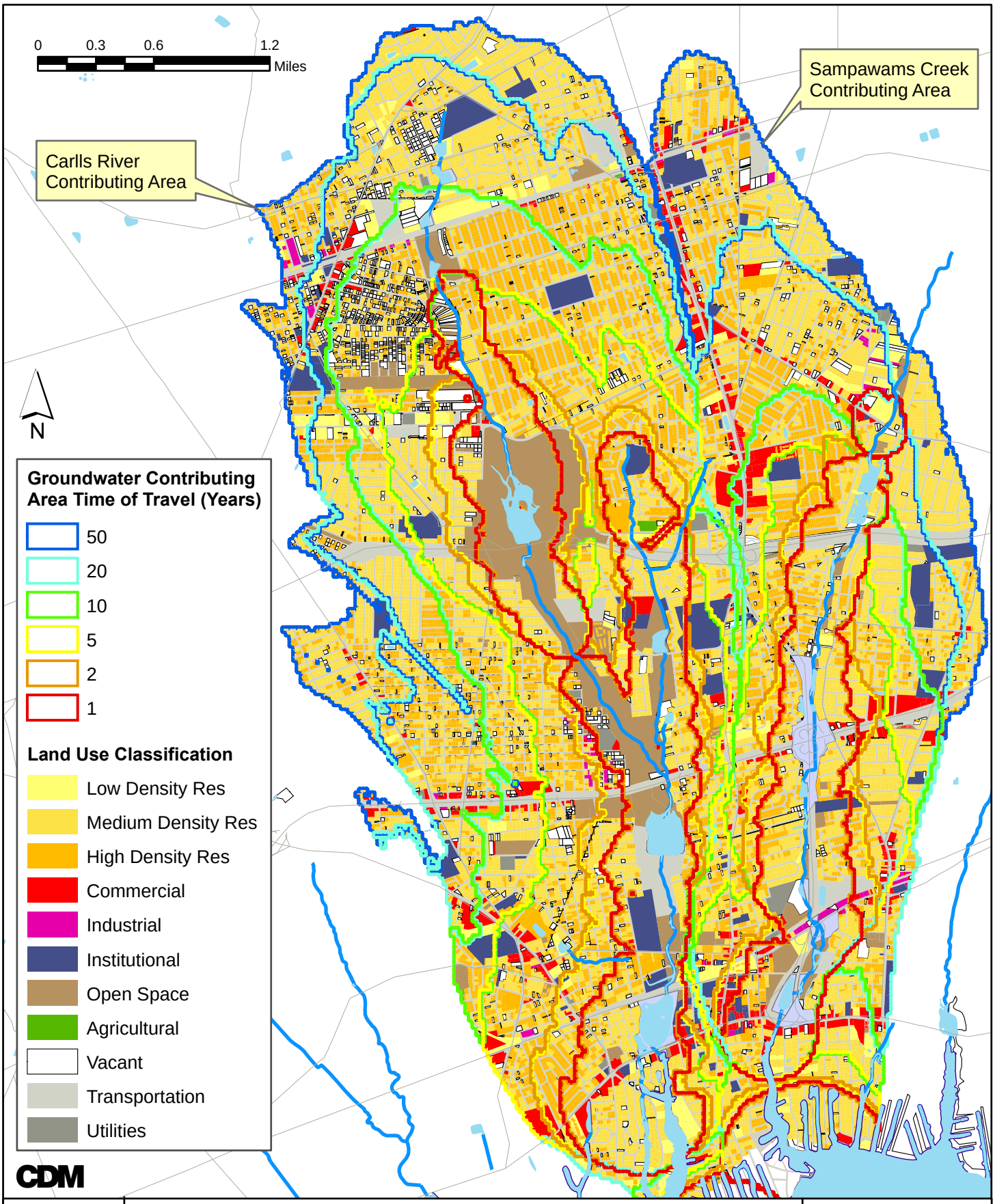
Figure 5-3 Nitrate Concentrations in Sampawams Creek

Table 5-4 Nitrate Concentrations in Streams in the Southwest Sewer District

Santapogue Creek	1960s	1970s	1980s	1990s	2000s	2013	2014
Number of Samples	10	126	22	16	40	4	2
Average (mg/L)	2.0	2.3	1.0	0.9	1.5	1.3	1.5
Maximum (mg/L)	2.8	15.0	1.4	1.4	4.0	1.6	1.7
Minimum (mg/L)	1.3	0.1	0.1	0.5	0.1	1.0	1.4
10th Percentile (mg/L)	1.4	1.2	0.7	0.5	0.9	1.1	1.4
50th Percentile (median) (mg/L)	1.9	2.0	0.9	0.9	1.3	1.3	1.5

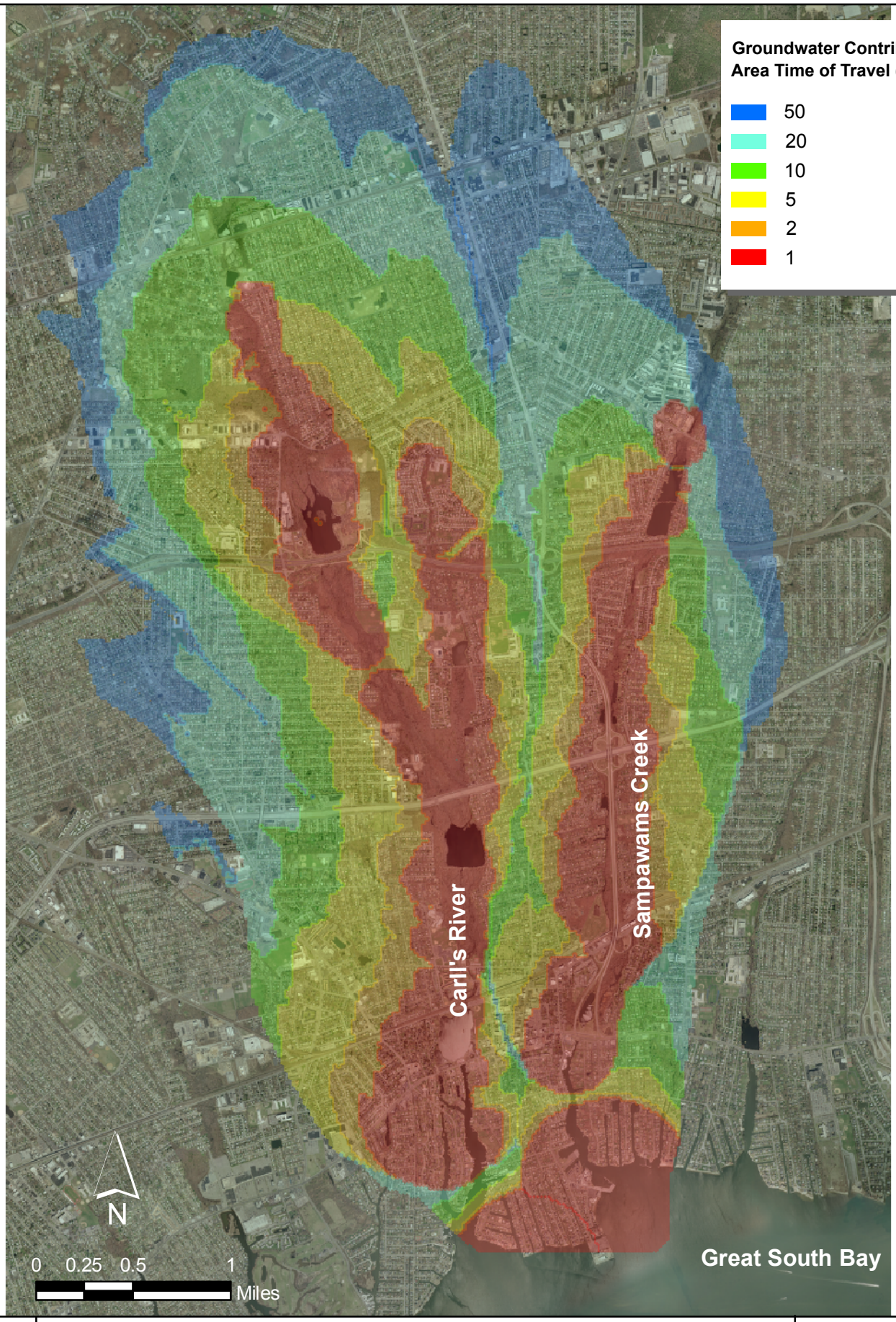
Carlls River	1960s	1970s	1980s	1990s	2000s	2013	2014
Number of Samples	-	63	20	22	65	6	3
Average (mg/L)	-	3.2	2.3	2.1	1.8	3.0	2.4
Maximum (mg/L)	-	6.1	3.5	4.8	3.4	8.5	2.7
Minimum (mg/L)	-	1.2	1.3	0.3	0.2	0.8	2.2
10th Percentile (mg/L)	-	2.2	1.6	1.1	1.0	0.8	2.3
50th Percentile (median) (mg/L)	-	3.1	2.2	2.2	1.9	2.3	2.5
90th Percentile (mg/L)	-	4.5	2.8	2.6	2.6	5.8	2.6

Sampawams Creek	1960s	1970s	1980s	1990s	2000s	2013	2014
Number of Samples	12	136	20	18	50	5	6
Average (mg/L)	2.2	3.2	2.4	1.7	1.6	10.4	1.9
Maximum (mg/L)	3.5	11.0	4.2	2.3	3.2	45.5	3.3
Minimum (mg/L)	0.7	0.1	0.7	0.7	0.1	1.4	0.7
10th Percentile (mg/L)	1.4	2.0	2.0	0.9	1.0	1.4	1.1
50th Percentile (median) (mg/L)	1.9	3.0	2.4	1.9	1.6	1.6	1.6
90th Percentile (mg/L)	3.1	4.6	3.0	2.2	2.2	28.0	2.9



Land Use Classifications within the Groundwater Contributing Areas to Carlls River and Sampawams Creek

Figure 5-4



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Groundwater Contributing Areas to Carlls River and Sampawams Creek

Figure 5-5

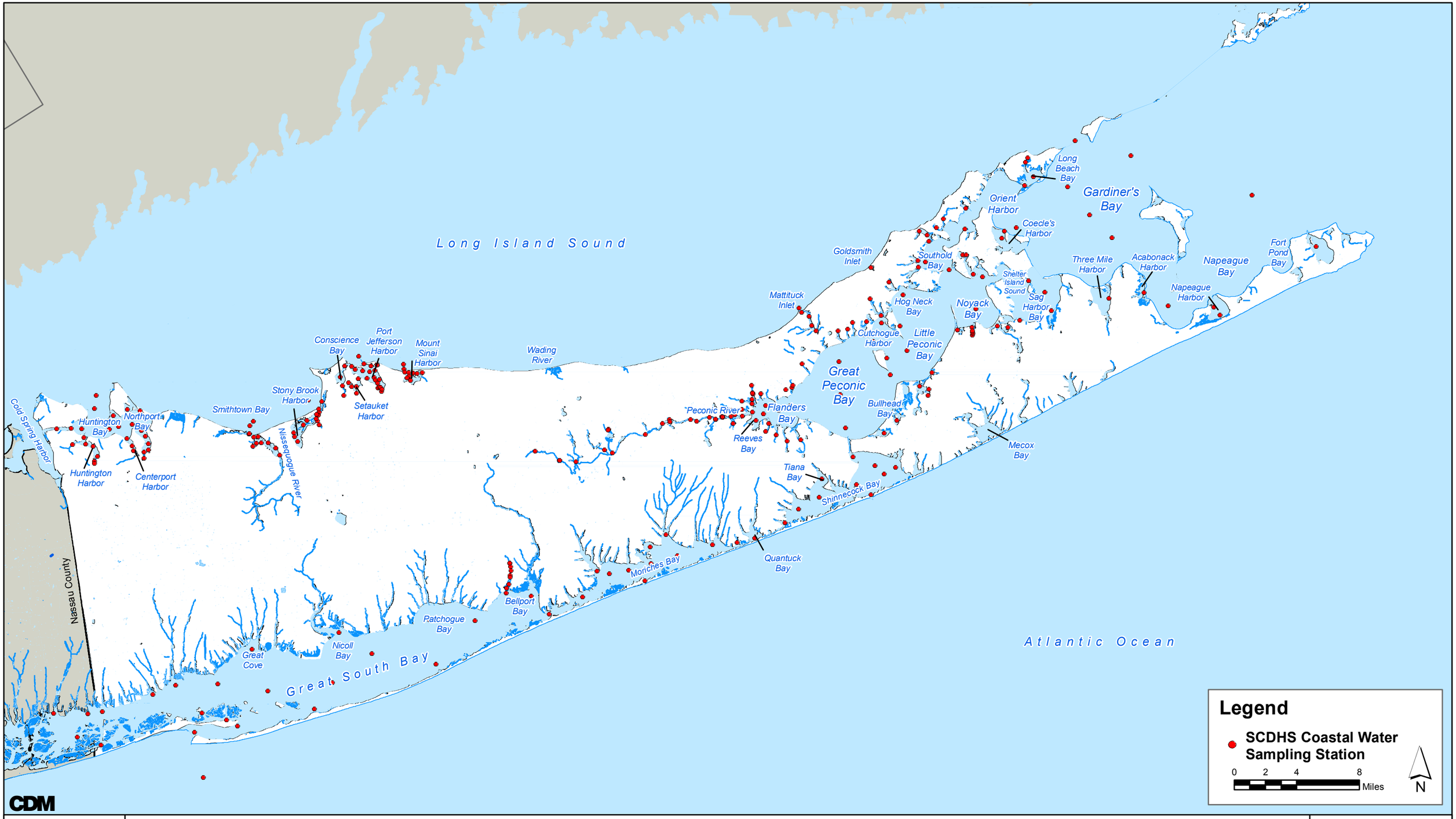
within a one year travel time is open space. VOCs were detected in stream samples collected from Sampawams Creek more than twice as often as in samples collected from the Carmans River. A review of land use types within the Carmans River watershed reveals that almost two thirds of the area that contributes groundwater baseflow to the Carmans River within a two year travel time remains open space, and over fifty percent of the entire groundwater contributing area is currently either open space or vacant land, as shown on **Table 5-5.** Not only does the open space reduce contaminant loading to groundwater, it provides a riparian buffer to protect the stream from contamination due to runoff.

Non-point source pollution controls and Total Maximum Daily Loads (TMDLs) are managed and implemented in New York State by the New York State Department of Environmental Conservation's (NYSDEC) Bureau of Water Assessment and Management. The Non-point Source Management Section works with federal, state, and local agencies and groups to develop TMDLs and address polluted runoff through the Non-point Source Coordinating Committee.

5.1.2 Coastal and Marine Resources

The quality of the County's coastal waters has been characterized using data collected by SCDHS from over 200 monitoring stations, shown on **Figure 5-6**. Coastal marine water body classifications and impairments identified by NYSDEC are summarized on **Table 5-6**. Nitrogen or aquatic toxicity concerns prompted the inclusion of fourteen water bodies, including portions of Great South Bay, Moriches Bay and five creeks on the 3c list, as shown. The presumed sources of the impairments included onsite wastewater treatment or urban runoff.

The coastal waters bordering Suffolk County are impacted to varying degrees by contaminants introduced by point and nonpoint sources. The estuary programs have demonstrated that nutrients (particularly nitrogen) and pathogens are primarily responsible for use impairments and for stressing the living marine resources. As of 2014, almost 30,000 acres are closed to shellfishing year-round, and approximately 9,000 acres are closed on a seasonal basis (NYSDEC, personal communication). Toxic contaminants also play a role in imparting stress on the living resources of Suffolk County's coastal waters. The cumulative impacts of these stresses on the overall health of the aquatic ecosystem are not well understood. Little is also known about the impact of emerging contaminants such as pharmaceuticals and personal care products (PPCPs) on the marine resources. The relative contribution of the sources of each of these contaminants of concern varies for each of the major coastal water bodies.



Suffolk County's Coastal Waters

Figure 5-6

Table 5-5
Analysis of Land Use within Carmans River Groundwater Contributing Areas

Land Use	Total Acres by Land Use within Contributing Areas					Total (Acres)
	0 to 2 Years	2 to 5 Years	5 to 10 Years	10 to 25 Years	25 to 50 Years	
Open Space	2,782	848	729	1,109	449	5,917
Medium Density Residential	530	487	565	652	376	2,608
Vacant	220	341	431	641	536	2,168
Institutional	110	85	66	770	487	1,519
Low Density Residential	343	131	156	203	127	960
Agricultural	108	63	235	147	164	717
Transportation	50	33	69	200	105	457
Industrial	33	58	41	95	65	291
Commercial	14	18	72	65	37	205
Waste Disposal	0	11	63	116	1	190
Utilities	18	12	11	19	62	122
High Density Residential	8	15	15	15	11	64
Total (Acres)	4,216	2,101	2,452	4,030	2,421	15,219

Land Use	Percentage of Land Use (by area) within Contributing Areas					Total (Percent)
	0 to 2 Years	2 to 5 Years	5 to 10 Years	10 to 25 Years	25 to 50 Years	
Open Space	66%	40%	30%	28%	19%	39%
Medium Density Residential	13%	23%	23%	16%	16%	17%
Vacant	5%	16%	18%	16%	22%	14%
Institutional	3%	4%	3%	19%	20%	10%
Low Density Residential	8%	6%	6%	5%	5%	6%
Agricultural	3%	3%	10%	4%	7%	5%
Transportation	1%	2%	3%	5%	4%	3%
Industrial	<1%	3%	2%	2%	3%	2%
Commercial	<1%	<1%	3%	2%	2%	1%
Waste Disposal	0%	<1%	3%	3%	<1%	1%
Utilities	<1%	<1%	<1%	<1%	2.6%	<1%
High Density Residential	<1%	<1%	<1%	<1%	<1%	<1%

Table 5-5
Coastal Marine Water Classification and Impairments

Item No.	Waters Index Number	Name	Description	Section 303(d) Part No.	Standards	New York State 2014 Section 303(d) List Water	
						Cause/Pollutant	Source
Part 1 - Segments with Impairments Requiring TMDL Development							
LIS1	(MW5.4c)LIS (portion 5)	Long Island Sound	East from Nassau-Suffolk county line to a line running north from Miller Place Beach and north to the New York-Connecticut boundary.	1	SA	Pathogens	Urban/Storm Runoff
SS17	(MW7.2a) AO-MB-168a thru 175	Tidal Tribs to West Moriches Bay (1701-0312) [1]	Estuary	1		D.O./Oxygen Demand	Urb/Storm,Ag,OWTS
SS17	(MW7.2a) AO-MB-168a thru 175	Tidal Tribs to West Moriches Bay (1701-0312) [1]	Estuary	1		Nitrogen	Urb/Storm,Ag,OWTS
SS17	(MW7.2a) AO-MB-168a thru 175	Tidal Tribs to West Moriches Bay (1701-0312) [1]	Estuary	1		Pathogens	Urb/Storm,Ag,OWTS
Part 2c - TMDL Required for Waters Impaired by Shellfishing Restrictions							
LIS17	(MW5.4b) LIS-P 339	Flax Pond		2c	SA	Pathogens	Urban/Storm Runoff
PEC9	GB-P 397	Spring Pond		2c	SA	Pathogens	Urban/Storm Runoff
PEC39	(MW6.1c) GB..LPB-CH-93, P420.	Mud/East Creeks and tribs (1701-0377		2c	SA	Pathogens	Urban/Storm Runoff
PEC40	(MW6.1c) GB..LPB-CH-94	Wickam Creek and tribs (1701-0378)		2c	SA	Pathogens	Urban/Storm Runoff
PEC46	(MW6.1d) GB.GPB-96	West Creek and tidal tribs (1701-0246)		2c	SA	Pathogens	Urban/Storm Runoff
PEC60	(MW6.3b)GB..GPB-122a-P 652	Scallop Pond (1701-0354)		2c	SA	Pathogens	Urban/Storm Runoff
PEC65	(MW6.3g) BIS..P 764	Oyster Pond/Lake Munchogue (1701-0169)		2c	SA	Pathogens	Urban/Storm Runoff
PEC67	(MW5.4g) LIS-FI-P1 1101	Beach Pond	Fishers Island	2c	SA	Pathogens	Urban/Storm Runoff
PEC68	(MW5.4g) LIS-FI-P1 P 1102	Island Pond	Fishers Island	2c	SA	Pathogens	Urban/Storm Runoff
SS6	(MW6.3i) AO-SB-155	Phillips Creek, Lower, and tidal tribs (1701-0299)		2c	SA	Pathogens	Urban/Storm Runoff
SS8	(MW6.3i) AO-SB-QgC	Quogue Canal (1701-0301)		2c	SA	Pathogens	Urban/Storm Runoff
SS16	(MW7.2a) AO-MB (portion 4)	Forge River, Lower and Cove (1701-0316)		2c	SA	Pathogens	Urban/Storm, Agric
SS23	(MW7.6) AO-GSB (portion 6)	Nicoll Bay (1701-0375)	Estuary	2c	SA	Pathogens	Urban/Storm Runoff
SS24	(MW7.8) AO-GSB (portion 7)	Great Cove (1701-0376)	Estuary	2c	SA	Pathogens	Urban/Storm Runoff
Part 3b - TMDL May be Deferred, Pending Verification of Cause/Pollutant/Source							
SS13	(MW7.2a) AO-MB (portion 1)	Moriches Bay, East (1701-0305)	Estuary	3b	NA	Nitrogen	Onsite WTS, Urban
SS14	(MW7.2a) AO-MB (portion 2)	Moriches Bay, West (1701-0038)	Estuary	3b	NA	Nitrogen	Onsite WTS, Urban
SS18	(MW7.3) AO-GSB (portion 1)-	Great South Bay, East (1701-0039)	Estuary	3b	NA	Nitrogen	Onsite WTS, Urban
SS19	(MW7.3) AO-GSB (portion 2)-	Great South Bay, Middle (1701-0040)	Estuary	3b	NA	Nitrogen	Onsite WTS, Urban
SS20	(MW7.3) AO-GSB (portion 3)-	Great South Bay, West (1701-0173)	Estuary	3b	NA	Nitrogen	Onsite WTS, Urban
SS25	(MW7.1b) AO-SB	Shinnecock Bay and Inlet (1701-0033)	Estuary	3b	NA	Nitrogen	Onsite WTS, Urban
SS10	(MW7.1c) AO-QB	Quantuck Bay (1701-0042)		3b	SA	Nitrogen	Onsite WTS, Urban
Part 4a - TMDL Has Already Been Established							
LIS6	HB-HH portion	Huntington Harbor	South of a line running from Wendower Road to Elbertsons Point.	4a	SA	Pathogens	Municipl,Urb/Storm
LIS7	HB-HH portion	Huntington Harbor	Remainder.	4a	SA	Pathogens	Municipl,Urb/Storm
LIS9	HB-NB-CH including P 240b	Centerport Harbor	Southeast of a line running west from land spit, including Mill Pond (P 240b).	4a	SA	Pathogens	Municipl,Urb/Storm
LIS10	HB-NB-NH	Northport Harbor	Waters south of a line running west from Bluff Point.	4a	A	Pathogens	Municipl,Urb/Storm
LIS14	SB-SBH	Stony Brook Harbor		4a	SA	Pathogens	Urban/Storm Runoff
LIS15	SB-SBH-64	West Meadow Creek		4a	SA	Pathogens	Urban/Storm Runoff
LIS18	LIS-PJH	Port Jefferson Harbor	From harbor entrance portion south to a line running between LILCO bulkhead and beach house at end of Beach Road, Belle Terre; excluding Setauket Harbor and Conscience Bay.	4a	SA	Pathogens	Municipl,Urb/Storm
LIS19	LIS-PJH-SH	Setauket Harbor		4a	SA	Pathogens	Municipl,Urb/Storm
LIS20	LIS-PJH-CB	Conscience Bay		4a	SA	Pathogens	Municipl,Urb/Storm
LIS21	LIS-MSH	Mount Sinai Harbor		4a	SA	Pathogens	Urban/Storm Runoff
LIS23	LIS-71 including P 366	Mattituck Creek		4a	SA	Pathogens	Urban/Storm Runoff
LIS24	LIS-71-1 portion	Trib. of Mattituck Creek	From mouth to Reeve Avenue bridge.	4a	SA	Pathogens	Municipl,Urb/Storm
LIS25	LIS-72 including P 376	Goldsmith Inlet		4a	SA	Pathogens	Urban/Storm Runoff
LIS26	(MW5.4g) LIS-FI-WH	West Harbor, Fishers Island		4a	SA	Pathogens	Urban/Storm Runoff
PEC1	FB	Flanders Bay, East/Center, and tribs	East/center, and tribs.	4a	SA	Pathogens	Municipl,Urb/Storm
	(MW6.1e) GB..FB,FB-111	Flanders Bay, West/Lower Sawmill Creek		4a	SC	D.O./Oxygen Demand/Nitrogen/Pathogens	Urban/Storm Runoff

Table 5-5
Coastal Marine Water Classification and Impairments

Item No.	Waters Index Number	Name	Description	Section 303(d) Part No.	Standards	New York State 2014 Section 303(d) List Water	
						Cause/Pollutant	Source
	(MW6.1e) GB..FB-110	Meetinghouse/Terrys Creeks and tribs		4a	SC	D.O./Oxygen Demand/Pathogens	Agricult/Urb/Storm
	(MW6.2) GB..FB-112 (portion 1)	Peconic River, Lower, and tidal tribs		4a	SC	D.O./Oxygen Demand/Nitrogen/Pathogens	Urban/Storm Runoff
PEC2	FB-RB	Reeves Bay	And tidal tribs.	4a	SA	Pathogens	Municipl,Urb/Storm
PEC12	GB-136 including P 713	Northwest Creek	And tidal tribs.	4a	SA	Pathogens	Urban/Storm Runoff
PEC15	GB-AH	Acabonack Harbor		4a	SA	Pathogens	Urban/Storm Runoff
PEC17	SIS-DH	Dering Harbor	South of a line running from Dering Point to Shelter Island Ferry.	4a	SA	Pathogens	Urban/Storm Runoff
PEC22	SIS-78	Stirling Creek and Basin		4a	SA	Pathogens	Urban/Storm Runoff
PEC24	SIS-80c including P 418b	Budds Pond		4a	SA	Pathogens	Urban/Storm Runoff
PEC25	SIS-P 420	Hashamomuck Pond		4a	SA	Pathogens	Urban/Storm Runoff
PEC26	SIS-83a	Town Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC27	SIS-83b portion	Jockey Creek	Below Oaklawn Avenue bridge.	4a	SA	Pathogens	Urban/Storm Runoff
PEC28	SIS-84 including P 423	Goose Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC29	SIS-126 including P 674	Noyack Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC30	SIS-SH	Sag Harbor	Harbor, northeast of Sag Harbor-North Haven bridge to breakwater and a line extending from breakwater to trib. 130.	4a	SA	Pathogens	Urban/Storm Runoff
PEC31	SIS-SHC	Sag Harbor Cove	All of cove southwest of Sag Harbor-North Haven bridge.	4a	SA	Pathogens	Urban/Storm Runoff
PEC35	LPB-90 including P 473	Richmond Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC41	LPB-123 including P 659	North Sea Harbor		4a	SA	Pathogens	Urban/Storm Runoff
PEC45	LPB-124 including P 665	Wooley Pond (P 665).	Trib. of Little Peconic Bay	4a	SA	Pathogens	Urban/Storm Runoff
PEC48	GPB-97 portion	Downs Creek	Tidal portion.	4a	SA	Pathogens	Urban/Storm Runoff
PEC49	GPB-98 portion	Halls Creek	Tidal portion.	4a	SA	Pathogens	Urban/Storm Runoff
PEC50	GPB-99	Deep Hole Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC51	GPB-99-P 492	Trib. of Deep Hole Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC52	GPB-100 portion	Trib. of Great Peconic Bay	Tidal portion.	4a	SA	Pathogens	Urban/Storm Runoff
PEC57	GPB-122	Sebonac Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC58	GPB-122-P 648	Bullhead Bay		4a	SA	Pathogens	Urban/Storm Runoff
PEC59	GPB-122a including P 651 and tribs.	Little Sebonac Creek		4a	SA	Pathogens	Urban/Storm Runoff
PEC64	BIS-P 761	Montauk Harbor		4a	SA	Pathogens	Urban/Storm Runoff
PEC91	SIS-83b portion	Jockey Creek	Above Oaklawn Avenue bridge.	4a	SC	Pathogens	Urban/Storm Runoff
PEC110	GPB-100-2	Subtrib. of Great Peconic Bay		4a	SC	Pathogens	Urban/Storm Runoff
PEC111	GPB-101 portion	Trib. of Great Peconic Bay	Tidal portion.	4a	SC	Pathogens	Urban/Storm Runoff
PEC112	GPB-102 portion	Brush Creek	Tidal portion.	4a	SC	Pathogens	Urban/Storm Runoff
PEC113	GPB-103	Trib. of Great Peconic Bay		4a	SC	Pathogens	Urban/Storm Runoff
PEC114	GPB-104 portion	Trib. of Great Peconic Bay	Tidal portion.	4a	SC	Pathogens	Urban/Storm Runoff
SS2	AO-P790	Mecox Bay	And tribs.	4a	SA	Pathogens	Agriculture
SS3	AO-SB-143, 144	Heady and Taylor Creeks	And tribs.	4a	SA	Pathogens	Urban/Storm Runoff
SS4	AO-SB-148, 150	Penny Pond and Smith Creek		4a	SA	Pathogens	Urban/Storm Runoff
SS5	AO-SB-153	Weesuck Creek	And tidal tribs.	4a	SA	Pathogens	Urban/Storm Runoff
SS7	AO-SB-156	Penniman Creek	And tidal tribs.	4a	SA	Pathogens	Urban/Storm Runoff
SS9	AO-SB-QgC-P834	Ogden Pond		4a	SA	Pathogens	Urban/Storm Runoff
SS11	AO-SB-QB-QtC	Quantuck Canal/Moneybogue Bay		4a	SA	Pathogens	Urban/Storm Runoff
SS12	AO-MB-NB	Narrow Bay		4a	SA	Pathogens	Urban/Storm, Agric
SS15	AO-MB (portion 3)	Tuthill, Harts, Seatuck Coves		4a	SA	Pathogens	Urban/Storm, Agric
SS21	AO-GSB (portion 4)	Bellport Bay		4a	SA	Pathogens	Urban/Storm Runoff
SS22	AO-GSB (portion 5)	Patchogue Bay		4a	SA	Pathogens	Urban/Storm Runoff
SS27	AO-P 780	Georgica Pond		4a	SA	Pathogens	Agriculture
SS28	AO-P 786	Sagaponack Pond		4a	SA	Pathogens	Agriculture

Table 5-5
Coastal Marine Water Classification and Impairments

Item No.	Waters Index Number	Name	Description	Section 303(d) Part No.	Standards	New York State 2014 Section 303(d) List Water	
						Cause/Pollutant	Source
Part 4c - TMDL Not Appropriate to Address Impairment							
LIS32	LIS-62 portion	Nissequogue River, Lower		4c	SC	Restricted Passage	Hab/Hyd Mod
	(MW6.2) GB..FB-112 (portion 1)	Peconic River, Lower, and tidal tribs		4c	Sc	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.1b) AO-SB	Shinnecock Bay (and Inlet)		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.1c) AO-QB	Quantuck Bay		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.2a) AO-MB (portion 1)	Moriches Bay, East		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.2a) AO-MB (portion 2)	Moriches Bay, West		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.3) AO-GSB (portion 1)	Great South Bay, East		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.3) AO-GSB (portion 2)	Great South Bay, Middle		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
	(MW7.3) AO-GSB (portion 3)	Great South Bay, West		4c	SA	Algal/Weed Growth	Hab/Hyd Mod
Waters NOT Included on the NYS 2014 Section 303(d) List of Impaired Waters Requiring a TMDL/Other Strategy							
LIS4	HB	Huntington Bay	Area bounded on west by a line running south from East Beach, on the east by a line running south from West Beach and on the north by a line running east from East Fort Point.		SA		
LIS5	HB-LH	Lloyd Harbor	Waters east of a line running south from East Beach.		SA		
LIS8	HB-NB	Northport Bay	East of a line running south from West Beach excluding Centerport Harbor and Northport Harbor.		SA		
LIS11	LIS-58 including P 269	Trib. of Long Island Sound			SA		
LIS12	LIS-59 portion	Crab Meadow Brook	From mouth to trib. 1.		SA		
LIS13	SB	Smithtown Bay	Waters south of a line running between mouth of Crab Meadow Brook and Crane Point.		SA		
LIS16	LIS-65		Trib. of Long Island Sound		SA		
LIS22	LIS portion	Long Island Sound	All waters of Long Island Sound in New York State, east of a line running north from Luce Landing to the New York-Connecticut boundary and north of a line extending from Orient Point, through Plum Island, to Great Gull Island.		SA		
LIS27	CSH-51	Trib. of Cold Spring Harbor	Tidal portion.		SC		
LIS28	CSH-P 204	Trib. of Cold Spring Harbor			SC		
LIS29	LIS-P 209	Unnamed pond			SC		
LIS30	HB-NB-CH-56a	Trib. of Centerport Harbor			SC		
LIS31	LIS-61 portion	Sunken Meadow Creek	Tidal portion.		SC		
LIS33	LIS-62-2	Trib. of Nissequogue River	Tidal portion.		SC		
LIS34	LIS-PJH portion	Port Jefferson Harbor	Remainder.		SC		
LIS35	LIS-PJH-CB-66 portion	Trib. of Conscience Bay	Mouth to outlet of P 340a.		SC		
LIS36	LIS-70 including P 361	Trib. of Long Island Sound			SC		
LIS37	LIS-71-1 portion	Trib. of Mattituck Creek	Tidal portion.		SC		
LIS38	LIS-P 386, P 388	Tribs. of Long Island Sound			SC		
PEC3	GB	Gardiners Bay	East of a line extending from Cleaves Point to Hay Beach Point on North Fork and east of a line extending from Mashomack Point to Barcelona Point on South Fork, to a line running south from Plum Island through Gardiners Island to Alberts Landing, including Orient Harbor, Long Beach Bay, Northwest Harbor.		SA		
PEC4	GB-LBB	Long Beach Bay	North of a line extending from Browns Point to Orient State Park. Includes Little Bay and Narrow River. (Part of Gardiners Bay.)		SA		
PEC5	GB-OH	Orient Harbor	North of a line running from Cleaves Point to Long Beach Point. (Part of Gardiners Bay.)		SA		
PEC6	GB-75	Trib. of Gardiners Bay			SA		
PEC7	GB-76 including P 395	Dam Pond			SA		
PEC8	GB-77a including P 396 portion	Marion Lake	Northeast of bridge.		SA		
PEC10	GB-CI	Coecles Inlet	Northwest of a line running between Reel Point and Sungic Point.		SA		
PEC11	GB-NWH	Northwest Harbor	East of a line running from Cedar Point to Barcelona Point.		SA		
PEC13	GB-TMH	Threemile Harbor			SA		

Table 5-5
Coastal Marine Water Classification and Impairments

Item No.	Waters Index Number	Name	Description	Section 303(d) Part No.	Standards	New York State 2014 Section 303(d) List Water	
						Cause/Pollutant	Source
PEC14	GB-140 including P 729	Hog Creek			SA		
PEC16	SIS	Shelter Island Sound	All waters east from a line extending south from Cedar Beach Point to Jessup Neck, to a line extending from Cleaves Point to Hay Beach Point on the North Fork and from Mashomack Point to Barcelona Point on the South Fork, including Noyack Bay, Sag Harbor Bay.		SA		
PEC18	SIS-WNH	West Neck Harbor	North of a line running from West Neck Point to Wards Point.		SA		
PEC19	SIS-SI-8 including P 457	Dickerson Creek			SA		
PEC20	SIS-SI-8a	Menantic Creek			SA		
PEC21	SIS-SI-9 including P 461	West Neck Creek and Bay			SA		
PEC23	SIS-80	Trib. of Shelter Island Sound			SA		
PEC32	LPB	Little Peconic Bay	From a line extending southerly from New Suffolk through Robins Island to Cow Neck Point and east to a line running from Cedar Beach Point to Jessup Neck and including Cutchogue Harbor.		SA		
PEC33	LPB-88 including P 467	Cedar Beach Creek			SA		
PEC34	LPB-89 including P 472	Corey Creek			SA		
PEC36	LPB-91	Little Creek			SA		
PEC37	LPB-CH	Cutchogue Harbor	Part of Little Peconic Bay - north of a line running from New Suffolk to Nassau Point.		SA		
PEC38	LPB-92 including P 477, 92a including P 478	Tribs. of Little Peconic Bay			SA		
PEC42	LPB-123-P 659a	Davis Creek			SA		
PEC43	LPB-123-P 659a-P 664	Turtle Cove			SA		
PEC44	LPB-123-P 660	Fish Cove			SA		
PEC47	GPB	Great Peconic Bay	From a line extending southerly from Miamogue Point to Red Cedar Point, east to a line extending southerly from New Suffolk through Robins Island to Cow Neck Point.		SA		
PEC53	GPB-118 including P 644	Red Creek Pond			SA		
PEC54	GPB-119 including P 645	Trib. of Great Peconic Bay			SA		
PEC55	GPB-121	Trib. of Great Peconic Bay			SA		
PEC56	GPB-121-P 647	Cold Spring Pond			SA		
PEC61	BIS	Block Island Sound	All waters within New York State, east of a line running from Plum Island through Gardiners Island to Alberts Landing, including Napeague Bay, Napeague Harbor and Fort Pond Bay.		SA		
PEC62	BIS-NH	Napeague Harbor	Part of Block Island Sound, southeast of a line running from Goff Point to Hicks Island.		SA		
PEC63	BIS-142 including P 752	Napeague Pond			SA		
PEC66	Gardiners Island-P 732, 5 including P 741, 7 including P 747, 739	Tribs. of Gardiners Island	Tidal portions.		SA		
PEC69	GB-73,74,75a,75b, 75c	Tidal portion.	Tribs. of Gardiners Bay		SC		
PEC70	GB-77a including P 396 portion	Marion Lake	Southwest of bridge.		SC		
PEC71	GB-P 399	Trib. of Gardiners Bay			SC		
PEC72	Trib. of Gardiners Bay	GB-P 439a			SC		
PEC73	GB-P 450a	Trib. of Gardiners Bay			SC		
PEC74	GB-137 portion	Trib. of Gardiners Bay	Tidal portion.		SC		
PEC75	GB-137-P 726	Alewife Pond			SC		
PEC76	GB-138	Hands Creek			SC		
PEC77	SIS-SI-1 including P 431	Crab Creek			SC		
PEC78	SIS-SI-2a including P 434	Chase Creek			SC		
PEC79	SIS-SI-2b and P 436	Gardiners Creek			SC		
PEC80	SIS-SI-3 and P 451b	Trib. of Shelter Island Sound			SC		
PEC81	SIS-SI-4	Trib. of Shelter Island Sound			SC		
PEC82	SIS-SI-4a including P 451a, 5 including P 452, 6 including P 455, 6a including P 456a, 6b including P 456,7	Tribs. of Shelter Island Sound			SC		
PEC83	SIS-77 including P 400	Gull Pond			SC		
PEC84	SIS-79	Trib. of Shelter Island Sound			SC		
PEC85	SIS-79-1 portion including P 408	Trib. of Shelter Island Sound	Tidal portion.		SC		
PEC86	SIS-79-2 portion	Moores Drain	Tidal portion.		SC		
PEC87	SIS-P 414, P 415	Tribs. of Shelter Island Sound			SC		

Table 5-5
Coastal Marine Water Classification and Impairments

Item No.	Waters Index Number	Name	Description	Section 303(d) Part No.	Standards	New York State 2014 Section 303(d) List Water	
						Cause/Pollutant	Source
PEC88	SIS-80a	Trib. of Shelter Island Sound			SC		
PEC89	SIS-80b including P 418	Trib. of Shelter Island Sound			SC		
PEC90	SIS-82 including P 421, 83 including P 422	Tribs. of Shelter Island Sound			SC		
PEC92	SIS-85 including P 428, 86 including P 429, 87 including P 430, P 672	Tribs. of Shelter Island Sound			SC		
PEC93	SIS-128	Trib. of Shelter Island Sound			SC		
PEC94	SIS-128-1 including P 678	Subtrib. of Shelter Island Sound			SC		
PEC95	SIS-129 including P 686, P 685, P 685a	Tribs. of Shelter Island Sound			SC		
PEC96	SIS-129a including P 689	Trib. of Shelter Island Sound			SC		
PEC97	SIS-130 including P 696	Trib. of Shelter Island Sound	P 696 is fresh pond.		SC		
PEC98	SIS-131 including P 697	Trib. of Shelter Island Sound			SC		
PEC99	SIS-132 portion	Ligonee Brook			SC		
PEC100	SIS-133	Trib. of Shelter Island Sound			SC		
PEC101	SIS-133-P 709	Subtrib. of Shelter Island Sound			SC		
PEC102	SIS-134 portion	Trib. of Shelter Island Sound	Tidal portion.		SC		
PEC103	SIS-135 including P 712	Trib. of Shelter Island Sound			SC		
PEC104	LPB-88a, 88b including P 470	Tribs. of Little Peconic Bay			SC		
PEC105	LPB-95	Trib. of Little Peconic Bay			SC		
PEC106	LPB-P 653	Trib. of Little Peconic Bay			SC		
PEC107	LPB-123-1 portion	Trib. of North Sea Harbor	Tidal portion.		SC		
PEC108	LPB-125 including P 667	Trib. of Little Peconic Bay	Fresh Pond (P 667).		SC		
PEC115	GPB-120	Shinnecock Canal	From Shinnecock Light to locks.		SC		
PEC116	BIS-141 portion including P 749	Trib. of Block Island Sound	From mouth to inlet of P 749.		SC		
PEC117	BIS-P 761-P 762	Little Reed Pond			SC		
PEC118	BIS-P 766, P 766a, P 767, P 767a	Tribs. of Block Island Sound			SC		
PEC119	Gardiners Island-P 731, P 736, P 737, P 737a, P 738, P 743, P 744, 6 including P 745, P 746, P 746a	Ponds and streams on Gardiners Island	Tidal portions.		SC		
PEC120	GPB-121-P 647-1	Trib. of Cold Spring Pond	Tidal portion. Freshwater portion.		SC C		
SS1	AO	Atlantic Ocean	To three miles out, Nassau county line east to line running south of Blue Point and Water Island.		SA		
SS26	AO portion	Atlantic Ocean	From a line running southerly from Mecox Coast Guard Station, east to Montauk Point and extending three miles from shore.		SA		
SS30	GSB-188a	Namkee Creek			SC		
SS31	GSB-188b	Herman's Creek			SC		
SS32	GSB-189 portion	Brown Creek	From mouth to outlet of Sayville Mill Pond (P 893).		SC		
SS33	GSB-190 portion	Green Creek	Mouth to Montauk Highway.		SC		
SS34	GSB-190-P 899	Trib. of Green Creek			SC		
SS35	GSB-191	Indian Creek			SC		
SS36	GSB-192, 192a	Tribs. of Great South Bay			SC		
SS37	GSB-193 portion	Connetquot River	Mouth to Montauk Highway.		SC		
SS38	GSB-193-1, 1a	Tribs. of Connetquot River			SC		
SS39	GSB-193-2 portion	Trib. of Connetquot River	Mouth to Montauk Highway.		SC		
SS40	GSB-193-2-P 901	Subtrib. of Connetquot River			SC		
SS41	GSB-193a	Heckscher Canal			SC		
SS42	GSB-194a	Quintuck Creek			SC		
SS43	GSB-194 portion	Champlin Creek	Mouth to outlet of P 910.		SC		
SS44	GSB-194b, 194c, 195	Tribs. of Great South Bay	Tidal portion.		SC		
SS45	GSB-196 portion	Orowoc Creek	From mouth to Montauk Highway.		SC		
SS46	GSB-197 portion	Awixa Creek	From mouth to Montauk Highway.		SC		
SS47	GSB-198 portion	Penataquit Creek	From mouth to Montauk Highway.		SC		
SS48	GSB-199	Watchogue Creek			SC		
SS49	GSB-199a	Trib. of Great South Bay			SC		
SS50	GSB-200	Lawrence Creek	Tidal portion.		SC		
SS51	GSB-201	Brightwaters Canal	Tidal portion.		SC		

Table 5-5
Coastal Marine Water Classification and Impairments

Item No.	Waters Index Number	Name	Description	Section 303(d) Part No.	Standards	New York State 2014 Section 303(d) List Water	
						Cause/Pollutant	Source
SS52	GSB-202	Thorn Canal	Tidal portion.		SC		
SS53	GSB-202a		Isbrandsen Canal		SC		
SS54	GSB-203 portion	Thompsons Creek	From mouth to Montauk Highway.		SC		
SS55	GSB-204 portion	Trues Creek	From mouth to Montauk Highway.		SC		
SS56	GSB-204a	Trib. of Great South Bay			SC		
SS57	GSB-205 portion	Willets Creek	From mouth to Montauk Highway.		SC		
SS58	GSB-206	Skookwams Creek			SC		
SS59	GSB-207 portion	Sampawams Creek	From mouth to Montauk Highway.		SC		
SS60	GSB-208 portion and tribs. 1, 1a	Carlls River	From mouth to Montauk Highway.		SC		
SS61	GSB-209 and trib. 1	West Babylon Creek	Tidal portions.		SC		
SS62	GSB-210 portion including P 958	Santapogue Creek	From mouth to Montauk Highway.		SC		
SS63	GSB-211 portion	Neguntatogue Creek	From mouth to Montauk Highway.		SC		
SS64	GSB-212 portion	Trib. of Great South Bay	From mouth to Montauk Highway.		SC		
SS65	GSB-212a, 212b		Tribs. of Great South Bay		SC		
SS66	GSB-213 portion	Great Neck Creek	From mouth to Montauk Highway.		SC		
SS67	GSB-213a, 213b	Tribs. of Great South Bay			SC		
SS68	GSB-214	Howell Creek			SC		
SS69	GSB-214a	Trib. of Great South Bay			SC		
SS70	GSB-215 portion	Woods Creek (Ketchams Creek)	From mouth to Merrick Road.		SC		
SS71	GSB-216 portion	Amityville Creek	From mouth to Merrick Road.		SC		
SS72	GSB-217	Narraskatuck Creek	Tidal portion within Suffolk County.		SC		
SS73	AO-P 786-2-P 789a	Subtrib. of Sagaponack Pond			SC		
SS74	Gardiners Island-P 731, P 736, P 737, P 737a, P 738, P 743, P 744, 6 including P 745, P 746, P 746a	Ponds and streams on Gardiners Island	Tidal portions.		SC		

Key:

Waters Index Number	Name of Waters	Explanation
LIS	Long Island Sound	Primary waters identified by abbreviation.
CSH	Cold Spring Harbor	
SB	Smithtown Bay	
HB	Huntington Bay	
GB	Gardiners Bay	Primary waters identified by abbreviation.
SIS	Shelter Island Sound	
LPB	Little Peconic Bay	
GPB	Great Peconic Bay	
BIS	Block Island Sound	
GSB	Great South Bay	Primary waters identified by abbreviation.
AO	Atlantic Ocean	

Source for 2014 NYS 303(d) List of Impaired Waters:

http://www.dec.ny.gov/docs/water_pdf/303dlistfinal2014.pdf

The management plans that are in place for the coastal waters bordering the County share many common issues and management strategies. Nitrogen and pathogens were identified as the parameters with the greatest impacts in terms of limiting uses and stressing the living marine resources. Within the Suffolk County watershed area, nonpoint sources are the major contributors of nutrients and pathogens, and recommendations identified within each of the estuary programs focus on reducing nitrogen loading from sanitary wastewater and fertilization, implementation of best management practices (BMPs) to improve stormwater quality, and open space preservation. The cumulative impacts of pesticides and PPCPs on the aquatic ecosystems have not yet been well defined, and are currently under study.

Not all impaired waters of the state are listed on the Section 303(d) list. By definition, the 303(d) list is limited to impaired waters that require the development of a TMDL. However New York State maintains a list of Other Impaired Waterbody Segments Not Listed on the 303(d) list to provide a more comprehensive inventory of waters that do not fully support designated uses. Waterbodies on this list are considered to be impaired, however a TMDL is not necessary. In some cases, this is because a TMDL has already been established for the segment/pollutant, or because urban stormwater runoff is identified as a source of impairment. **Table 5-7**, the All Impaired Waters List is a complete listing of all impaired water bodies (contains the Section 303(d) List waters as well as the Other Impaired Waterbody Segments Not Listed) as shown on the figure below.

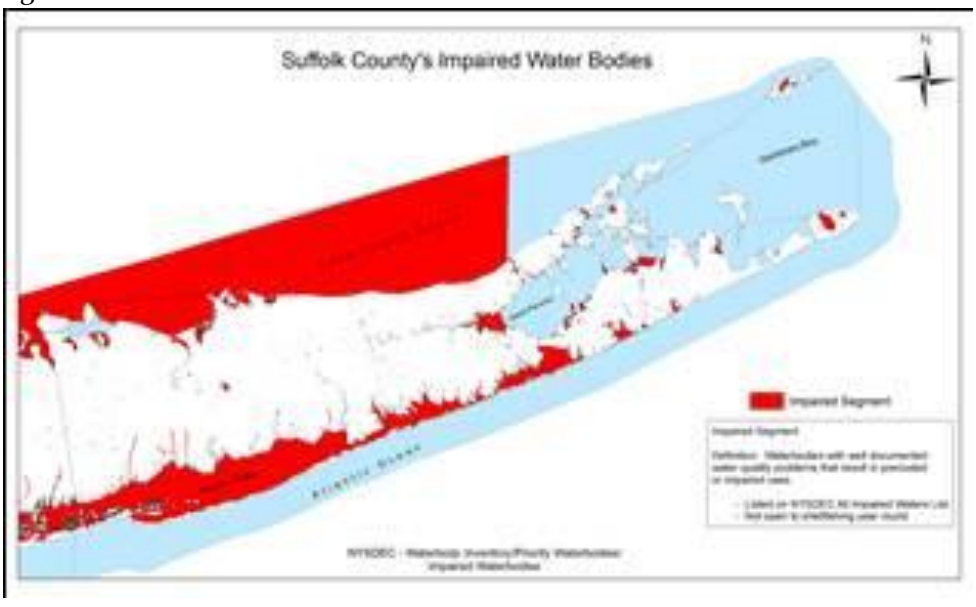


Table 5-7 Suffolk County Impaired Waters

Waters Index Number	Water Body Name	CAUSE/POLLUTANT	SOURCE
(MW5.4c) LIS (portion 5)	Long Island Sound, Suffolk Co, Central	Pathogens	Urban/Storm Runoff
(MW7.2a) AO-MB-168a thru 175 (sel.)	Tidal tribs to West Moriches Bay	D.O./Oxygen Demand	Urb/Storm,Ag,OWTS
(MW7.2a) AO-MB-168a thru 175 (sel.)	Tidal tribs to West Moriches Bay	Nitrogen	Urb/Storm,Ag,OWTS
(MW7.2a) AO-MB-168a thru 175 (sel.)	Tidal tribs to West Moriches Bay	Pathogens	Urb/Storm,Ag,OWTS
Part 2c TMDL Required for Waters Impaired by Shellfishing Restrictions			
(MW5.4b) LIS-P339	Flax Pond	Pathogens	Urban/Storm Runoff
(MW5.4g) LIS-FI-P1101,P1102	Beach/Island Ponds, Fishers Island	Pathogens	Urban/Storm Runoff
(MW6.1a) GB-P397	Spring Pond	Pathogens	Urban/Storm Runoff
(MW6.1c) GB..LPB-CH-93, P420	Mud/East Creeks and tribs	Pathogens	Urban/Storm Runoff
(MW6.1c) GB..LPB-CH-94	Wickham Creek and tribs	Pathogens	Urban/Storm Runoff
(MW6.1d) GB..GPB- 96	West Creek and tidal tribs	Pathogens	Urban/Storm Runoff
(MW6.3b) GB..GPB-122a-P652	Scallop Pond	Pathogens	Urban/Storm Runoff
(MW6.3h) BIS..P764	Oyster Pond/Lake Munchogue	Pathogens	Urban/Storm Runoff
(MW7.1b) AO-SB-155	Phillips Creek, Lower, and tidal tribs	Pathogens	Urban/Storm Runoff
(MW7.1b) AO-SB-QgC	Quogue Canal	Pathogens	Urban/Storm Runoff
(MW7.2a) AO-MB (portion 4)	Forge River, Lower and Cove	Pathogens	Urban/Storm, Agric
(MW7.6) AO-GSB (portion 6)	Nicoll Bay	Pathogens	Urban/Storm Runoff
(MW7.8) AO-GSB (portion 7)	Great Cove	Pathogens	Urban/Storm Runoff
Part 3b - TMDL May be Deferred, Pending Verification of Cause/Pollutant/Source			
(MW7.1b) AO-SB	Shinnecock Bay (and Inlet)	Nitrogen	Onsite WTS, Urban
(MW7.1c) AO-QB	Quantuck Bay	Nitrogen	Onsite WTS, Urban
(MW7.2a) AO-MB (portion 1)	Moriches Bay, East	Nitrogen	Onsite WTS, Urban
(MW7.2a) AO-MB (portion 2)	Moriches Bay, West	Nitrogen	Onsite WTS, Urban
(MW7.3) AO-GSB (portion 1)	Great South Bay, East	Nitrogen	Onsite WTS, Urban
(MW7.3) AO-GSB (portion 2)	Great South Bay, Middle	Nitrogen	Onsite WTS, Urban
(MW7.3) AO-GSB (portion 3)	Great South Bay, West	Nitrogen	Onsite WTS, Urban
Part 4a - TMDL Has Already Been Established			
(MW5.2a) LIS-HB-HH	Huntington Harbor	Pathogens	Municipl,Urb/Storm
(MW5.2a) LIS-HB-NB-CH	Centerport Harbor	Pathogens	Municipl,Urb/Storm
(MW5.2a) LIS-HB-NB-NH	Northport Harbor	Pathogens	Municipl,Urb/Storm
(MW5.4a) LIS-SB-SBH	Stony Brook Harbor and West Meadow Creek	Pathogens	Urban/Storm Runoff
(MW5.4c) LIS-PJH (portion 1)	Port Jefferson Harbor, North, and tribs	Pathogens	Municipl,Urb/Storm
(MW5.4c) LIS-PJH-CB	Conscience Bay and tidal tribs	Pathogens	Municipl,Urb/Storm
(MW5.4c) LIS-PJH-SH	Setauket Harbor	Pathogens	Municipl,Urb/Storm
(MW5.4d) LIS- MSH	Mt Sinai Harbor and tidal tribs	Pathogens	Urban/Storm Runoff
(MW5.4e) LIS- 71	Mattituck Inlet/Cr, Low, and tidal tribs	Pathogens	Urban/Storm Runoff
(MW5.4e) LIS- 72	Goldsmith Inlet	Pathogens	Urban/Storm Runoff
(MW5.4g) LIS-FI-WH	West Harbor, Fishers Island	Pathogens	Urban/Storm Runoff
(MW6.1b) GB-SIS- 78	Stirling Creek and Basin	Pathogens	Urban/Storm Runoff
(MW6.1b) GB-SIS- 80c-P418a	Budds Pond	Pathogens	Urban/Storm Runoff
(MW6.1b) GB-SIS- 83a,83b	Town/Jockey Creeks and tidal tribs	Pathogens	Urban/Storm Runoff
(MW6.1b) GB-SIS- 84-P423	Goose Creek	Pathogens	Urban/Storm Runoff
(MW6.1b) GB-SIS(-DH)	Dering Harbor	Pathogens	Urban/Storm Runoff
(MW6.1b) GB-SIS-P420	Hashamomuck Pond	Pathogens	Urban/Storm Runoff
(MW6.1c) GB..LPB- 90	Richmond Creek and tidal tribs	Pathogens	Urban/Storm Runoff
(MW6.1d) GB..GPB- 97 thru 104	Tidal Tribs to Gr Peconic Bay, Northshr	Pathogens	Urban/Storm Runoff
(MW6.1e) FB	Flanders Bay, East/Center, and tribs	Pathogens	Municipl,Urb/Storm
(MW6.1e) GB..FB,FB-111	Flanders Bay, West/Lower Sawmill Creek	D.O./Oxygen Demand	Urban/Storm Runoff
(MW6.1e) GB..FB,FB-111	Flanders Bay, West/Lower Sawmill Creek	Nitrogen	Urban/Storm Runoff
(MW6.1e) GB..FB,FB-111	Flanders Bay, West/Lower Sawmill Creek	Pathogens	Urban/Storm Runoff
(MW6.1e) GB..FB-110	Meetinghouse/Terrys Creeks and tribs	D.O./Oxygen Demand	Agriculture
(MW6.1e) GB..FB-110	Meetinghouse/Terrys Creeks and tribs	Nutrients	Agriculture
(MW6.1e) GB..FB-110	Meetinghouse/Terrys Creeks and tribs	Pathogens	Urban/Storm Runoff
(MW6.2) GB..FB-112 (portion 1)	Peconic River, Lower, and tidal tribs	D.O./Oxygen Demand	Urban/Storm Runoff
(MW6.2) GB..FB-112 (portion 1)	Peconic River, Lower, and tidal tribs	Nutrients	Urban/Storm Runoff
(MW6.2) GB..FB-112 (portion 1)	Peconic River, Lower, and tidal tribs	Pathogens	Urban/Storm Runof
(MW6.3a) GB..FB-RB	Reeves Bay and tidal tribs	Pathogens	Municipl,Urb/Storm
(MW6.3b) GB..GPB-122a-P651	Little Sebonac Creek	Pathogens	Urban/Storm Runoff
(MW6.3b) GB..GPB-122-P648	Sebonac Cr/Bullhead Bay and tidal tribs	Pathogens	Urban/Storm Runoff
(MW6.3c) GB..LPB-123-P659	North Sea Harbor and tribs	Pathogens	Urban/Storm Runoff
(MW6.3c) GB..LPB-124-P665	Wooley Pond	Pathogens	Urban/Storm Runoff

(MW6.3d) GB-SIS-126	Noyack Creek and tidal tribs	Pathogens	Urban/Storm Runoff
(MW6.3e) GB-SIS-SHB,SHC	Sag Harbor and Sag Harbor Cove	Pathogens	Urban/Storm Runoff
(MW6.3f) GB-AH	Acabonack Harbor	Pathogens	Urban/Storm Runoff
(MW6.3f) GB-SIS-NH-136	Northwest Creek and tidal tribs	Pathogens	Urban/Storm Runoff
(MW6.3h) BIS..P761	Lake Montauk	Pathogens	Urban/Storm Runoff
(MW7.1a) AO-P780	Georgica Pond	Pathogens	Agriculture
(MW7.1a) AO-P786	Sagaponack Pond	Pathogens	Agriculture
(MW7.1b) AO-P790	Mecox Bay and tribs	Pathogens	Agriculture
(MW7.1b) AO-SB-143,144	Heady and Taylor Creeks and tribs	Pathogens	Urban/Storm Runoff
(MW7.1b) AO-SB-148 thru 150	Penny Pond, Wells and Smith Creeks	Pathogens	Urban/Storm Runoff
(MW7.1b) AO-SB-153	Weesuck Creek and tidal tribs	Pathogens	Urban/Storm Runoff
(MW7.1b) AO-SB-156	Penniman Creek and tidal tribs	Pathogens	Urban/Storm Runoff
(MW7.1b) AO-SB-QgC-P834	Ogden Pond	Pathogens	Urban/Storm Runoff
(MW7.1c) AO-QB	Quantuck Bay	Pathogens	Urban/Storm Runoff
(MW7.1c) AO-SB-QB-QtC	Quantuck Canal/Moneybogue Bay	Pathogens	Urban/Storm Runoff
(MW7.2a) AO-MB (portion 3)	Tuthill, Harts, Seatuck Coves	Pathogens	Urban/Storm, Agric
(MW7.2b) AO-MB-NB	Narrow Bay	Pathogens	Urban/Storm, Agric
(MW7.3) AO-GSB (portion 4)	Bellport Bay	Pathogens	Urban/Storm Runoff
(MW7.3) AO-GSB (portion 5)	Patchogue Bay	Pathogens	Urban/Storm Runoff
Part 4c -TMDL Not Appropriate to Address Impairment			
(MW5.3) LIS- 62	Nissequogue River, Lower	Restricted Passage	Hab/Hyd Mod
(MW6.2) GB..FB-112 (portion 1)	Peconic River, Lower, and tidal tribs	Algal/Weed Growth	Hab/Hyd Mod
(MW7.1b) AO-SB	Shinnecock Bay (and Inlet)	Algal/Weed Growth	Hab/Hyd Mod
(MW7.1c) AO-QB	Quantuck Bay	Algal/Weed Growth	Hab/Hyd Mod
(MW7.2a) AO-MB (portion 1)	Moriches Bay, East	Algal/Weed Growth	Hab/Hyd Mod
(MW7.2a) AO-MB (portion 2)	Moriches Bay, West	Algal/Weed Growth	Hab/Hyd Mod
(MW7.3) AO-GSB (portion 1)	Great South Bay, East	Algal/Weed Growth	Hab/Hyd Mod
(MW7.3) AO-GSB (portion 2)	Great South Bay, Middle	Algal/Weed Growth	Hab/Hyd Mod
(MW7.3) AO-GSB (portion 3)	Great South Bay, West	Algal/Weed Growth	Hab/Hyd Mod
(MW5.0) - - -	Spring Pond/Lake	Chlordane	Contaminated Sed.
(MW5.3) LIS- 62-P288	Philips Mill Pond	Restricted Passage	Hab/Hyd Mod
(MW5.3) LIS- 62-P292	New Mill Pond	Restricted Passage	Hab/Hyd Mod
(MW5.3) LIS-62-P296	Millers Pond	Algal/Weed Growth	Hab/Hyd Mod
(MW5.3) LIS-62-P296	Millers Pond	D.O./Oxygen Demand	Urban/Storm Runoff
(MW5.3) LIS-62-P296	Millers Pond	Phosphorus	Urban/Storm Runoff
(MW6.1d) GB..GPB-P495	Mattituck (Marratooka) Pond	D.O./Oxygen Demand	Urban/Storm Runoff
(MW6.1d) GB..GPB-P495	Mattituck (Marratooka) Pond	Pathogens	Urban/Storm Runoff
(MW6.1d) GB..GPB-P495	Mattituck (Marratooka) Pond	Phosphorus	Urban/Storm Runoff
(MW6.1d) GB..GPB-P496	Laurel Pond	D.O./Oxygen Demand	
(MW6.2) GB..FB-112-2-P536	Wildwood Lake (Great Pond)	Restricted Passage	Hab/Hyd Mod
(MW6.2) GB..FB-112-P555/P556	Peconic Lake/Swans Pond	Restricted Passage	Hab/Hyd Mod
(MW6.3c) GB..LPB-123..P661,P662	Big/Little Fresh Ponds	Nutrients	Urb/Storm/CSO,Muni
(MW6.3d) GB-SIS-SI-WNH-P458	Fresh Pond	Phosphorus	Urban/Storm Runoff
(MW6.3h) BIS..P753	Fresh Pond	Mercury	Atmospheric Dep.
(MW6.3h) BIS..P755	Fort Pond	D.O./Oxygen Demand	
(MW7.1a) AO-P782/P784	Wainscott Pond/Fairfield Pond	D.O./Oxygen Demand	
(MW7.1b) AO-P790- 2-2-P793,P794	Mill and Seven Ponds	Phosphorus	Urb/Storm/CSO,Muni
(MW7.1b) AO-P814	Old Town Pond	D.O./Oxygen Demand	
(MW7.1b) AO-P815	Agawam Lake	D.O./Oxygen Demand	
(MW7.2a) AO-MB-174-P850/P851	West and East Mill Ponds	D.O./Oxygen Demand	
(MW7.5) AO-GSB-185-P889	Canaan Lake	Phosphorus	Urban/Storm Runoff
(MW7.5) AO-GSB-185-P889	Canaan Lake	Silt/Sediment	Urban/Storm Runoff
(MW7.7) AO-GSB-193..P304	Lake Ronkonkoma	Algal/Weed Growth	Hab/Hyd Mod
(MW7.7) AO-GSB-193..P304	Lake Ronkonkoma	Pathogens	Urban/Storm Runoff
(MW7.7) AO-GSB-193..P304	Lake Ronkonkoma	Phosphorus	Urban/Storm Runoff
(MW7.8) AO-GSB-205-P934	Lake Capri	Cadmium	Cont.Sed,Land Disp
(MW7.8) AO-GSB-205-P934	Lake Capri	Chlordane	Cont.Sed,Land Disp
(MW5.3) LIS- 62	Nissequogue River, Upper, and tribs	Restricted Passage	Hab/Hyd Mod
(MW6.2) GB..FB-112 (portion 2)	Peconic River, Middle, and tribs	Restricted Passage	Hab/Hyd Mod
(MW6.2) GB..FB-112 (portion 3)	Peconic River, Middle, and tribs	Restricted Passage	Hab/Hyd Mod
(MW6.2) GB..FB-112-3a thru 9 (sel)	Tribs to Peconic River	Restricted Passage	Hab/Hyd Mod
(MW7.2a) AO-MB-170	Terrell River, Upper, and tribs	Unknown Toxicity	Urb/Storm Runoff
(MW7.5) AO-GSB-178	Beaverdam Creek and tribs	Ammonia	Urb/Storm Runoff
(MW7.5) AO-GSB-179	Motts Creek, Upper, and tribs	Unknown Toxicity	Urb/Storm Runoff
(MW7.8) AO-GSB-194	Champlin Creek, Upper, and tribs	Thermal Changes	Urban/Storm Runoff
(MW7.8) AO-GSB-196	Orowoc Creek, Upper, and tribs	Unknown Toxicity	Urban/Storm Runoff

(MW7.8)	AO-GSB-197	Awixa Creek, Upper, and tribs	Unknown Toxicity	Urb/Storm Runoff
(MW7.8)	AO-GSB-198	Penataquit Creek, Upper, and tribs	Unknown Toxicity	Urb/Storm Runoff
(MW7.8)	AO-GSB-207	Sampawams Creek, Upper, and tribs	Unknown Toxicity	Urban/Storm Runoff

5.1.2.1 Long Island Sound

As described in the Task 6.2 Memorandum, the Long Island Sound Study (LISS) was initiated in 1985 as a partnership between the United States Environmental Protection Agency (USEPA) and the states of New York and Connecticut. In 1987, the Long Island Sound was designated as an "Estuary of National Significance" under the National Estuary Program (NEP), which is implemented according to Section 320 of the Clean Water Act to protect nationally significant estuaries from pollution, development and overuse.

The LISS CCMP identified strategies to address:

- Low dissolved oxygen (DO);
- Toxic Contamination;
- Pathogen Contamination;
- Floatable debris;
- The impact of these water quality problems and habitat degradation and loss on the health of the living resource, and
- Land use and development resulting in habitat loss and degradation of water quality.

Nitrogen has been identified as the primary pollutant contributing to low dissolved oxygen levels and hypoxia in the Sound, which results in the subsequent loss of designated uses. Total nitrogen concentrations from 2001 to 2013 at select north shore embayment sampling stations are shown on **Figure 5-7**. In general, it appears that higher total nitrogen concentrations were observed closer to shore, and that nitrogen levels decreased moving northward towards the Long Island Sound. It is interesting to note that based on the limited set of sampling stations evaluated, average annual total nitrogen levels were generally lower at the Port Jefferson Harbor Complex stations than at the other sample points; it is hypothesized that these lower values may result from the fact that much of the drainage area is served by a sanitary sewer system.

Low levels of oxygen threaten many forms of aquatic life in portions of the Sound's bottom waters, typically between July and September when water temperatures are high. Because of the numerous and significant impacts, management efforts have focused on reducing major nitrogen inputs to the Sound.

The LISS adopted a TMDL for nitrogen to improve dissolved oxygen levels. However, the TMDL did not consider the nitrogen contribution from

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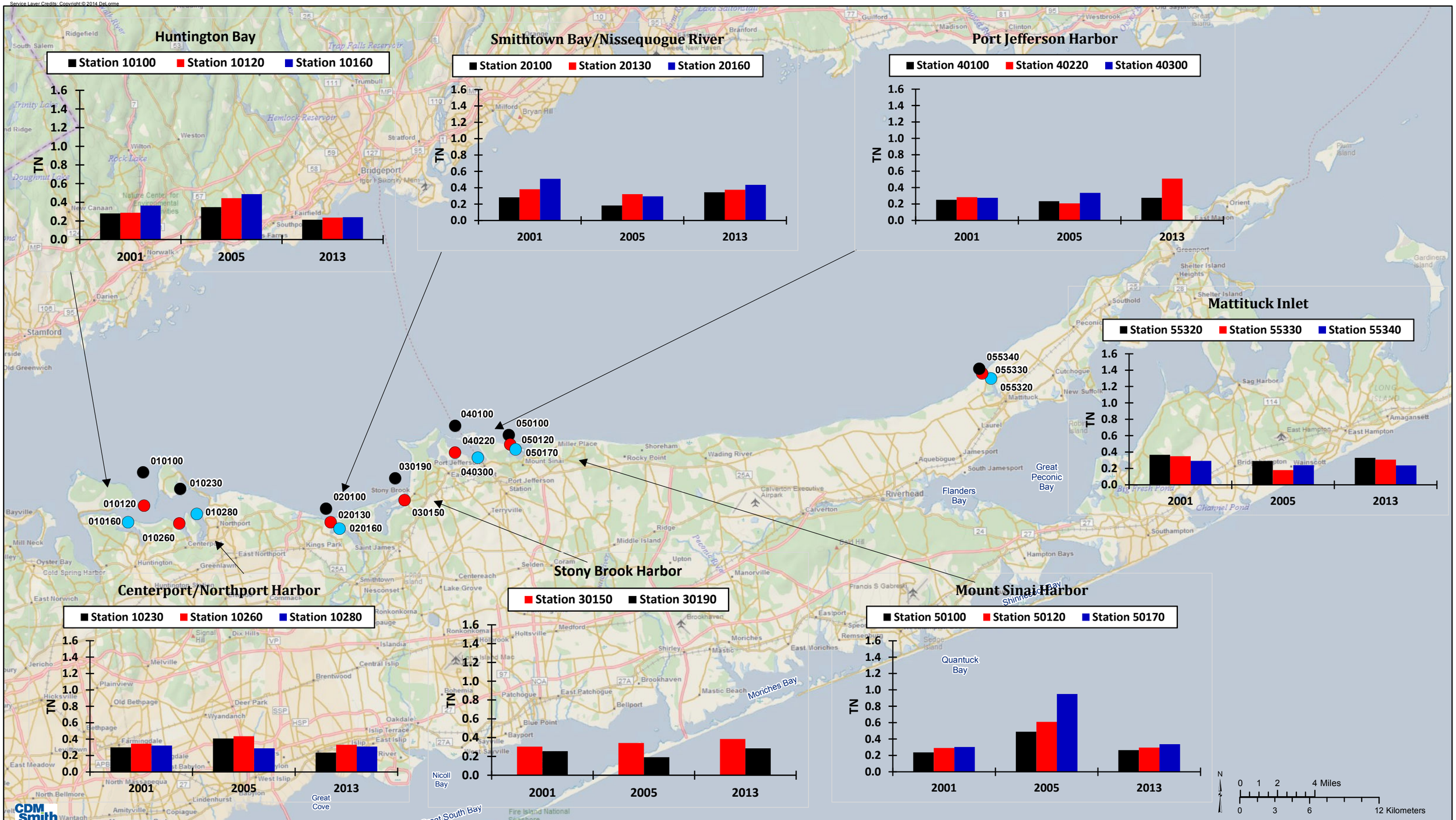

CDM Smith

Average Annual Total Nitrogen Concentrations (mg/L) by Year at Selected Sampling Locations within North Shore Embayments

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-7

groundwater discharges. Working in partnership with NYSDEC, Suffolk County Department of Health Services (SCDHS) Office of Ecology developed the North Shore Embayments Watershed Management Plan

(Nelson, Pope and Vorhees, 2007) to reduce nitrogen loading to the LIS. The evaluation concluded that groundwater discharge is the most significant source of nitrogen to the Sound along the Suffolk County coastline; and the Plan identified a number of recommendations to reduce nitrogen loading.

5.1.2.2 Peconic Estuary

The Peconic Estuary includes 120 classified bays, harbors, embayments, and tributaries encompassing 158,000 acres of surface waters. New York State and the Peconic Estuary Program (PEP) established a nitrogen Total Maximum Daily Load (TMDL) in 2007 to identify the nitrogen loading reductions needed to comply with dissolved oxygen criteria, and pathogen TMDLs were established for 20 water bodies within the Estuary to address coliform levels. Nitrogen trends at SCDHS sampling stations in the Peconic Estuary are shown on **Figure 5-8.**

The brown tide blooms in the mid-1980s and 1990s have caused significant reductions in the once abundant bay scallop population and have reduced the number of eelgrass beds, an important estuarine nursery habitat for finfish and shellfish. Eelgrass beds are now limited to waters near Shelter Island and to the east. Eelgrass beds, at about 1,550 acres as of 2010, are not expanding, despite generally good water quality. Because of the decline in bay scallops, commercial shellfishing operations have turned to the hard clams; however, there is some evidence of a decline in the hard clam population as well.

Some of the declines in the finfish population of the Peconic Estuary are attributed to over-harvesting and habitat degradation. Habitat degradation (feeding and spawning areas) has resulted from shoreline hardening, fertilizer and pesticide use, commercial trawling, recreational boating, historic oyster harvesting, and dredging.

Low dissolved oxygen conditions are evident in the western estuary's tidal creeks including Meetinghouse Creek, Sawmill Creek and at the mouth of the Peconic River. Nevertheless, recent trend analyses completed for SCDHS indicate that dissolved oxygen levels are increasing at many locations throughout the Estuary.

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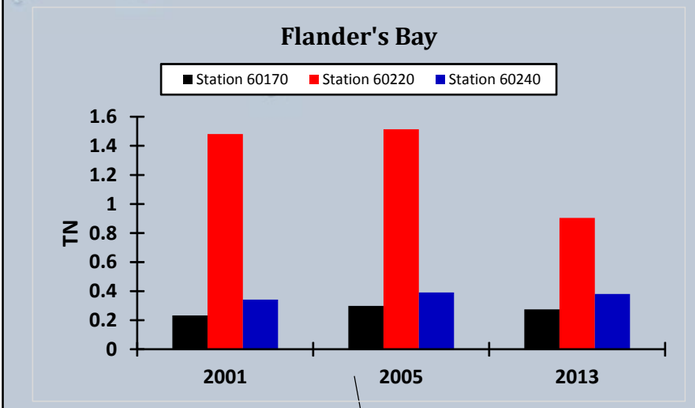

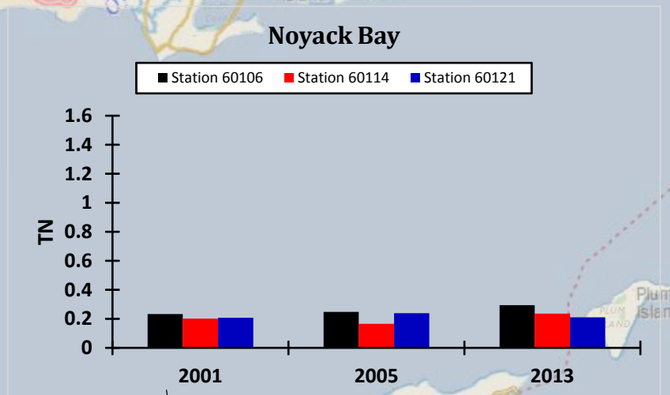

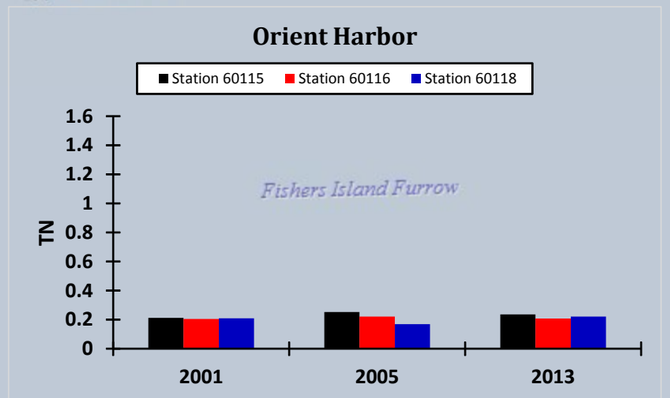

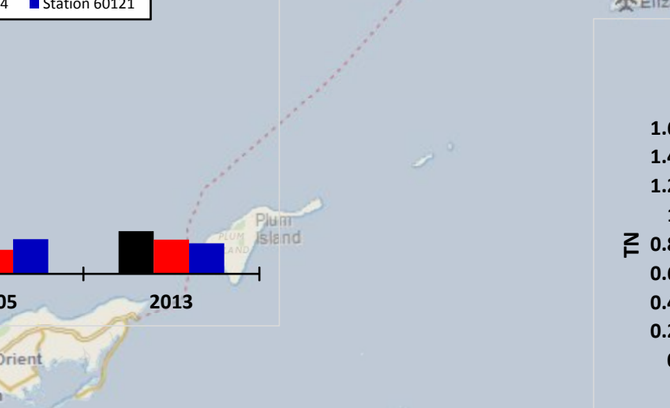

Average Annual Total Nitrogen Concentrations (mg/L) by Year at Selected Sampling Locations within Peconic Bay

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-8

In a recent study of ten tidal creeks in the Peconic Estuary, four had a benthic community structure that was representative of other New York-area nutrient rich waters such as Jamaica Bay and the New York Harbor. The primary source of nitrogen was identified as a sewage treatment plant (STP) discharge, or in the case of Meetinghouse Creek, a duck farm. The low oxygen, nutrient-rich waters were noted for causing the low benthic diversity of the creeks. In each case, the density of a single amphipod species (which can better tolerate such conditions) was very high.

Nitrogen reductions as a result of TMDL implementation progress have resulted in reduced algal blooms and chlorophyll a levels. The reduction in algal blooms and increased dissolved oxygen concentrations have benefited both the benthic and pelagic organisms.

Lower pathogen levels have been observed at approximately half of the stations monitored through the estuary, as a result of fewer duck farms, improved stormwater management, pet waste cleanup and establishment of pump-out stations for boaters.

There is widespread use of pesticides on farms in the watersheds that drain to the estuary. Pesticides and their metabolites have been detected in surface waters, sediments and groundwater, occasionally at levels exceeding State drinking water standards. Little is known about the impact of herbicide and pesticide "cocktails" on phytoplankton, eelgrass, shellfish, and other living resources of the estuary. Other potential contaminants to the Peconic Estuary and other Suffolk County coastal waters include endocrine disrupting chemicals contained in pharmaceuticals, flame retardants and personal care products.

The effort to acquire open space is being outpaced by development, with nearly 600 acres of agricultural land and open space being developed each year. The loss of open space results in an increase in impervious surface and offers the potential for increased runoff with the possibility of degraded water quality. However, the development of agricultural land for residential, commercial, or similar uses could potentially result in less risk to the estuary, if proper stormwater controls are implemented in conjunction with development.

Trends in Peconic Estuary water quality have been documented in **Peconic Estuary Water Quality Status and Trends** (Cameron Engineering & Associates, LLP, 2012). **Table 5-8** summarizes water quality trends since the Comprehensive Conservation and Management Plan was adopted in 2001, indicating improvement in many water quality indicators.

Table 5-8 Changes in Water Quality Post CCMP

Parameter	Result	Trend
A.Anophagefferens	Consistently lower	Improved
Chlorophyll a	Generally lower	Improved
Dissolved oxygen	Generally higher or much higher	Improved
Fecal coliform	Generally decreasing	Improved
Nitrate and Nitrite	Generally higher	Declined
Total nitrogen	Generally lower	Improved in some areas, but some areas are higher post-CCMP
Organic nitrogen	Similar or slightly lower	Slightly improved
Total phosphorus	Generally much lower	Improved
Dissolved organic nitrogen	Similar or slightly lower	Slightly improved

Note: Peconic Estuary Water Quality Status and Trends, 2012, Cameron Engineering and Associates, LLP

5.1.2.3 South Shore Estuary Reserve and Southern Coastal Waters

Impairments of the south shore waters result from pathogens from urban/stormwater runoff, and nitrogen from on-site wastewater treatment systems and urban/stormwater runoff. Although the shallow bays of the Reserve are generally well mixed, which enables reaeration and reduces oxygen depletion, low oxygen levels are typical along the northern margins of the bays and in the tributary mouths. Excess nutrients, in particular nitrogen, are responsible for eutrophication that triggers algal blooms that create low dissolved oxygen levels. The lack of oxygen threatens many forms of aquatic life in the Reserve. Fish kills have been noted in the Forge River, in response to hypoxic events believed to be triggered by excess nutrients.

The hard clam harvest in Great South Bay has fallen by more than 93 percent in the last 25 years. Shellfish, particularly the hard clams, provide important nutrient cycling and water filtration functions, and offer substantial recreational and commercial value as well.

The loss of salt marshes and other coastal habitats has reduced estuarine productivity and eliminated critical feeding and nursery habitat for finish, shellfish, shorebirds, and colonial water birds.

5.1.3 Contaminants of Emerging Concern

In addition to the pharmaceuticals and personal care products described in Section 3.1.1.6, microplastics are another emerging contaminant of emerging concern to surface water quality that are being studied by SCDHS. These plastic particles, usually made of polyethylene or polypropylene, and less than 5 millimeters in any one direction, are commonly found in personal care products such as toothpaste, creams, lotions and cosmetics. Microplastics, or microbeads have been in use by manufacturers of these products for approximately 10 years. Microplastics can be released to the environment by sewage treatment plants which discharge to surface waters. These tiny plastic particles can then adhere to toxic chemicals such as poly aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), etc. and bioaccumulate in animals upon ingestion. There are many alternatives available to manufacturers including rice, seeds, salt, sugar, bark, cornmeal, oats and shells. Microbeads have been banned in some states and several major manufacturers have agreed to phase out their use.

5.1.4 Summary

Non-point source contributions of nutrients, pathogens and other contaminants have been identified as the primary cause of surface water quality impairments in Suffolk County. Groundwater discharge is one primary source of nutrient loading to fresh and coastal resources. Management actions implemented to reduce nutrient and contaminant loads to groundwater within the areas contributing to the County's surface water features will reduce these non-point source loads to the surface waters. Based on estimated travel time from the water table to surface water discharge, it may take years for the benefits of improved water quality to be fully realized.

5.2 Goals and Objectives

Working together with the SCDHS, Suffolk County Water Authority (SCWA), and the Suffolk County Comprehensive Water Resources Management Plan Steering Committee, five surface water management goals were identified, along with more detailed and measurable objectives. These goals and objectives were developed to protect and improve surface water quality in the coming years, recognizing that maintenance of these invaluable resources is vital to the health and economic well-being of Suffolk County residents. Achievement of some of these goals may not be fully realized within the next twenty years; however the recommendations presented in this document provide the structure needed to build upon the existing regulatory framework to safeguard the resource for future generations.

The goals and objectives are consistent with the policy declarations that are articulated in the Suffolk County Sanitary Code:

§760-701: " The designated best use of all groundwaters of Suffolk County is for public and private water supply, and of most surface waters for food production, bathing and recreation …. it is hereby declared to be the policy of the County of Suffolk to maintain its water resources as near to their natural condition of purity as reasonably possible for the safeguarding of the public health, and to that end, to require the use of all available practical methods of preventing and controlling water pollution from sewage, industrial and other wastes, toxic or hazardous materials, and stormwater runoff."

The surface water resource management goals and objectives that were developed based on surface water issues identified during this study are summarized on **Table 5-9**.

Table 5-9 Surface Water Management Goals and Objectives

Table 5-9
Surface Water Management Goals and Objectives

GOAL 1: Surface water quality should be in compliance with New York State ambient water quality standards and guidance values for surface waters, and support human health, aquatic life and recreational and aesthetic values in accordance with their best usage classifications.

OBJECTIVE: All surface water should be in compliance with New York State ambient water quality standards and guidance values that have been developed to protect human health, aquatic life, and recreational and aesthetic values in accordance with their best usage classifications.

GOAL 2: Groundwater nitrogen inputs to the County's surface waters should be reduced, consistent with the goals of the Long Island Sound Study (LISS), Peconic Estuary Program (PEP) and the South Shore Estuary Reserve (SSER) programs – that is to protect, preserve and restore the estuaries for long term sustainability of the resource and to support coastal resiliency.

OBJECTIVES:

1. The magnitude of nitrogen loads discharged to surface waters from groundwater baseflow and the relative contribution of nitrogen loads from groundwater baseflow should be defined.
2. Nitrogen loading in areas within the twenty-five year contributing area to surface water features should be reduced to support aquatic life and recreational and aesthetic values, accomplish LISS, PEP and SSER goals and support coastal resiliency.

GOAL 3: Ground and surface water nitrogen management plans and water quality management plans should be integrated to minimize the impacts of VOCs, pesticides, pathogens and inorganics to human health and the ecology of Suffolk County's wetlands and aquatic ecosystems.

Table 5- 9 (continued)
Surface Water Management Goals and Objectives

OBJECTIVES:

1 Groundwater impacts on surface waters should be defined.
2 Nitrogen loading reduction alternatives should be identified and prioritized based on effectiveness and cost effectiveness.
3 Nitrogen levels should be managed for compliance with established TMDLs.
4 The most cost-effective nitrogen loading reduction alternatives should be implemented, to the extent feasible and practical.

GOAL 4: Harmful algal blooms resulting from water quality impairments from groundwater and stormwater discharges should be identified and prevented, and monitored and managed to minimize impacts.

OBJECTIVES:

1. The role of groundwater impacts on harmful surface water blooms should be better defined.
2. Nitrogen loading in areas within the twenty-five year contributing area to surface water features should be reduced to the extent feasible and practical.

GOAL 5: Existing programs to monitor, prevent contamination of, and manage the County's surface water resources should continue to be strengthened to provide the information necessary to protect, preserve and restore the County's surface water features for long term sustainability.

OBJECTIVES:

1. Monitoring programs (e.g., surface water features to be monitored, monitoring stations, parameters and frequencies) should be identified and documented.
2. The data should be entered into a database developed to facilitate data review, identification of trends and water quality concerns, and the evaluation necessary to support management functions.
3. Existing tools (e.g., contributing area coverages) should continue to be maintained and updated and should be made available to water resource managers.

5.3 Recommendations

5.3.1 Introduction

Working together with project stakeholders, a variety of alternative approaches to protect surface waters from further contamination, to better understand the impacts of groundwater baseflow upon surface water quality, and to implement the additional studies needed to identify necessary targeted management plans have been identified. Due to the significant contribution of groundwater baseflow to these surface water features, these recommendations are generally consistent with the groundwater resource management recommendations described in Section 3; they include:

- Guidance to reduce the impacts of new development on surface water resources;
- Recommendations for structural and non-structural methods to reduce the impacts of existing developed areas on surface water quality;
- Establishment of a framework and programs to collect and evaluate the additional information needed to fully accomplish the resource protection goals articulated in this Plan, and
- An approach to engage County residents in resource protection.

Because there are many comprehensive surface water-body specific programs that have been underway for decades (e.g., Long Island Sound Study, Peconic Estuary Program), this study has not sought to duplicate those efforts. Instead, recommendations are more targeted at better understanding and mitigating the impacts of groundwater on surface water quality.

5.3.2 New Development

5.3.2.1 Recommendation for Open Space Preservation

As described in Section 3.3, it has been well documented that preservation of open space is the most effective means of protecting ground and surface water resources (USEPA, AWWA, Trust for Public Land). Studies throughout the country have established that open space preservation is also often the most cost-effective approach to protect water quality. Major cities such as New York and Boston purchased land in their water supply source areas over a century ago, to protect the resource for future generations. Recent research has confirmed the foresight of earlier generations, concluding that "allowing water quality to degrade, in addition to threatening public health, increases treatment and capital costs" (AWWA, 2004).

Water quality data collected by SCDHS and the County's water suppliers and evaluations relating surface water quality to land use within a stream's contributing area also confirm that groundwater and surface water quality downgradient of areas of open space in Suffolk County (Task 5.1 and 5.2 memoranda) does not exhibit the levels of contamination evident downgradient of commercial, industrial, residential or agricultural land uses. Because contaminants of concern such as nitrates, VOCs and pesticides are not used, stored or disposed of in protected open space areas, the potential to contaminate downgradient resources is significantly reduced, or even eliminated.

From a national perspective, the costs and benefits of open space preservation have been considered in a variety of different ways. Because there are many societal benefits associated with open space preservation, the techniques used to assess the costs and benefits consider a much broader range of criteria than water quality protection. Some researchers have concluded that it is not possible or appropriate to attempt to assign a 'cost' to the non-tangible benefits afforded by open space, which can be characterized instead as "invaluable."

As described previously in Section 3, one approach is to conduct a fiscal impact analysis that compares the cost of providing community services and the tax revenue associated with properties of different land use types. For example, an American Farmland Trust summary of 83 studies completed around the country concluded that the median cost of providing community services to a property per tax dollar raised by that property was:

- $0.27 for commercial/industrial developments;
- $0.36 for farm/forest land and
- $1.15 for residential development.

That assessment documented that the cost of providing services such as schools, roads, police and fire protection, etc. to a property developed for residential use was greater than the tax revenue provided by that property, while the cost of providing community services to land maintained as farmland or forest was only about one third of the tax revenue that a community could expect to collect. This type of analysis does not consider secondary or long-term impacts however (e.g., that commercial/industrial development often instigates residential development or that the presence of open space can increase surrounding property values). A 2010 report by the New York State Office of the Comptroller reports that even if a municipality purchases development or full ownership rights of a property, on a long term

pay-back period of 15 years or longer, the municipalities realized net fiscal benefits, as a result of the maintenance of ecosystem services and limiting the growth of the demand for services.

Over the past six decades, Suffolk County has purchased more than 53,000 acres of land at a cost of more than $1 billion to preserve important environmental resources and significant ecological areas including wetlands, river corridors and upland habitat in addition to land for active recreation, hamlet parks, and historic and/or cultural uses. The County has also acquired the rights to 10,000 acres of productive farmland. The result of this preservation is a permanent benefit to the health and quality of life for current and future generations of Suffolk County residents. As of 2013, more than 162,500 acres, or more than 25 percent of the County has been preserved. Overall, 38,000 acres of the 55,000 Central Pine Barrens core preservation area is now in public ownership (NYS Office of Comptroller). Based on the land use information provided by the Suffolk County Department of Economic Development and Planning (2014), it is estimated that there are approximately 35,000 acres of vacant land available for development throughout Suffolk County, with the majority of that acreage located in the five eastern towns and Brookhaven. While properties purchased in the past often exceeded 100 acres, most vacant parcels that remain available today are considerably smaller. In addition to County programs, Town-specific programs such as the Community Preservation Fund, have been successful in preserving thousands of additional acres.

Continued open space preservation is recommended from a water resource protection perspective, as the most effective way to achieve the groundwater and surface water resource management goals.

The enabling legislation for the new Drinking Water Protection Program requires that a property being proposed for acquisition must meet at least one of the following five criteria:

1. Freshwater/tidal wetlands and buffer lands for same
2. Lands within the watershed of a coastal stream as determined by a reasonable planning or hydrological study
3. Any tract of land located fully or partially within a statutorily designated Special Groundwater Protection Area
4. Lands determined by the County Department of Planning to be necessary for maintaining the quality of surface or groundwater in Suffolk County

5. Lands identified by the South Shore Estuary Reserve (SSER), Peconic Estuary Program (PEP), and/or the Long Island Sound Comprehensive Conservation and Management Plan (LICMP) as needed to protect coastal water resources

The cost of historic land purchases for open space preservation programs has averaged about $17,700/acre. It is anticipated that future per-acre costs will be somewhat greater, as the value of the more limited land available for development increases, the size of the remaining vacant parcels decreases, and because a number of the properties initially purchased were in the Central Pine Barrens with more limited development potential. While preservation of open space is the most effective way to protect ground and surface water quality from a water resources management perspective, it is acknowledged that many other interests also require consideration. Therefore, open space preservation must continue to be considered within a comprehensive planning framework.

Land acquisitions and preservation continue to be accomplished in Suffolk County under the auspices of a variety of programs that have different goals and objectives. Recently, the County undertook an effort to review, update and consolidate prior disparate Open Space "Master Lists" that included properties proposed for acquisition that were identified as important for open space preservation. The 2012 Comprehensive Master List Update identified 86 proposed open space sites and assemblages, totaling 4,650 acres that are recommended for future open space acquisitions.

In 2013, the Suffolk County Legislature amended Chapter 1070 of the Code of Suffolk County for Real Estate Appraisal, Acquisition and Disposition Legislation to streamline the acquisition of open space, farmland and active recreation parcels. The procedure, known as "Triple A" (referencing the appraisal, acquisition and approval steps of the planning process) provides more information to lawmakers earlier in the acquisition process, and allows for the prioritization of properties to be acquired by Suffolk County through the Drinking Water Protection Program, which funds open space farmland and active recreation acquisitions.

The procedural refinement builds on work by the Department of Economic Development and Planning to evaluate and rank all properties on the County's four master lists. Taken together, the new procedural tool and the Comprehensive Master List will be used to determine the best use of limited funds based on objective criteria, including environmental rating, appraisal value, recommendations from planning staff and available funding.

Continued open space preservation is recommended from a water resource protection perspective, as the most effective way to achieve surface water resource management goals. Parcels are currently selected based upon the policies articulated in the Suffolk County Department of Planning's Open Space Acquisition Policy Plan for Suffolk County. The Planning Department has identified the New Drinking Water Protection Program, the Multifaceted Land Preservation Program, the Save Open Space Program and the Environmental Legacy Program as the most significant County open space programs moving forward, given available funding.

Within this overall planning context articulated by the Department of Economic Development and Planning, it is further recommended that parcels within the 25 year contributing area to surface water features be specifically identified and assigned a high priority for purchase, particularly when there is a significant opportunity to protect and preserve existing ground or surface water quality. The areas contributing groundwater baseflow to the County's surface water features have been mapped as shown on **Figure 5-9**, and were documented on a stream-specific basis as part of Task 15 (as noted, surface drainage areas may extend beyond the areas contributing groundwater baseflow). These mappings will help to assess property compliance with Department of Economic Development and Planning criteria 2 and 4, above. Based on land use information from there are over tens of thousands of vacant parcels (or parts of parcels) located within the 25 year contributing area to surface water features, as shown on **Figure 5-10.**

Land acquisitions and preservation continue to be accomplished in Suffolk County under the auspices of a variety of programs that have different goals and objectives. Recently, the County undertook an effort to review, update and consolidate prior disparate Open Space "Master Lists" that included properties proposed for acquisition that were identified as important for open space preservation. The 2012 Comprehensive Master List Update identified 86 proposed open space sites and assemblages, totaling 4,650 acres that are recommended for future open space acquisitions.

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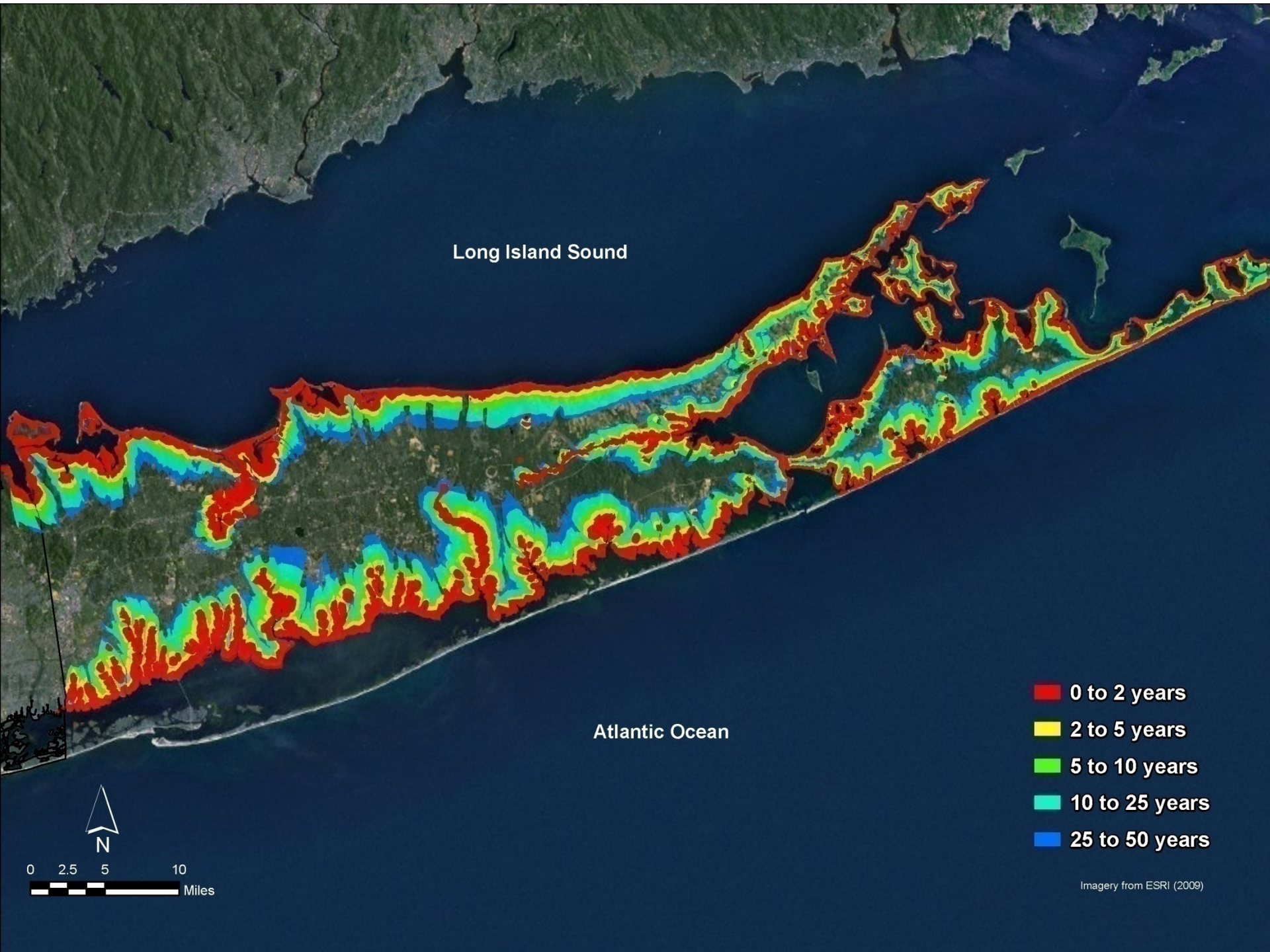
Long Island Sound
Atlantic Ocean
0 to 2 years
2 to 5 years
5 to 10 years
10 to 25 years
25 to 50 years
N
0 2.5 5 10
Miles
Imagery from ESRI (2009)

Suffolk County Comprehensive Water Resources Management Plan
Vacant Land within the 25 Year Baseflow Contributing Area to Surface Waters

Figure 5-10

The procedural refinement builds on work by the Department of Economic Development and Planning to evaluate and rank all properties on the County's four master lists. Taken together, the new procedural tool and the Comprehensive Master List will be used to determine the best use of limited funds based on objective criteria, including environmental rating, appraisal value, recommendations from planning staff and available funding.

While preservation of open space is the most effective way to protect ground and surface water quality from a water resources management perspective, it is acknowledged that many other interests also required consideration. Therefore, open space preservation must continue to be considered within a comprehensive planning framework.

5.3.2.2 Recommendations for New Developments

The North Shore Embayment Watershed Management Plan (SCDHS, 2007) reported that groundwater was the greatest contributor of nitrogen to the embayments within the study area; it appears that this is the case in coastal waters along most of the north shore. Sanitary wastewater management is the most important factor affecting nitrate levels in groundwater throughout most of the County. Due to the significant contribution of groundwater baseflow to the County's surface waters, improved sanitary wastewater management practices can also affect nitrate levels in surface waters.

As described in Section 3, in 1980, Suffolk County amended Article 6 of the Suffolk County Sanitary Code to specifically address the impacts of sanitary wastewater on the County's groundwater. On-site sanitary wastewater disposal was limited to parcels that were either one or one-half acre in size, depending in which Groundwater Management Zones the parcel was located.

However, many existing residences with on-site wastewater disposal systems had already been constructed on smaller parcels prior to 1980. Data provided by the Suffolk County Planning Department (SCPD) show that almost 53 percent of the unsewered residential parcels in the County are less than or equal to one half acre. Almost three quarters of the residential properties in Babylon are less than or equal to one quarter acre; groundwater contamination resulting from the on-site septic systems prompted the implementation of the Southwest Sewer District in the 1970s. Groundwater data collected by both SCDHS and the Nassau County Department of Public Works (2005) has confirmed that sanitary sewering programs have successfully reduced groundwater nitrate levels in the sewered areas. Nitrogen trends in the Great South Bay south of the SWSD are shown on **Figures 5-11** and **5-12**.

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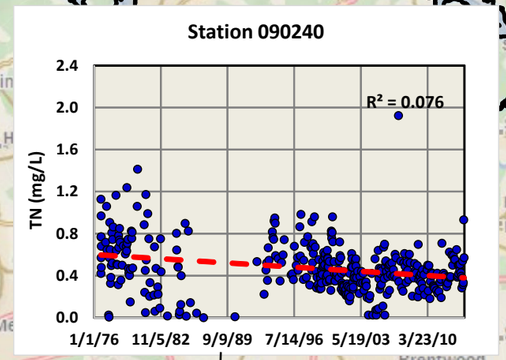

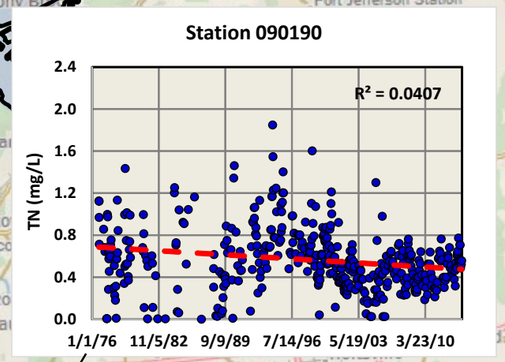

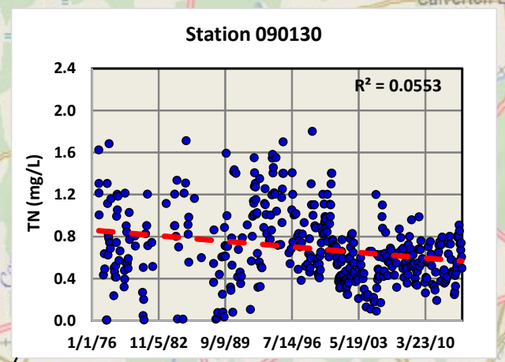

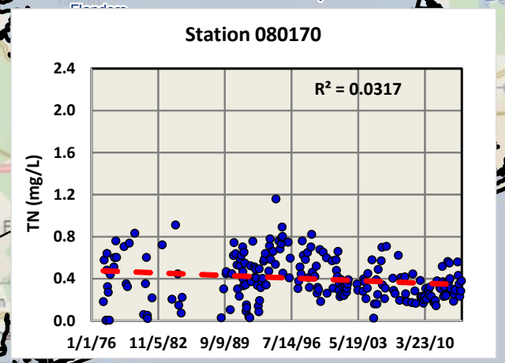

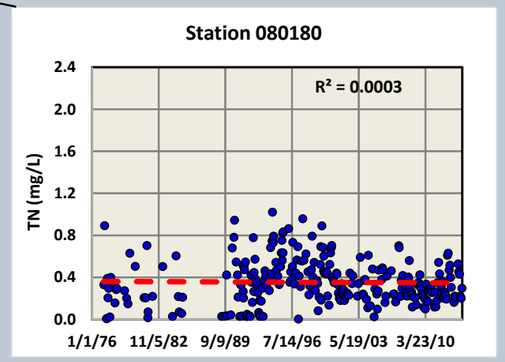

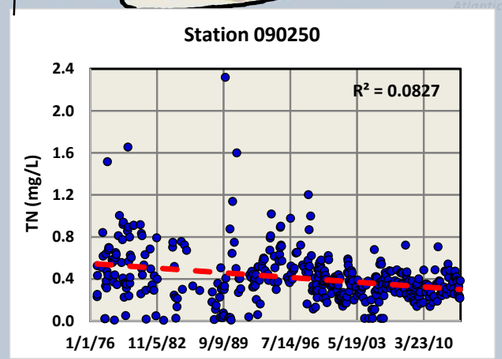

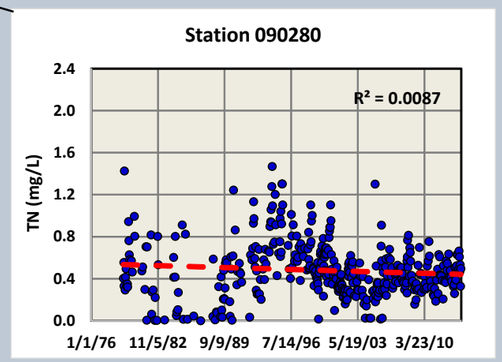

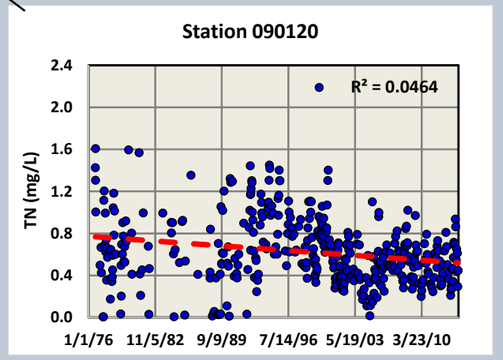

090190
090280
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Nicoll Bay
Patchogue Bay
Great South Bay
Great Cove
Quantuck Bay
Moriches Bay

N
0 0.75 1.5 3 Miles
0 2 4 8 Kilometers

CDM Smith

Total Nitrogen Concentrations & Trends in South Shore Estuary Sampling Stations, 1976 - 2013

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-11

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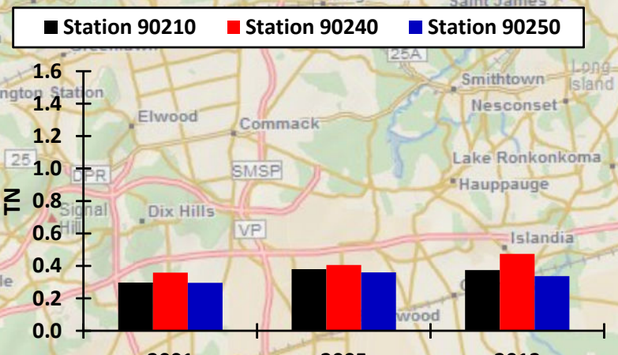
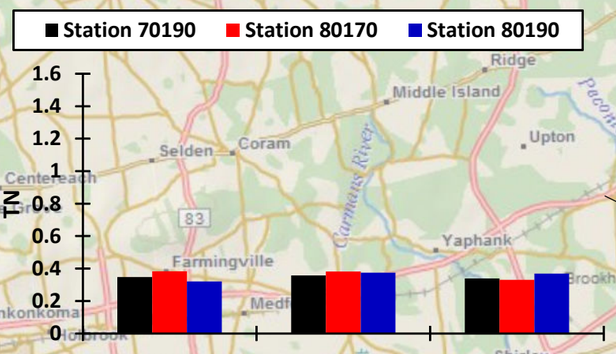
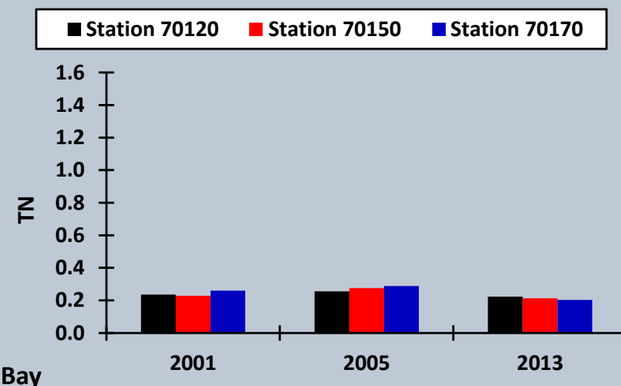
Great Cove



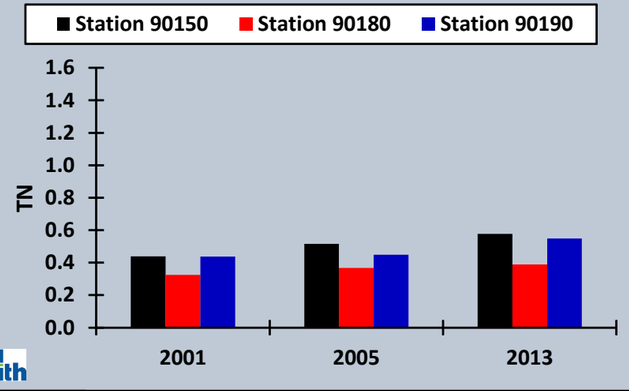
Quantuk Bay



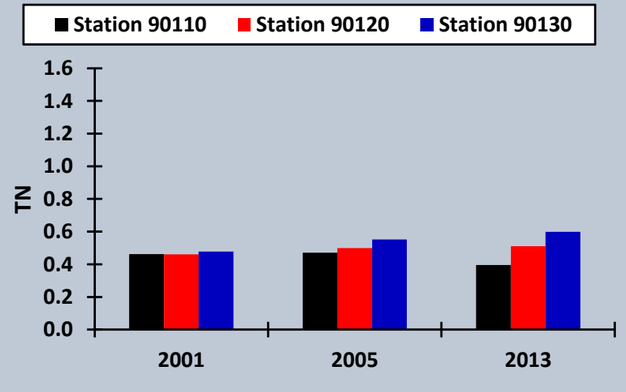
Shinnecock Bay



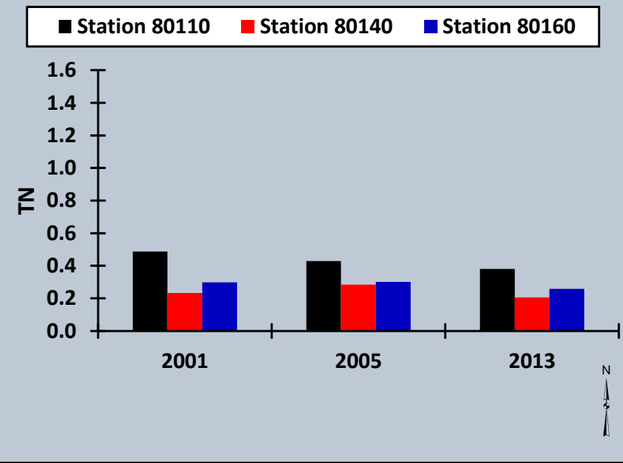
Nicoll Bay



Patchogue Bay



Moriches Bay



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Great South Bay
Fire Island National Seashore
Ocean Beach
Atlantic Ocean
Shinnecock Bay
Moriches Bay
Patchogue Bay
Nicoll Bay
Quantuk Bay

0 0.75 1.5 3 Miles
0 2 4 8 Kilometers

CDM Smith

Average Annual Total Nitrogen Concentrations (mg/L) by Year at Selected Sampling Locations within South Shore Estuary

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-12

The observed nitrogen levels in groundwater, which have continued to increase since the 1987 Comp Plan was prepared, result from a combination of the Article 6-compliant and the older non-compliant parcels. Building upon the work documented in the 1987 Comp Plan, several evaluations of parcel size and downgradient groundwater nitrogen concentration have been conducted which demonstrate that nitrate levels in groundwater increase with increasing density. However, because existing water quality data and land use information are not always straightforward to interpret, given the variation in land use, density, household size and nitrogen loading in any given area of interest, a modeling assessment of the impacts of uniform residential densities on groundwater nitrogen levels was completed, as described in Section 3.

The results were consistent with observed data throughout the County, with simulated nitrate concentrations resulting from discharge of sanitary wastewater via on-site septic systems in areas with ¼ acre zoning exceeding 10 mg/L in the shallow aquifer, and simulated nitrate levels resulting from on-site wastewater disposal on 1 acre properties remaining below 4 mg/L; nitrate levels in groundwater downgradient of properties where lawns have been fertilized range from 4 to 6 mg/L.

The results assumed an initial background nitrate concentration of zero in the groundwater, and illustrate that it can take years for nitrogen introduced at the water table to travel through the system to discharge to a supply well. Similarly, it can take years or decades for nitrogen introduced to the shallow groundwater to travel to a downstream surface water discharge point. Based upon a wide variety of factors, including pH, dissolved oxygen, benthic conditions, etc., transformation/uptake may affect the magnitude of nitrate that is actually discharged to the overlying surface water body.

Building upon the body of SCDHS work over the past decades, the evaluations relating land use to observed nitrate levels completed as part of this study (e.g., documented in task memoranda 5.1, 5.2, and 18), review of density/nitrate relationships established elsewhere in the country, and these most recent model results, it is recommended that Article 6 be modified to also require one acre density in hydrogeologic zones IV and VIII to protect surface water quality, unless provision is made for a higher level of treatment than is provided by a typical on-site wastewater treatment system, or, the development rights from existing undeveloped open space controlled by the developer are transferred, in accordance with standards adopted by the SCDHS in 1995. While nitrate concentrations resulting from an area of uniform ½ acre density are simulated to be close to 6 mg/L, development occurs within the framework of properties that have already been developed; many pre-1980 developments include parcels that are less than ½ acre or even ¼ acre in size.

The recommended minimum of one acre zoning in unsewered areas of Hydrogeologic Zones IV and VIII will also reduce nitrogen loading to surface waters from groundwater baseflow. While this recommendation focuses upon nitrogen criteria, it was also developed in recognition of the fact that many other contaminants of potential concern can be introduced to the subsurface from on-site wastewater disposal.

Developments of increased density (in areas permitted by local zoning regulations) discharge to sewage treatment plants. Because most new sewage treatment plants discharge to groundwater, the SCDHS Office of Wastewater Management (OWM) reviews the proposed discharge location to minimize potential impacts on downgradient resources. Developments of increased density (in areas permitted by local zoning regulations) discharge to sewage treatment plants. Because most new sewage treatment plants discharge to groundwater, the SCDHS Office of Wastewater Management (OWM) reviews the proposed discharge location to minimize potential impacts on downgradient resources, including public supply wells. Current SCDHS guidance for siting new or expanded STPs advises that siting of STPs within the zero to twenty-five year contributing area to sensitive surface waters **(as shown by Figure 5-9)** should be minimized to the extent feasible; if an STP is located within this zone, an advanced treatment process shall be provided (SCDHS, 2014).

5.3.3 Existing Developed Areas

While the preceding pages outlined an approach to protect surface waters from the impacts of additional development, the following recommendations were developed to respond to the impacts of the 1.5 million existing residents of the watershed.

5.3.3.1 Recommendations to Evaluate Sanitary Wastewater Treatment and Disposal Options

Sanitary wastewater disposal and fertilization practices are the two largest sources of nitrate to the aquifer system. As described in Section 3, unsewered areas where property sizes are less than an acre are likely to cause groundwater nitrogen concentrations that exceed target levels of 6 mg/L. In areas where property sizes are ¼ acre or smaller, groundwater levels are predicted to exceed 10 mg/L, as has been observed in several SCDHS studies.

Recognizing the impact that densely developed unsewered areas has on surface water quality, Suffolk County has already begun to develop projects to reduce the impacts of sanitary wastewater disposal on the environment. The County is prioritizing and addressing wastewater management in developed

areas through a series of projects identified by the Suffolk County Sewer District/Wastewater Treatment Task Force, including:

- Sewer District Capacity Study for seven unsewered areas (CP 8185)
- Expanding districts of four existing sewered areas (CP 8185)
- Expansion of Southwest Sewer District No. 3 (CP 8139)
- Expansion of Kings Park Sewer District

In addition, SCDHS is conducting a study of alternative on-site sewage system technologies that could reliably reduce nitrogen levels to 10 mg/L for individual residences or smaller sub-divisions, to identify alternative systems that could provide viable, low cost systems to protect public health. This study will include monitoring those most promising alternative technologies to collect data establishing system effectiveness, in an effort to identify more cost-effective alternatives to centralized sewage collection and treatment.

Consistent with the recommendations for groundwater resource protection presented in Section 3, it is recommended that Suffolk County complete the studies identified above, and utilize the results along with the GIS-mappings of areas contributing recharge to surface waters and relationships between density and nitrate levels developed during this study, in a County-wide wastewater planning study that considers density, conventional wastewater collection and treatment systems, alternative treatment systems, alternative on-site systems, and operational and maintenance guidelines for existing on-site systems. The County-wide evaluation should identify any additional high priority areas within the County where a new approach to wastewater treatment and disposal is required to achieve surface water quality criteria for nitrates. The proposed approach to implementing this program is described in detail in Section 8 of this Plan.

5.3.3.2 Recommendations with Respect to Nitrate Loads from Fertilization

Suffolk County has developed and is implementing a plan to reduce the impacts of fertilizer on ground and surface water features. The Suffolk County Legislature established a goal of reducing fertilization in residential areas by 10 to 25 percent, and passed Local Law 41-2007 in 2007 to reduce nitrogen pollution by reducing the use of fertilizer throughout the County. The law notes that *"the quality of our water should be considered a higher priority than the aesthetics of lawns, and that high maintenance lawns require more nitrogen and are more likely to leach excess nitrogen, so that high maintenance lawns should be discouraged."*

The Plan mandated by the widely acclaimed legislation includes the following components:

- A Countywide ban on fertilizer application between November 1 and April 1, to avoid applying fertilizer to frozen ground;
- A ban on fertilization of County properties, except for golf courses, athletic fields, the Suffolk County farm, and new turf establishment at public works properties;
- Codifying the County's Organic Parks Maintenance Plan, limiting fertilizer application to 3 pounds of nitrogen for each 1,000 square feet of golf course;
- Use of Best Management Practices (BMPs) at the County Farm;
- Expansion of educational programs to encourage reduction of fertilization rates and increase the use of slow-release fertilizers;
- Establishment of an inter-active website for residents to establish fertilization needs;
- Requirement that licensed landscapers (approximately 1,200 in Suffolk County) complete a turf management course;
- Requirement that retail establishments selling fertilizers post signs, and provide educational materials describing proper fertilization rates and practices;
- Preparation of annual reports summarizing the amount and types of fertilizers sold by the County; and
- Beginning in 2014, preparation of reports at five year intervals summarizing the effectiveness of this Law.

In July 2010, New York State adopted the Dishwasher Detergent and Nutrient Runoff Law to reduce phosphorus loading to the state's ground and surface waters. Reducing the amount of phosphorus that is released to the environment is much more effective and cost-effective than collecting and treating contaminated stormwater, or implementing treatment processes to reduce phosphorus levels in sanitary wastewater. Beginning in August, 2010, the sale of newly stocked phosphorus-containing dishwasher detergent for residential use was prohibited, and the sale of dishwasher detergent containing phosphorus for commercial use will be prohibited beginning July 2013.

Beginning on January 1, 2012:

- Lawn fertilizers containing phosphorus were prohibited, except for establishment of new lawns, or if data confirms that phosphorus is required;
- Application of lawn fertilizers on impervious surfaces was prohibited;
- Application of lawn fertilizers was prohibited within 20 feet of a surface water body except in cases where a vegetative buffer of ten feet or more exists, or special application techniques are employed;
- Application of fertilizer between December 1 and April 1 was prohibited state-wide.

The state-wide law does not affect agricultural or garden fertilization practices. However, to date, over 300 local vegetable, nursery, sod, and fruit farms and vineyards have participated in the tiered strategy of the Agricultural Environmental Management (AEM) Program being run by Suffolk County and Cornell Cooperative Extension of Suffolk County.

Over sixty farm demonstration projects have been implemented in cooperation with Cornell Cooperative Extension's agricultural research specialists and Cornell University to evaluate the costs and benefits of using alternative nutrient management practices to minimize groundwater quality while maintaining crop viability, and 25 sweet corn and 22 potato farms have participated in Controlled Release Nitrogen Fertilizer demonstration projects. Resulting improvements to groundwater quality in terms of reduced nutrient levels have not yet been demonstrated; as conservation plans and BMPs are implemented, groundwater quality data should be collected to assess the effectiveness of the program in reducing nutrient levels.

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Suffolk County continues to work with Cornell University and Cornell Cooperative Extension to reduce nitrogen loads from fertilizer. One of the activities, the golf course challenge, is seeking to implement best management practices at East End golf courses, so that nitrate levels in downgradient groundwater are maintained at less than 2 mg/L. The County should evaluate the effectiveness of the fertilizer BMPs and based upon the results, consider working together with golf courses throughout the County for wider implementation.

Finally, Suffolk County is evaluating and updating the 2004 Suffolk County Agricultural Stewardship Program, to address current needs of the farming community and the County, including the need to protect the quality of the County's water resources, soil and natural habitats. The collaborative effort includes participants from the farming community as well as Suffolk County Department of Economic Development and Planning, SCDHS, the Peconic Estuary Program (PEP), Cornell Cooperative Extension of Suffolk County, SCWA, the Suffolk County Soil and Water Conservation District, NYSDEC, and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The updated Program describes the need for collaborative cooperation to reduce the nutrient loads from agriculture to the County's ground and surface water resources while maintaining a strong, viable agricultural industry. The primary goal of the program is to increase Suffolk County farmer completion of Tier III in the AEM program to at least 90 percent. The program will encourage participation by funding research to develop BMPs to reduce nitrogen impacts, by providing educational programs to encourage implementation of nitrogen reducing BMPs, and providing funding to continue to improve BMPs to reduce nitrogen impacts.

Farmers that participate in County preservation programs, purchase of development rights, and other programs should be encouraged to participate, by agreement, in the AEM program and adopt best management practices (BMPs) to minimize or prevent contamination from fertilizers, considering use of improved timing of fertilizer application, choice of product (e.g., slow-release formulations) and new technologies to limit fertilizer leaching and run-off.

5.3.4 Recommendations to Address Volatile Organic Compound Contamination

Review of water quality data has shown that the highest levels of VOCs are found in streams in the western part of the County with industrial, commercial, transportation or institutional uses within their contributing areas. VOCs were detected less frequently in streams with significant undeveloped areas within their contributing areas. Nevertheless, low levels of VOCs were widely detected in groundwater throughout the County, indicating a more widespread low-level source of the observed contaminants, such as residential septic systems. In general, as would be expected based upon their properties, VOCs have a lower rate of detection, and lower reported concentrations, in surface waters than in groundwater. Recommendations presented here are therefore focused primarily on VOC inputs to groundwater; as most fresh surface waters continue to derive most of their baseflow from groundwater; reducing VOC levels in shallow groundwater is also expected to reduce VOC detections and concentrations in downgradient surface waters, with the possible exception of MTBE. Since 2004, MTBE, the most frequently detected VOC in Suffolk County surface waters, has not been used as an additive in gasoline sold in New York State; this significant reduction in MTBE use should also result in concomitant reductions in MTBE detections in surface waters; SCDHS data confirms that MTBE contamination has declined since 2005.

It is not known whether the observed VOC contamination in the streams originates from groundwater baseflow, or from direct stormwater runoff. Given the significant contribution of groundwater to stream flow, even in the sewered southwestern part of the County, it is presumed that groundwater is the most significant source. Reductions in VOC levels in groundwater would therefore result in lower VOC levels in surface waters as well. Before targeted recommendations to reduce the release of VOCs to the County's groundwaters can be developed, a better understanding of the potential sources of the observed contamination is required. SCDHS Office of Pollution Control (OPC) has developed a scope of work for a capital project to evaluate existing industry in the County using or storing hazardous materials, including the volume of materials stored, location of storage, potential for release and assessment of contaminant fate and transport. The contaminant inventory and characterization should form the basis for a revised facility ranking system, and identification of potential new regulations, storage requirements, operator training requirements or inspection/enforcement procedures to improve the effectiveness of OPC programs, and to reduce the further release of toxic contaminants, including VOCs, to the environment.

It is recommended that Suffolk County implement this program as a priority.

As an additional task to that program, the SCDHS should also further explore the role that residential areas have in terms of VOC contamination. If residential areas are determined to be a significant source of the observed low level VOC contamination in groundwater, SCDHS should respond by:

- Incorporating information on the types of household products that may contain VOCs and preferred alternatives into the education and outreach program described below;
- Potentially regulating the use and disposal of specific contaminants of concern (e.g., household cleaners, etc.), and
- Incorporating relevant information on appropriate use and disposal of household products using VOCs into the public education and outreach and school curricula development programs described in the Task 10.2/10.3 memorandum and Section 4.1.5 below.

In general, reduced sources of VOCs in the watershed will result in reduced levels in surface waters.

5.3.5 Recommendations to Address Pesticides

Pesticide contamination of Suffolk County surface waters is primarily associated with agriculture on the East End. Multiple programs are in place to help reduce non-point pesticide sources from agriculture; however, the overuse of pesticides on agricultural lands continues to be one of the most significant sources of contamination in agricultural areas. Programs such as the AEM program described above in Section 3.3.3.2 are being implemented to address these issues. The AEM Program is a state-wide voluntary, incentive based process that helps farmers to make common sense decisions to achieve their business objectives while protecting and conserving natural resources and groundwater quality. Through the AEM program, the Suffolk County Soil and Water Conservation District, partners at Cornell Cooperative Extension of Suffolk County (CCE), NRCS and private sector planners and crop consultants provide on-farm environmental assessments, conservation planning and technical services.

It is recommended that farmers that participate in County preservation programs, purchase of development rights, and other programs should be encouraged to participate, by agreement, in the AEM program and adopt best management practices (BMPs) to minimize or prevent contamination from pesticides, considering integrated pest management or products that are safer

alternatives to the pesticides that have been observed to impact the County's groundwater.

Suffolk County and Cornell Cooperative Extension should continue to work closely with the agricultural community to identify crop-specific practices (e.g., integrated pest management) or products that provide safer alternatives to the pesticides that have been observed to impact the County's groundwater. It would be useful if monitoring well installation and groundwater sampling and analysis were also included to help determine the effectiveness of BMPs in reducing ground and surface water contamination. As BMPs are implemented, groundwater quality data would assess the effectiveness of the program in reducing pesticide levels. It is recommended that the agricultural community, Suffolk County and Cornell Cooperative Extension work together to install monitoring wells, and conduct targeted sampling, analysis and reporting to help assess the effectiveness of BMPs in reducing ground and surface water contamination from pesticide application.

Suffolk County is evaluating and updating the 2004 Suffolk County Agricultural Stewardship Program, to address current needs of the farming community and the County, including the need to protect the quality of the County's water resources, soil and natural habitats. The collaborative effort includes participants from the farming community as well as Suffolk County Department of Economic Development and Planning, SCDHS, the Peconic Estuary Program (PEP), Cornell Cooperative Extension of Suffolk County, SCWA, the Suffolk County Soil and Water Conservation District, NYSDEC, and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The updated Program describes the need for collaborative cooperation to reduce pesticide loading from agriculture to the County's ground and surface water resources while maintaining a strong, viable agricultural industry. The primary goal of the program is to increase Suffolk County farmer completion of Tier III in the AEM program to at least 90 percent. The program will encourage participation by funding research to develop BMPs to reduce pesticide impacts, by providing educational programs to encourage implementation of pesticide reducing BMPs, and providing funding to continue to improve BMPs to reduce pesticide impacts.

As part of the Agricultural Stewardship Program, fifteen orchards are currently implementing integrated pest management plans.

Suffolk County and Cornell Cooperative Extension should continue to work closely with the agricultural community to identify crop-specific practices (e.g., integrated pest management) or products that provide safer alternatives to the pesticides that have been observed to impact the County's surface waters.

5.3.6 Recommendations to Address Pharmaceuticals and Personal Care Products

New information is published nearly every day on the detection, fate and transport characteristics, or potential effects of one or another of the PPCPs. It is recommended that SCDHS continue to monitor the literature and regulatory initiatives concerning PPCPs, including research on:

- Development of methods (e.g., analytical techniques) to identify PPCPs at the very low concentrations expected in the environment, development of efficient methodologies to analyze mixtures of compounds, development of cost-effective analytical methods;
- Identification of priority or target compounds that can be used for rapid/cost effective screening for PPCPs;
- Fate of PPCPs in the environment (including subsurface environment/groundwater);
- Exposure;
- Effects of low levels of PPCPs on human health and the environment;
- Establishment of sensible analytical detection limits and treatment goals;
- Additive effects of PPCPs with similar modes of action, and finally
- Treatability.

It is just not possible to monitor for all of the contaminants of emerging concern (CECs), including PPCPs that could potentially be present in the environment, given that more than 88 million organic and inorganic chemicals have been registered with Chemical Abstracts Services, and thousands of new chemicals are listed each day. It should not be necessary to monitor for all of these parameters, however the subset of compounds with potential human-health impacts that ultimately should be monitored has not yet been identified. In addition, analytical methods to detect the extremely low levels of some PPCPs and their metabolites that may exist in the environment are not yet available. While analytical protocols to detect some PPCPs have been developed, cost effective methods to rapidly detect the presence of many of the other compounds that may be present have not.

SCDHS should continue to conduct targeted monitoring as summarized below:

- Increase the number of sample analyses available from the Public and Environmental Health Laboratory (PEHL) to analyze each sample from all community supply wells as part of annual facility inspections, as well as samples from non-community and the private drinking water wells;
- To the extent staffing permits, the PEHL should explore expansion of existing analytical methods to increase the number of PPCPs analyzed, particularly focusing on those already identified in our groundwater resource, summarized on Table 5-10 below.
- Continue targeted monitoring, focusing on wells downgradient of laundromats, hospitals and nursing homes, using a similar approach to the focused plan implemented for the Pesticides Monitoring Program.

Table 5-10 Recommended New Analytes for SCDHS PEHL

PCCP	Use
Codeine	Pain killer
Cotinine	Pain killer
Cis-Diltiazem	Antihypertensive
1,4-Dioxane	Personal care product contaminant
Erythromycin	Antibiotic
Hydrochlorothiazide	Diuretic
Meprobamate	Anti-anxiety agent
Metropolol	Antihypertensive
Naproxen	Anti-inflammatory
4-Nonylphenol	Surfactant, known estrogen disruptor
Nonylphenolpolyethoxylate (NPEO)	Surfactant
Paraxanthine	Stimulant
Phenolbarbital	Barbituate
Ranitidine	Inhibits stomach acid
Sulfamethoxazole	Antibiotic
Tramadol	Analgesic

While there have been significant advances in the number of compounds that can be measured, at increasingly lower detection limits, the approach to linking the detection of CECs to human health or ecological effects is not clear

cut. For example, pharmaceuticals ingested by mammals are often excreted as the unaltered parent compound to only a small degree and many pharmaceuticals, steroids, and biogenic and anthropogenic hormones are chemically changed by human or animal digestive tracts by formation of glucuronide or sulfate conjugates (Berg et al., 2007). Thus in addition to studying the parent compound, it is necessary to examine the metabolic by-products of these compounds. For example, gemfibrozil, a lipid regulating pharmaceutical, is excreted mostly as the glucuronide conjugate, with less than 2% excreted as unchanged gemfibrozil (RxList, 2014).

Considering the number of possible chemicals and their degradates that could be analyzed, our historical and current paradigms for evaluating occurrence, fate, and toxicity cannot keep pace with chemical development and commercialization, let alone regulatory evaluation. The objective of identifying all of the constituents and their degradation products that may be of concern in wastewater effluent is an impossible task.

With respect to monitoring for potential biological impacts, the use of biological surrogates has had a long history in protecting human health and, in fact the current risk assessment framework includes testing using in vivo animal models to extrapolate endpoints that can be translated to regulatory limits e.g., MCL for drinking water. However, with the number of chemicals and mixtures of chemicals and chemical transformation products, this approach is limited and high-throughput screening methods are being evaluated to provide information on the mechanisms of biological toxicity at a relatively small cost (Snyder, 2014).

Even with the limitations of extrapolation from a cellular response to human health outcomes, high throughput assays could provide a more comprehensive view of chemical constituents present in water as well as an assessment of their cumulative (mixture) toxicity.

Equipment to perform most in vitro cellular bioassays is significantly less expensive than those required for mass spectrometric techniques used for targeted analyses. Although many cell bioassays, such as the Ames test or Microtox®, are available commercially, EPA continues to develop a wide array of assays that could be made publically available for very little cost to water agencies. Cell culture equipment is already available in many water laboratories, and plate-scanning spectrophotometers can be procured at reasonable costs that are at least an order of magnitude less than commonly employed liquid chromatography tandem mass spectrometer equipment. The proliferation of 384 well-plate assays along with robotics for liquid handling also will continue to reduce labor and supply costs while simultaneously increasing reproducibility. These types of high throughput assays will continue

to be developed and applied for water quality evaluations, allowing for rapid and relatively inexpensive characterization of the mixtures of chemicals that may occur in water (Snyder, 2014).

In addition to monitoring, Suffolk County should continue to collaborate with water management colleagues and review the latest findings from other jurisdictions. Of equal importance, is continued public outreach and education efforts to encourage appropriate disposal of pharmaceuticals through take-back programs at pharmacies or other collection programs, such as "Operation Medicine Cabinet.

5.3.7 Wastewater Treatment Recommendations

As previously reported, sanitary wastewater management is one of the most significant issues facing Suffolk County in terms of ground and surface water resource protection. Prior to development, precipitation falling on the ground surface recharged the aquifer system, and the recharged precipitation travelled down through the aquifer system to eventual discharge to fresh streams, intertidal areas, harbors, coastal embayments or other marine waters. Prior to extensive development, private wells were used to withdraw potable supply from the aquifer; most of the water withdrawn was returned to the aquifer system via on-site cesspools or septic systems. The sanitary wastewater introduced nitrogen and bacteria to the aquifer system, but this was successfully diluted by the greater volume of recharging precipitation and did not cause widespread impacts. Eventually, the sanitary wastewater recharged by more and more residents exceeded the assimilative capacity of the resource in densely developed areas, causing noticeable impacts to the aquifer, drinking water supply and surface water ecology, and prompting implementation of wastewater management measures.

Sanitary wastewater management options were implemented to protect the groundwater resource, as indicated by compliance with the 10 mg/L drinking water standard. Centralized sewage treatment and collection systems such as Southwest Sewer District No. 3 were established to reduce levels of observed wastewater parameters in groundwater located beneath densely developed areas. Provision of a centralized sanitary wastewater collection and treatment is an effective way to reduce the impacts of development on ground and surface water features; conventional treatment schemes remove suspended solids, organic material, and deactivate pathogens via disinfection. More advanced treatment processes can be used to remove nutrients such as nitrogen and prevent eutrophication and degradation of ecological communities. Nitrogen levels in sanitary wastewater vary considerably; typical secondary wastewater treatment processes reduce influent total nitrogen concentrations by 50 percent or less. Additional treatment processes utilized at

biological nutrient removal (BNR) facilities can further reduce nitrogen levels to less than 10 mg/L, and sometimes to as low as 4 to 6 mg/L. The practical limit of nitrogen removal in Suffolk County is currently about 2 to 3 mg/L.

In addition to the significant economic costs associated with centralized sewage collection and treatment, there are other potential impacts. For example, discharge of the treated effluent off-shore results in a net loss of a significant amount of water from the aquifer system, and can have detrimental impacts on area streams, pond levels and wetlands. In addition, the energy requirements associated with operating a treatment plant, and treating and disposing of sludge greatly exceed the requirements associated with on-site disposal systems, and conventional wastewater treatment does not address all contaminants of concern, such as organics and PPCPs.

Suffolk County and NYSDEC also permit the use of alternative treatment systems for flows up to 15,000 gallons per day (gpd); these systems are required to meet effluent nitrogen limits of 10 mg/L. When successfully operated and maintained, these systems are, in many cases, capable of significantly reducing the nitrogen load to groundwater. However, they do require considerable operator attention to consistently and successfully operate, they require considerable SCDHS oversight, and they do not necessarily remove organics and PPCPs that may be contained in the effluent. SCDHS is currently implementing a study to specifically evaluate the effectiveness of innovative wastewater treatment systems capable of treating 30,000 gpd that reportedly can reduce nitrogen levels to less than 10 mg/L.

The last alternative, which is currently utilized by approximately 74 percent of County residents, is on-site wastewater disposal systems, typically consisting of a septic tank and leaching field. Septic systems are widely used throughout the world, they are passive systems that successfully reduce organic loading to the environment. Septic systems, or on-site wastewater treatment systems, have been identified by NYSDEC as the source of the nitrogen causing use impairment for several of the impacted water body segments in the Great South Bay drainage area.

When properly sited (e.g., appropriate density), all three of these approaches are capable of enabling the groundwater resource to achieve the 10 mg/L groundwater standard for nitrate on a regional basis. However, lower nitrate levels in groundwater discharging to some surface waters are required to meet water body-specific water quality and ecologic goals. Either nitrogen or phosphorus may be the limiting nutrient in a particular surface water body. In general, phosphorus is typically the limiting nutrient for algal growth and productivity in fresh water systems, and nitrogen is usually the limiting nutrient in marine water bodies. Like nitrogen, phosphorus may be introduced

to the aquifer system by sanitary wastewater or by fertilization. Unlike nitrogen, dissolved phosphorus is more likely to sorb onto sediments, and is not as mobile. Therefore, most discussions of nutrient loads to surface waters from groundwater baseflows focus on nitrogen.

Target nitrogen levels in groundwater discharging to surface water must be established on a water body-specific basis, taking into account a variety of factors such as biogeochemical reactions in the hyporheic zone, advective and tidal mixing, dilution, and other sources of nitrogen load to the system. In many locations, nitrogen concentrations in groundwater are reduced prior to discharge to the receiving surface water body by biogeochemical transformation in the hyporheic zone, the upper portion of the bottom sediment of the surface water body. For example, SCDHS found that the nitrate concentrations in groundwater discharges to West Neck Bay in 1999 were reduced by approximately 25 percent from nitrate levels in wells adjacent to the shoreline. Changes in nitrate levels that occur within this zone vary depending on the substrate, and may also vary by season.

Sufficient information does not exist at this time to establish a target nitrate level in groundwater to achieve surface water quality goals; these targets must be established on a water body- specific basis. Nevertheless, it is apparent that target nitrate concentrations are lower for surface waters than the 10 mg/L criteria established for groundwater for public health protection. In addition, nitrogen contamination is also an indicator of the presence of other contaminants of potential concern that are found in sanitary wastewater, some of which are routinely reduced via treatment systems, and others that are not.

It is recommended that:

- TMDLs be established for contaminants of concern causing water quality impairments in priority surface water features; SCDHS monitoring data should be used to support these efforts;
- For those surface waters where nitrate in groundwater is established as a significant component requiring reduction, site-specific studies should be completed to assess any reduction throughout the year in the hyporheic zone to establish nitrate groundwater level targets within the surface water contributing area, and
- An approach to provide any required higher levels of nitrate removal within the mapped surface water contributing areas should be implemented.

5.3.8 Stormwater Management Recommendations

Urban stormwater runoff is listed as the source of impairment for most of the water bodies identified on the New York State 2014 303 (d) list of impaired individual water body segments in Suffolk County, as well as for the water body segments identified as water bodies for which TMDL development may be deferred pending verification of cause/pollutant. The 2014 303 (d) list of impaired individual water body segments in Suffolk County requiring development of a TMDL includes eighteen fresh water segments. The source of pollutants resulting in impairments at fifteen of the individual fresh water body segments is identified as urban stormwater runoff. These include seven lakes (Millers Pond, Maratooka Pond, Fresh Pond, Canaan Lake, Lake Ronkonkoma, Big/Little Fresh Ponds, Mill and Seven Ponds) and eight rivers and river systems (Champlin Creek, Terrell River, Beaverdam Creek and tributaries, Motts Creek, Orowoc Creek, Awixa Creek, Penatquit Creek and Sampawams Creek). At the remaining three lakes, (Saint James Pond, Spring Lake and Lake Capri), contaminated sediment is identified as the source of the pollutant (chlordane, DDT and/or cadmium) impacting these water bodies.

Fifteen additional marine water body segments that drain to the Atlantic Ocean/Long Island Sound Drainage Basin are included on the 303 (d) list; however it is noted that these segments might be addressed by a water body-specific TMDL or possibly some other strategy to attain water quality standards. Sources of impairment to each one of these water body segments includes urban stormwater runoff. Onsite wastewater treatment systems and agriculture are identified as additional sources.

A final seven saltwater body segments that also drain to the Atlantic Ocean/Long Island Sound Basin are included on the 303 (d) list as water bodies for which TMDL development may be deferred pending verification of cause/pollutant. In each instance, urban stormwater runoff is again noted as the source causing the impairment. Additionally, onsite wastewater treatment systems are noted as an additional source for all of the water bodies listed.

Not all impaired waters of the state are included on the Section 303(d) list. By definition, the 303 (d) list is limited to impaired waters that require development of a TMDL. However, New York State maintains a list of Other Impaired Waterbody Segments Not Listed on the 303 (d) list to provide a more comprehensive inventory of waters that do not fully support designated uses. Waterbodies on this list are considered to be impaired, however a TMDL is not necessary. In most cases, this is because a TMDL has already been established for the segment/pollutant and identifies urban stormwater runoff as a source of impairment.

Per the Clean Water Act, New York State is required to develop TMDLs to address the source(s) of impairments. The County and Towns should work closely with the state to establish water body-specific TMDLs and determine which structural and non-structural controls will be the most effective to implement. TMDL allocations are calculated for all non-point sources that contribute to the use impairments, including stormwater runoff, and in some instances, onsite wastewater treatment systems and fertilizer runoff from agricultural areas consistent with the specific sources of contamination. Unlike point sources, the TMDL does not have authority in most cases to force a reduction of pollutants from non-point sources. In these cases, a TMDL Implementation Plan will outline a set of recommendations to reduce the non-point source pollution identified in the TMDL. These plans are the basis for initiating local, regional, and state actions that reduce pollutant loads to levels established in TMDLs for non-point sources.

Local input to the TMDL process is essential in determining which controls will be the most effective. Additional sampling will also be required to determine the effectiveness of the chosen controls. If the controls are found to be inadequate, then the implementation plan will be revised and more stringent measures may be adopted. Local jurisdictions may need to enact new zoning ordinances, require existing development to add new or additional stormwater BMPs, or conduct other actions. Where agriculture is determined to be a source of impairment, the plans may ask farmers to use new management practices to prevent fertilizers and pesticides from reaching water bodies. TMDLs are usually only effective at addressing non-point sources when enough local interest exists to carry out the implementation plan.

Since monitoring is necessary to determine the effectiveness of the chosen controls, the County's surface water monitoring programs will also continue to be relied upon to provide essential water quality information. Further study is needed to determine the relationship of nitrogen and other factors in causing harmful algal blooms (HAB) or Brown Tide. The Suffolk County regional groundwater model has been used to estimate groundwater underflow (by aquifer) to the coastal water bodies (see Task 4-3– Hydrology, CDM, 2006). These estimates of underflow can be used together with estimates of the hyporheic zone uptake to estimate nitrogen loading from onsite wastewater treatment systems to Great South Bay, which may provide useful information when examining the relationship of nitrogen to algal blooms. Water body-specific estimates of underflow can also be developed using sub-regional groundwater flow models to provide a higher level of accuracy and help investigate specific occurrences of Brown Tide.

Consistent with the recommendations documented in the LISS, PEP, SSER CMP, and the North Shore Embayments Study, non-structural efforts to reduce contaminants from stormwater impacting the County's streams, embayments, and groundwater should focus on the general practices of reducing fertilizer use; keeping pollutants out of stormwater runoff; reducing impervious surfaces; and preserving open space.

The Peconic Estuary Program has successfully guided the creation of a Stormwater Inter-municipal Agreement (IMA) in the Peconic Estuary watershed. The PEP's contract is being completed and it is anticipated that six towns and three villages will be members of the coalition. The IMA will establish collaborative efforts and shared resources to meet the MS4 General Permit (stormwater) requirements and facilitate cooperation and coordination among municipalities on a variety of water quality initiatives. The Action Plan prepared will provide a road map of recommendations, implementation strategies and prioritize actions for collective efforts to assist all the municipalities in meeting the MS4 General Permit Requirements. Additionally, the proposal includes implementation assistance for several of the key 2010 MS4 General Permit Requirements, resulting in increased compliance for the participating MS4s.

5.4 Establishment/Enhancement of Surface Water Monitoring Programs

Monitoring the state of the County's water resources is an essential function in terms of protecting human health (e.g., compliance with recreational water quality criteria for beaches) that should not be compromised. Monitoring data also provides the information necessary to identify areas and/or contaminants of concern, to evaluate cause and effect relationships with respect to sources of contamination and resulting water quality, and establish potential impacts on ecological communities. Summaries of the monitoring programs that should be continued and/or implemented are provided below.

5.4.1 Beach Monitoring

Suffolk County's beaches are an important recreational resource used by thousands of residents each year. Water quality at some beaches can be affected by pathogenic contamination introduced to the water body by stormwater runoff, boat discharges or area septic systems; the impacts of these potential sources are exacerbated in areas that are poorly flushed. SCDHS Office of Ecology is responsible for implementing the County's beach monitoring program to protect public health, in accordance with the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act.

From May to September, Suffolk County beaches are monitored by Public Health Sanitarians for the presence of enterococcus, the indicator organism selected by USEPA as most indicative of the presence of potentially pathogenic organisms in marine waters, as required by the State Sanitary Code (2004). Beaches are monitored under §6-2 of the state Sanitary Code to ensure compliance with water quality standards. The Office of Ecology has developed a risk-based approach to the monitoring program, and beaches that are most likely to be impacted by pathogens are sampled most frequently. Approximately 200 beaches in the County are monitored, including private community beaches and permitted beaches; thousands of samples are collected and analyzed each bathing season, as summarized on **Table 5-11** below. The permitted beaches monitored by SCDHS are located throughout the County on the Atlantic Ocean and Great South Bay, Long Island Sound and north shore bays and harbors, Peconic Estuary and lakes as shown by **Figure 5-13.**

Table 5-11 Suffolk County Bathing Beach Monitoring Program Summary

Bathing Beach Program	2007	2008	2009	2010	2011	2012	2013	2014
Facilities Permitted	133	133	134	132	133	134	134	128
Inspections	141	148	151	148	159	158	163	159
Sampling Sites	230	240	241	267	260	212	206	200
Samples Collected	4,901	5,171	4,577	5,124	3,949	3,292	4,190	3,832
BEACH Act Grant ($)	99,324	99,557	171,999	91,278	91,278	95,550	93,650	95,890

Based on the sampling, SCDHS maintains a website that provides nearly real-time information on the status of beach closings and beach warnings. An annual federal BEACH Act Grant provides support to fund the positions and sampling supplies necessary to implement the program.

Only by collecting and analyzing water quality samples can water quality of the County's beaches be ascertained and public health adequately safeguarded. Continued implementation of this program is essential to provide continued protection of public health.

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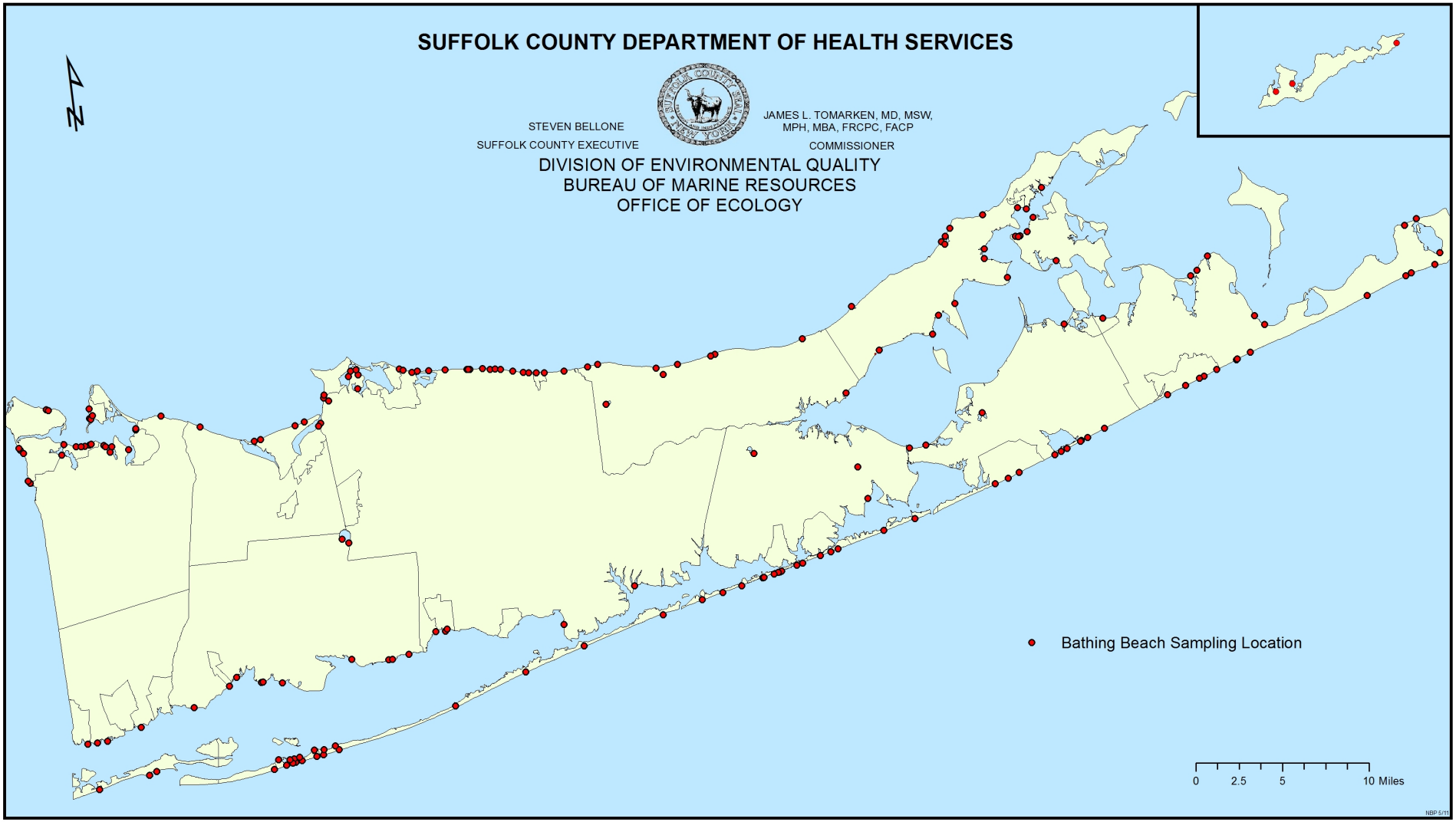

Suffolk County Department of Health Services
Beaches Monitored by SCDHS

Figure 5-13

Suffolk County Comprehensive Water Resources Management Plan

5.4.2 Estuary Program Monitoring

Since 1976, SCDHS Office of Ecology has monitored water quality in parts of the Long Island Sound, the South Shore Estuary Reserve and the Peconic Estuary at varying frequencies. Currently, monitoring is performed at the locations shown on **Figures 5-14** through **5-23**. Samples are analyzed for temperature, secchi depth, irradiance, dissolved oxygen, salinity, conductivity, nutrients, coliform, suspended solids, chlorophyll-a, phytoplankton, and, in some cases, VOCs and pesticides/herbicides. Sampling is conducted to improve the understanding of the County's ecosystems, to help to understand the inter-relationships between water quality parameters and the marine and estuarine ecosystems, to assess the impacts of human activities on water quality and ecosystems, and to help to assess the effectiveness of management activities in terms of water quality improvements.

5.4.3 Stream and Pond Monitoring

In the past, SCDHS conducted regular monitoring of targeted streams and ponds. Monitoring, including assessment of start-of-flow, baseflow measurement and collection and analysis of water quality data, was performed to assess the ecological health and wellbeing of the surface water features. As citizen attention becomes increasingly focused on the resources of the community, it is recommended that the County's surface water monitoring program be restored. Based on historical sampling stations and a field survey of each stream to identify access points, discharge points, etc., sampling stations should be identified on each of the streams identified on **Figure 5-24** and **Table 5- 12**.

Shorter streams can be characterized with a single sampling station; longer streams should, as a minimum have upstream (typically reflective of groundwater baseflow quality) and downstream (reflective of groundwater baseflow and stormwater runoff) stations. The five major streams (Carlls, Carmans, Connetquot, Nissequogue, and Peconic) should be sampled at the same stations sampled in the past for consistency, and to enable analysis of long term trends.

As a minimum, stream samples should be analyzed for pathogens, dissolved oxygen and nutrients. To the extent that resources allow, stream samples should also be analyzed for VOCs and PPCPs. Streams on the North Fork should also be analyzed for pesticides. Depending upon water body-specific characteristics, a sampling program should be designed to characterize conditions during both dry weather, and during wet weather events, in order

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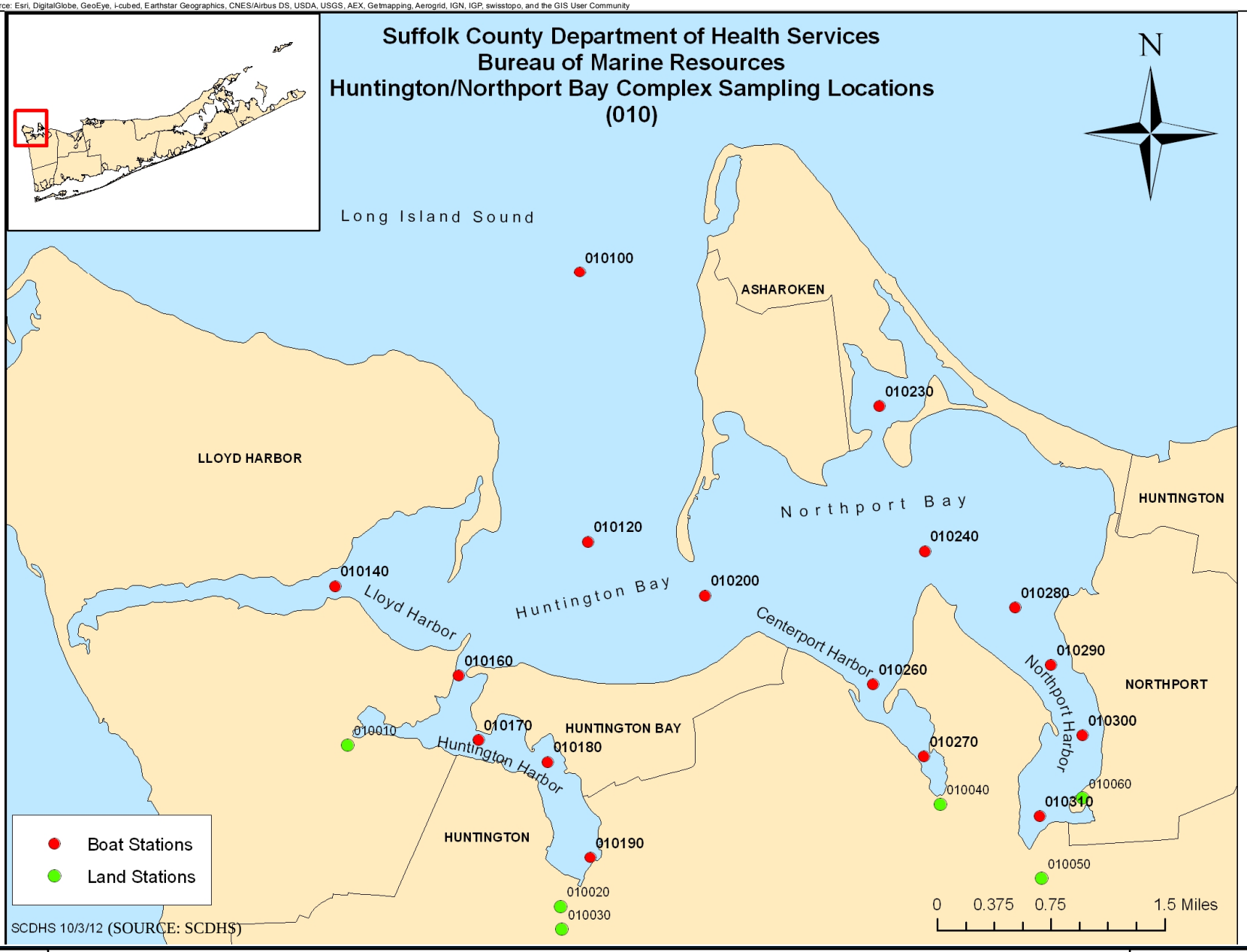
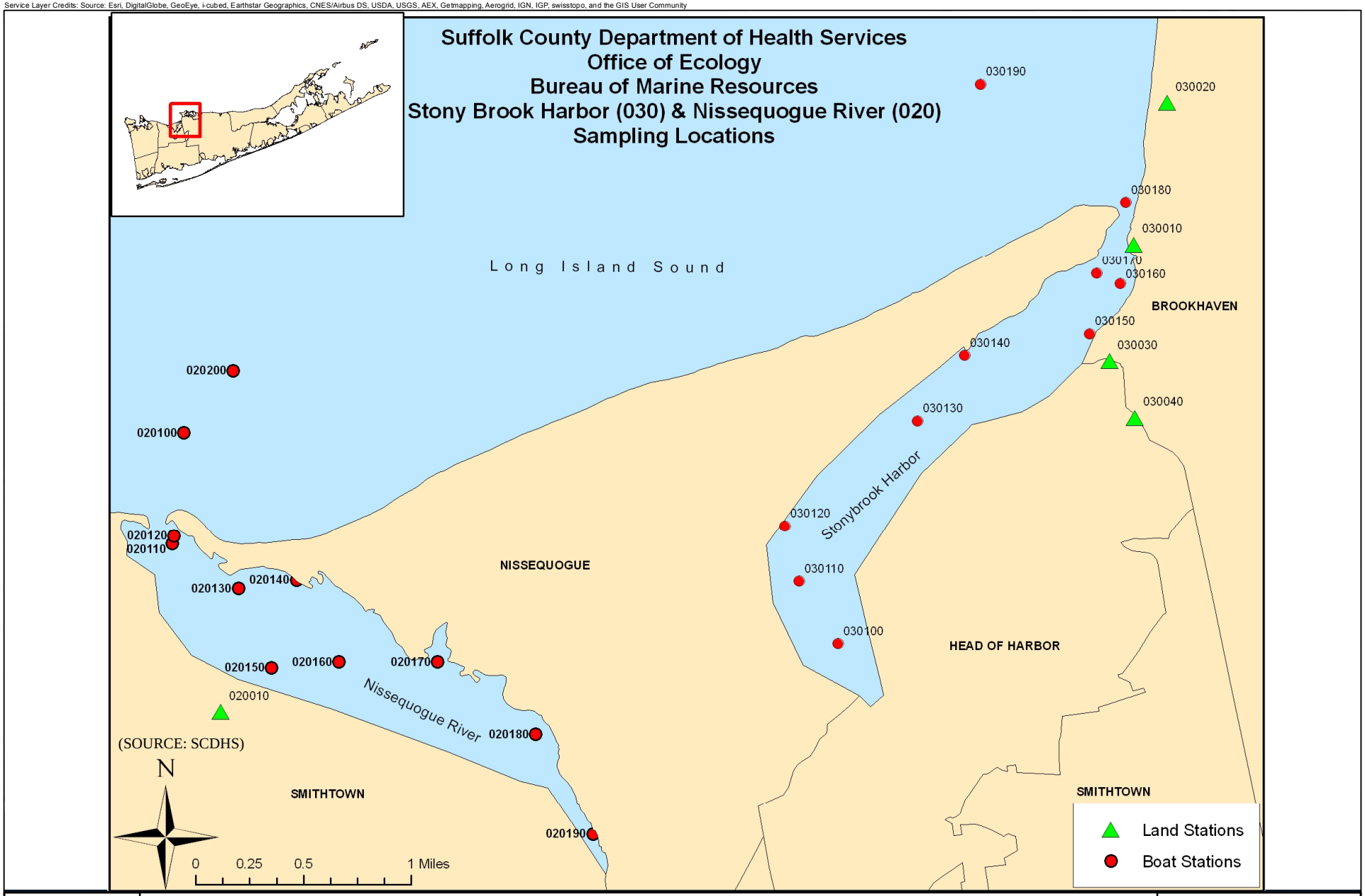


Suffolk County Department of Health Services
Sampling Locations
Huntington-Northport Harbor

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-14

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

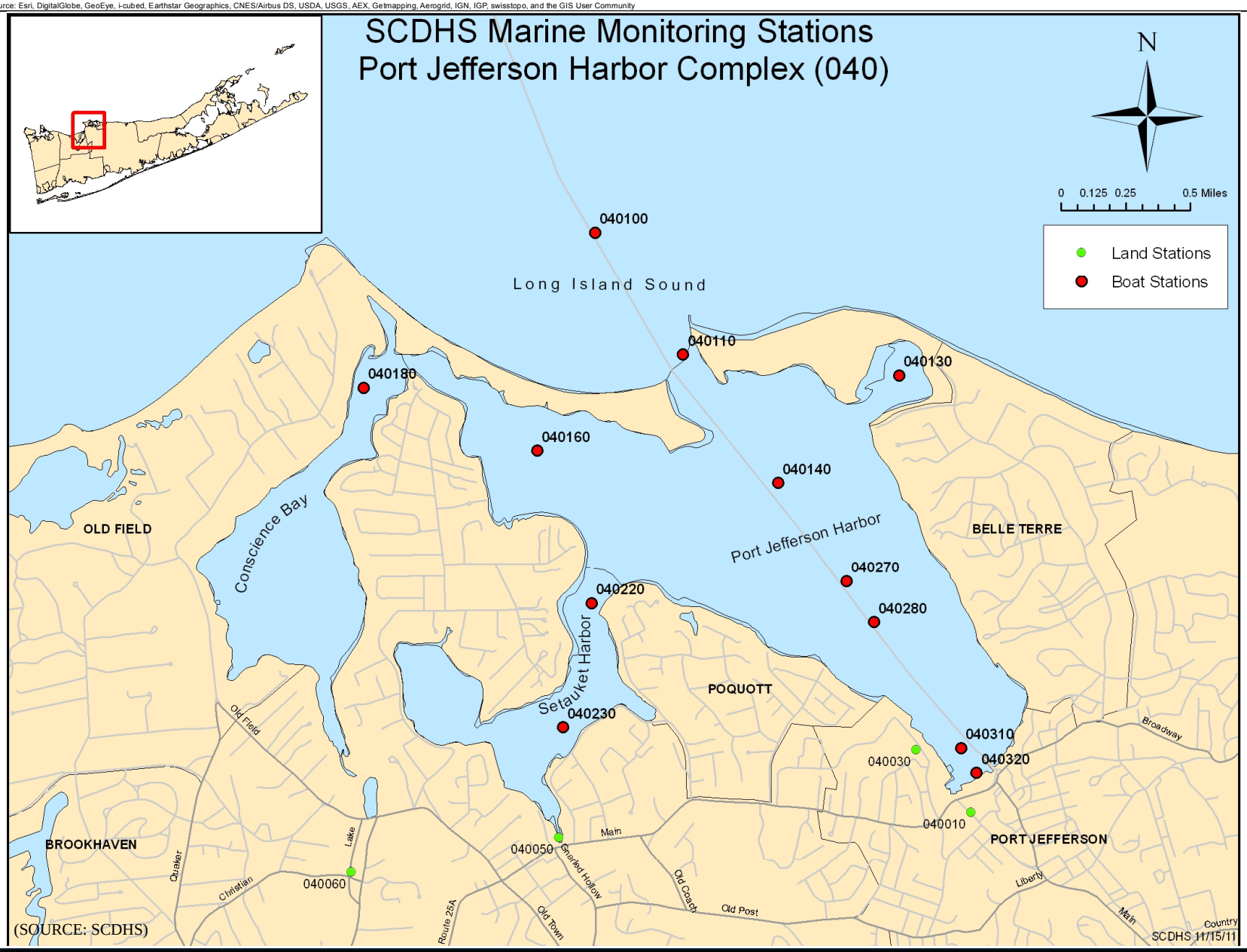


Suffolk County Department of Health Services
Sampling Locations
Nissequogue and Stony Brook Harbor

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-15

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

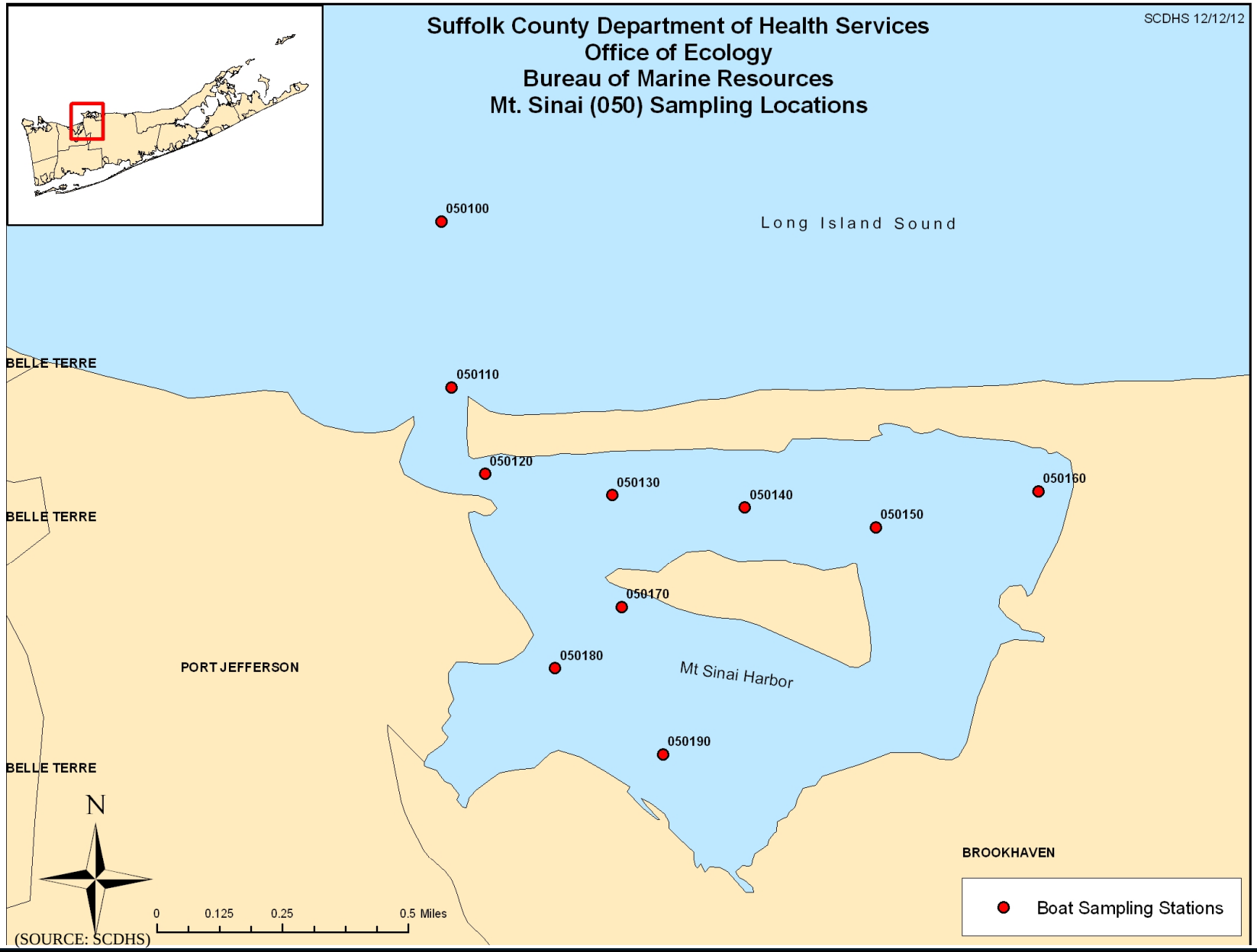


Suffolk County Department of Health Services
Sampling Locations
Port Jefferson Harbor

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-16

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



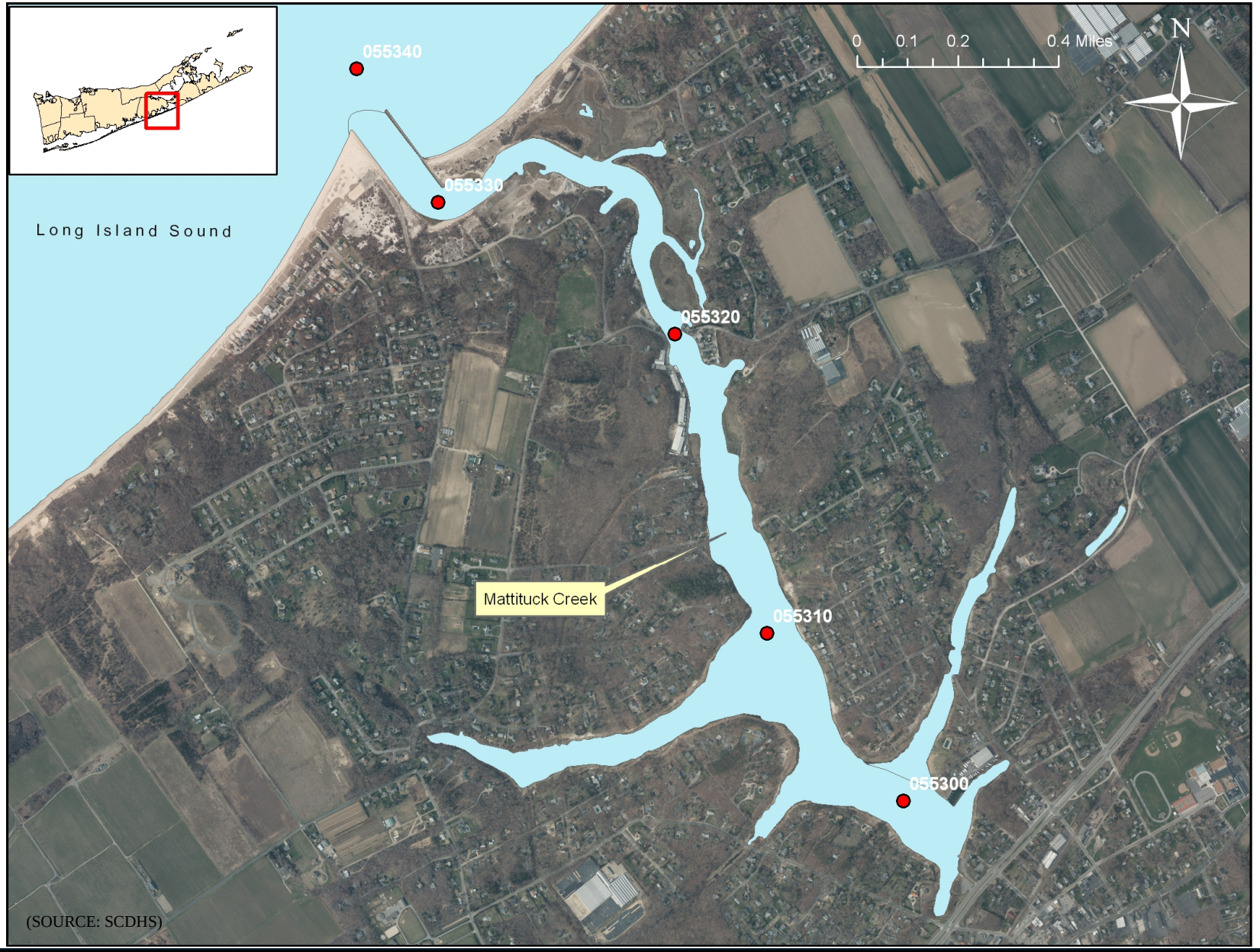
(SOURCE: SCDHS)

Suffolk County Department of Health Services
Sampling Locations
Mount Sinai Harbor

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-17

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Suffolk County Department of Health Services
Sampling Locations
Mattituck Creek

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-18

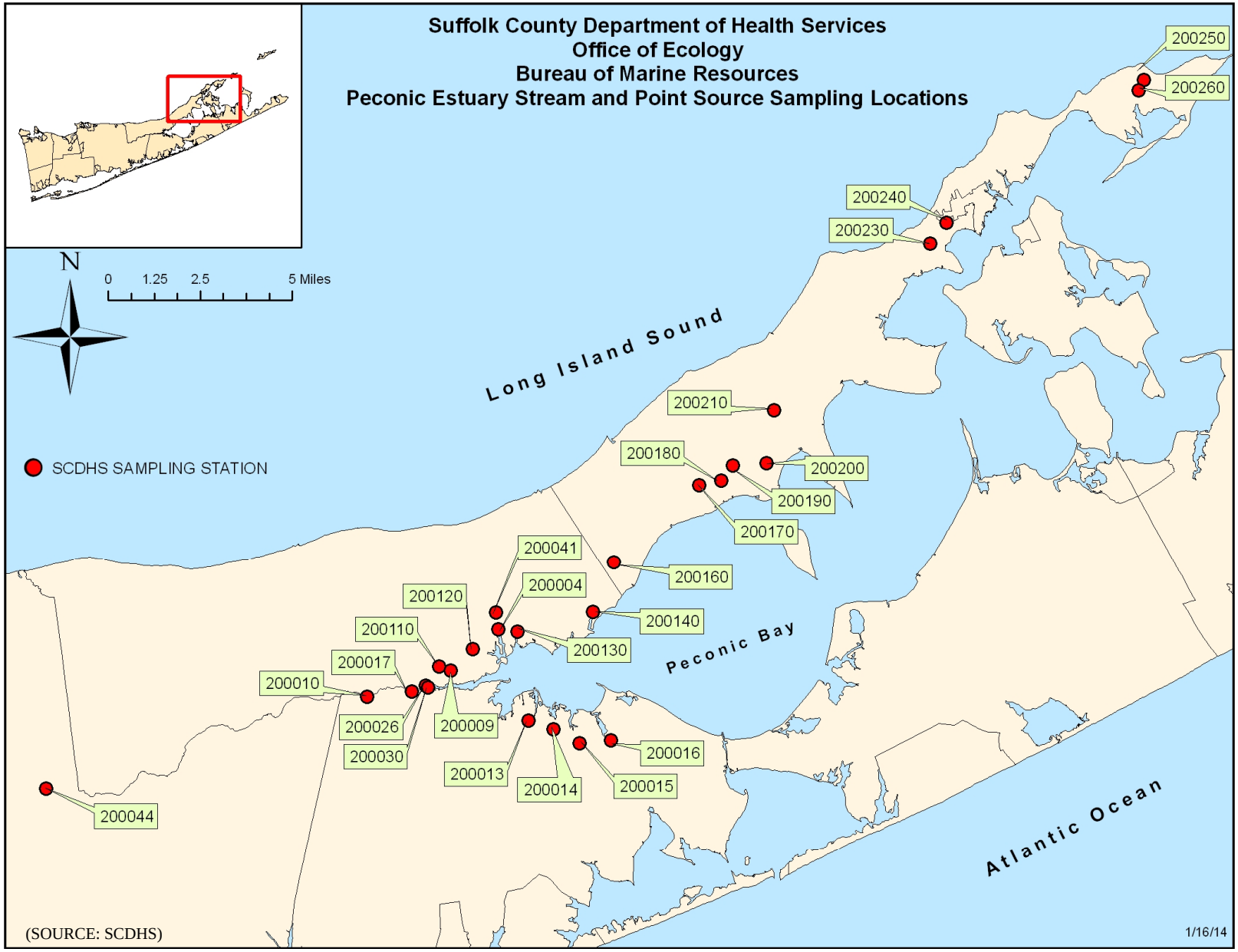
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Suffolk County Department of Health Services
Marine Monitoring Locations
Peconic Estuary

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-19a

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

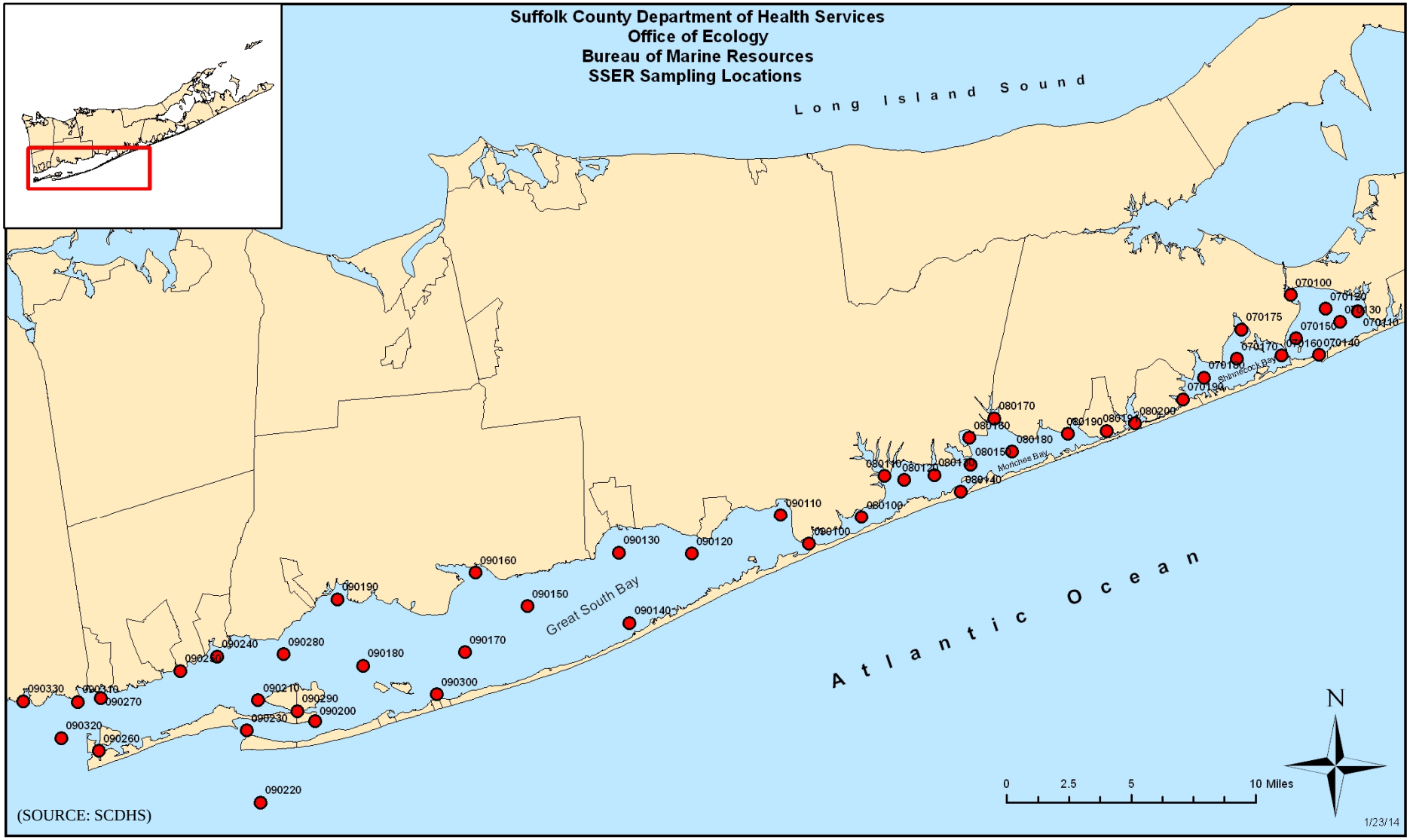


Suffolk County Department of Health Services
Stream Monitoring Locations
Peconic Estuary

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-19b

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



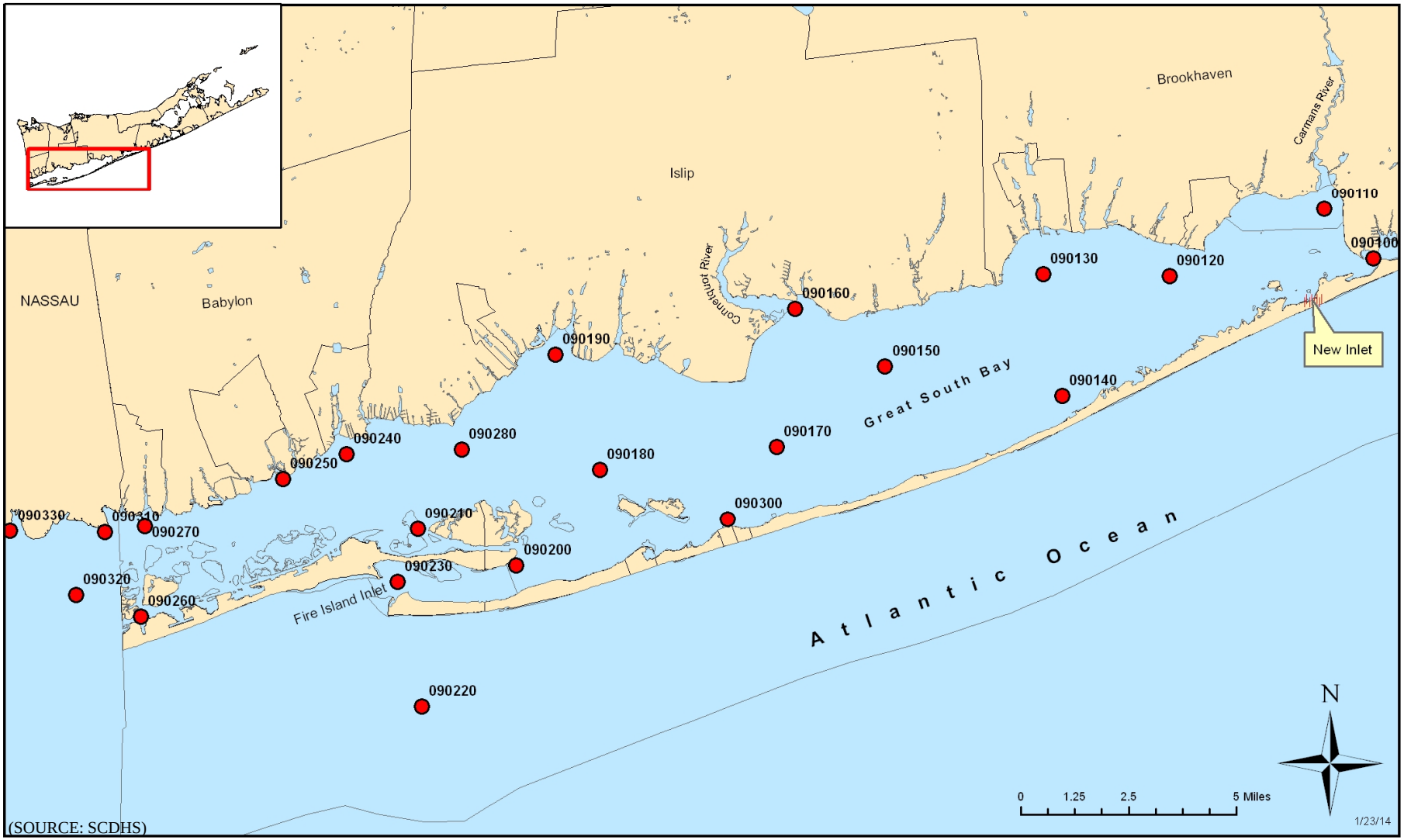
Suffolk County Department of Health Services
Monitoring Stations
South Shore Estuary Reserve (SSER)

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-20

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Suffolk County Department of Health Services
Office of Ecology - Bureau of Marine Resources
Great South Bay Sampling Locations (090)

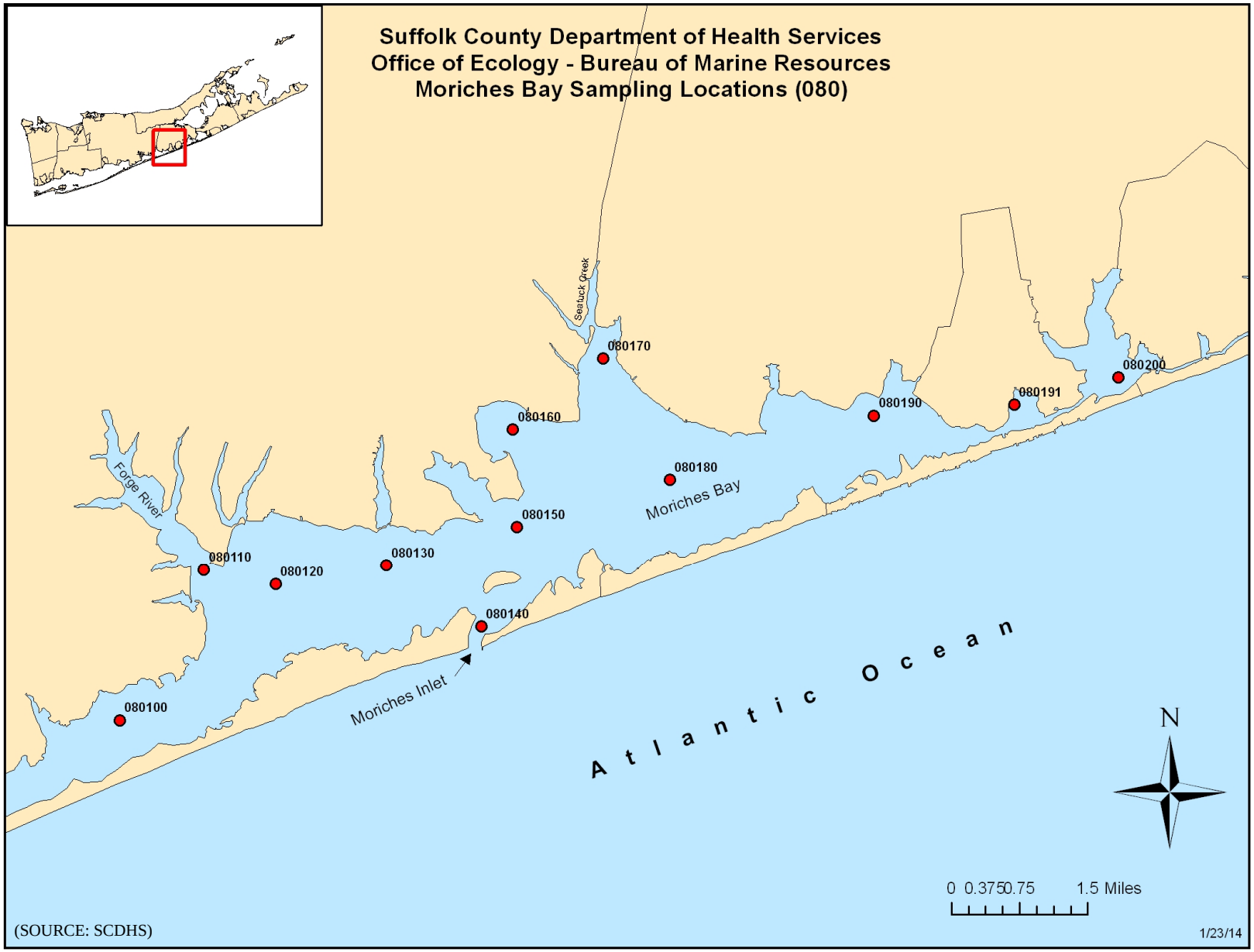


Suffolk County Department of Health Services
Monitoring Stations
Great South Bay

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-21

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

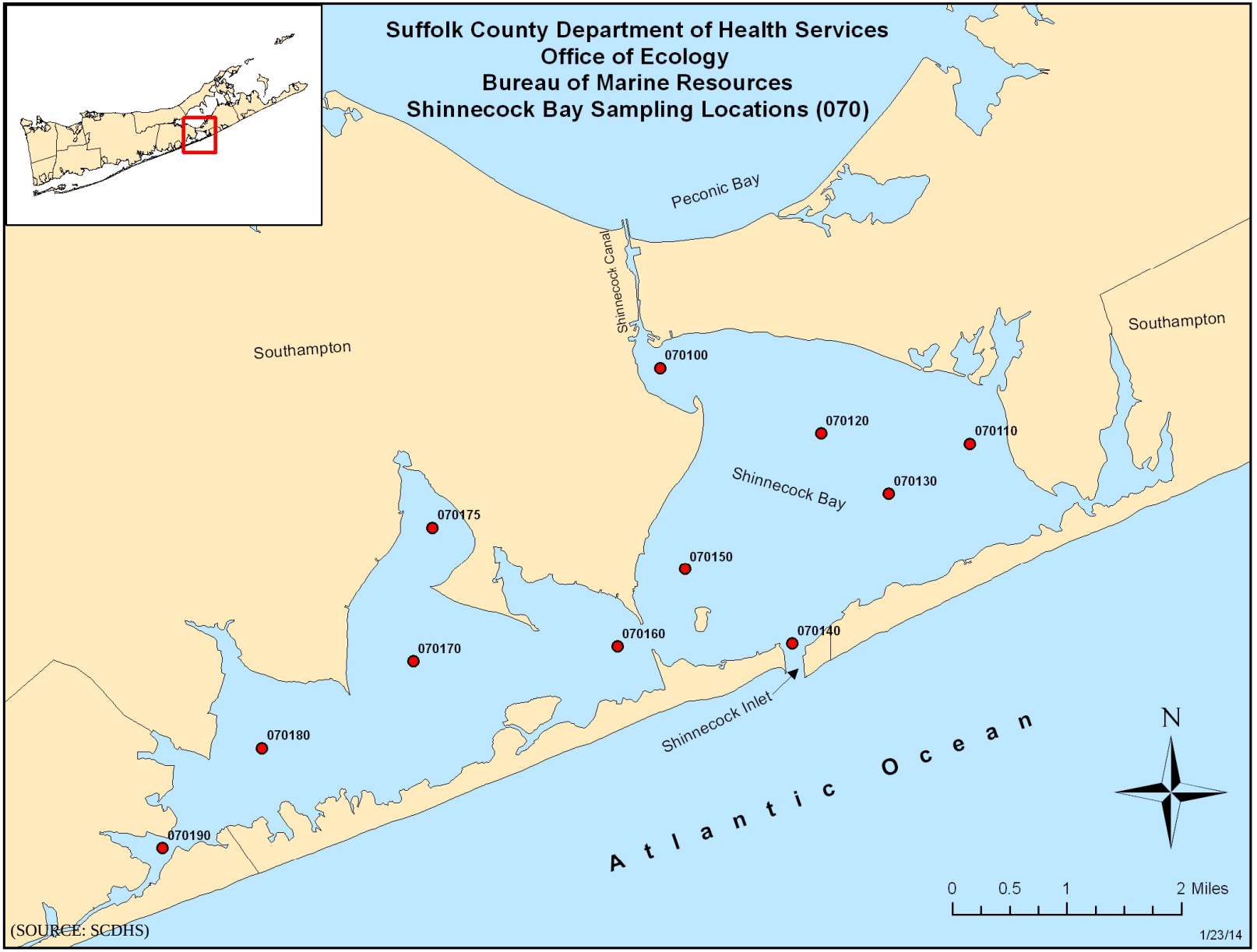


Suffolk County Department of Health Services
Monitoring Stations
Moriches Bay

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-22

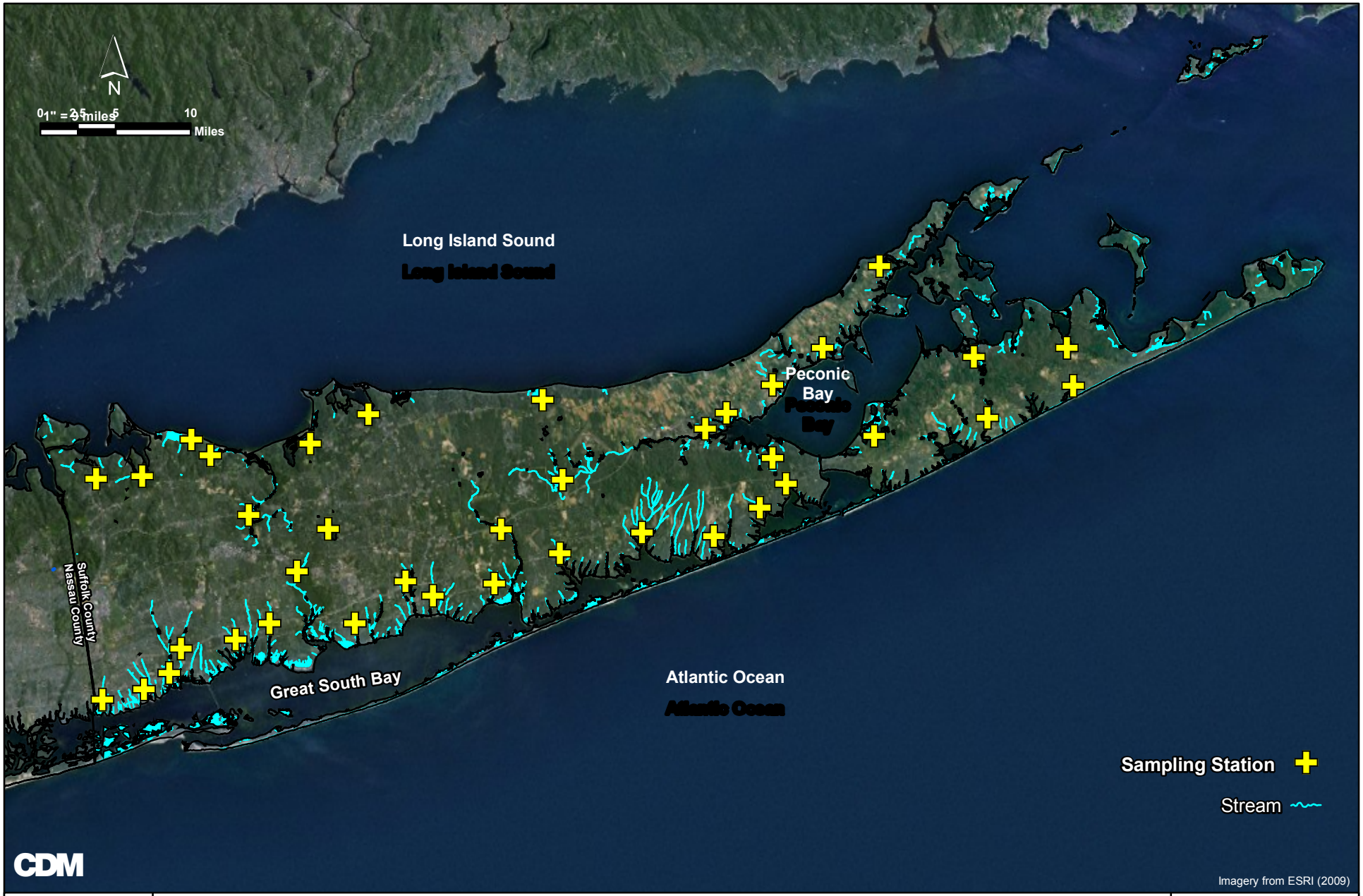
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Suffolk County Department of Health Services
Monitoring Stations
Shinnecock Bay

Suffolk County Comprehensive Water Resources Management Plan

Figure 5-23



Suffolk County Comprehensive Water Resources Management Plan
Recommended Stream Sampling Stations

Figure 5-24

Table 5-12 Streams to be Included in SCDHS Sampling Program

Fresh Water Streams	
Amityville Creek	Long Creek
Aspatuck Creek	Meetinghouse Creek
Beaverdam Creek	Mill Creek (Huntington)
Brookhaven Creek	Neguntatogue Creek
Brush's Creek	Nissequogue River
Carlls River	Patchogue River
Carmans River	Peconic River
Champlin Creek	Penatquit Creek
Connetquot River	Port Jefferson Creek
Down's Creek	Sagaponack Creek
Forge River	Sampawams Creek
Fresh Pond	Sawmill Creek
Green Creek	Seatuck Creek
Hook Pond Creek	Sebonac Creek
Hubbard Creek	Stony Brook
Lake Ronkonkoma Inlet	Stony Hollow Run
Ligonee Brook	Sunken Meadow Creek
Tanbark Creek	Swan River
Tiana Creek	Wading River
Weesuck Creek	

to assess the impacts associated with stormwater runoff. Based upon stream-specific objectives and available resources, dry and wet weather sampling events can be targeted in alternate years, or multiple events including both dry and wet events can be completed in a single season. Sampling programs should be developed in more detail to support TMDL development, implementation and evaluation.

5.4.4 Special Studies

Special focused studies may be required to support TMDL development, to assess whether phosphorus or nitrogen is the limiting nutrient in specific impaired water bodies, and to continue to assess the causes of harmful algal blooms (HABs) so that they may be mitigated.

In order to identify any required nitrogen controls within each surface watershed of interest, a nutrient balance should be conducted. Controllable sources of nitrogen to surface water such as point source discharges have been identified; non-point sources such as stormwater runoff have also been identified in some areas. Additional study would, however, be beneficial in identifying the contribution of the nitrogen load in groundwater baseflow. The existing suite of groundwater models has already been used to establish the

groundwater baseflow to many of the County's freshwater streams, harbors and embayments, and estuaries (CDM, 1999, Nelson & Pope, 2007). Observed groundwater nitrogen concentrations are also available to begin to characterize the high end of the range of potential nitrogen contributions. Model-generated contributing areas could be associated with groundwater quality and land use information via GIS to estimate nitrogen loads.

Additional information is, however, required to assess the load of nitrogen that actually travels through the groundwater to travel through the hyporheic zone to affect a surface water with an established TMDL. Existing literature and research documentation should be adequate to evaluate the transformation of various nitrogen species from septic field leachate through the groundwater as it approaches the County's surface water features. Scientific literature should be used to provide estimates of the rate constants associated with the transformation of organic nitrogen to ammonia nitrogen, and the subsequent transformations of ammonia to nitrite and nitrate (nitrification) and then to nitrogen gas (denitrification) where that occurs. It will be important to account for any nitrogen lost from the groundwater system via denitrification so that the groundwater nitrogen load is not over-estimated.

Based on a literature review to assess the types of factors affecting nitrogen transformation in the hyporheic zone, a field program can be developed to quantify nitrogen species in the shallow groundwater, groundwater discharge and adjacent surface water. A modeling tool such as the sediment nutrient diagenesis model (used by the USEPA and New York State and Connecticut in the Long Island Sound model) can then be used to estimate the delivery of groundwater nitrogen to the overlying water column based on the estimated transformations of ammonia nitrogen and nitrate nitrogen in the active benthic layer of the water bodies under study.

5.4.5 Data Management and Reporting

As a minimum, all surface water quality and quantity, groundwater quality and quantity and drinking water information should be entered into a new integrated database. Field data should be entered via portable hand held devices (e.g.; tablet such as an iPad or other mobile device) to reduce the time needed for transcription, data entry and data availability. Field and laboratory data should be regularly reviewed after routine uploading. SCDHS DEQ OWR should be responsible for maintaining this database. This database would be comprise a portion of the proposed Capital Project 4081, the Environmental Health Information Management System (EHIMS) described by SCDHS that would encompass all of the Environmental Health programs. In addition to the groundwater, surface water and drinking water supply data, the database

would incorporate data currently located within 30 different databases, including:

- Community, Non-Community and Bottled Water Supply Plant Inspections
- Private Well Inspection and Sampling
- Groundwater Pollution Investigations and Sampling
- Community Water Supply Plan Review
- Bathing Beaches
- Individual Water and Sewer Construction Plan Review
- Reality Subdivision Water and Sewer Plan Review
- State Pollutant Discharge Elimination System (SPDES)
- Sewage Treatment Plant Monitoring
- Petroleum Bulk Storage Tank Plan Review Inspection and Registration
- Enforcing Toxic and Hazardous Materials Storage regulations, which involve plan review, inspection and permitting of commercial and industrial facilities
- Sampling of Marine and Surface Waters for Chemical, Bacteriological and Algal Quality
- Environmental Remediation
- Public and Environmental Health Laboratory (PEHL) Laboratory Information Management System data integration with water quality databases
- State Environmental Quality Review (SEQR) Reviews

Integration of all of the existing databases addressing water quality and water quantity, as well as the factors affecting water quality and water quantity (e.g., facilities, spills, etc.) into a single database that could be viewed using a GIS interface would provide a number of benefits. For example, all of the datasets could be accessed by any user, instead of limiting access to an individual or group with access to and knowledge of a particular type of software;

information currently residing within different databases could be mapped simultaneously to help assess water resource implications, and the data back-up would protect against the impacts of any hardware malfunctions (e.g., individual personal computer failure) or facility disaster (e.g., paper records).

Alternatively, it could be part of a larger, comprehensive Countywide database as recommended by IBM's Smarter Cities Challenge Report, the data would be readily available to all departments within the County to help to identify public health concerns and water resources issues, to identify appropriate management actions, to assess priorities and guide decision making. This data would be readily accessible so that queries relating to ground or surface water quality or data trends can be readily answered, issues can be rapidly and appropriately addressed, and the County can have the information to develop responses to long range concerns such as sea level rise. Finally, the data should be made available to other stakeholders outside the County such as SCWA, NYSDEC, the estuary programs, etc., so that timely decisions can be made based on the best available information.

It is recommended that SCDHS prepare a concise annual report summarizing the results of the countywide groundwater and surface water quality and quantity monitoring.

The report should contain, at a minimum, the following information:

- Background information on precipitation over the sampling period;
- Water supply pumping from each of the major water use categories, and monthly pumping from community supplies;
- Mapping of ground water levels, and figures depicting baseflow and stream flow; figures showing groundwater baseflow as a percentage of total stream flow;
- "Dot plot" type graphics depicting countywide water quality within each aquifer for each parameter of concern (e.g., nitrates, most often detected VOCs, pesticides, PPCPs);
- Statistics on water quality comparing annual water quality with baseline (1987, 2005 and 2013) years (baseline year dependent upon parameter of concern);
- Trend graphs of contaminants of concern for selected indicator wells, as well as trends in the minimum, mean, and maximum concentrations from all the wells;

- Water level graphs of selected indicator wells showing trends;
- Saltwater interface monitoring results depicting chlorides concentrations with time;
- Results of nitrogen and pesticide analyses in monitoring wells characterizing agricultural areas;
- Identification of any newly observed contaminants of concern for future targeting;
- Tables summarizing surface water quality data identifying any contaminants of concern identified;
- Tables summarizing beach monitoring data;
- Figures depicting trends in nitrate concentrations at sampling stations in the Long Island Sound, Peconic Estuary and South Shore Estuary; and
- Tables summarizing water quality data at the estuary program sampling locations and figures showing time histories of nitrogen and dissolved oxygen at key estuary program sampling locations.

In addition, each document should identify the apparent most significant issues affecting the resource and identify any additional priorities for monitoring and/or research.

Over the years, new monitoring tools and improved analytical capabilities have facilitated the identification of increasing numbers of contaminants in the environment, and the presence of these constituents can be detected at lower and lower concentrations. In addition, new tools and more powerful computer capabilities have facilitated the synthesis of various types of data and information (e.g., GIS information, groundwater modeling output and groundwater quality data for example) and are conducive to presentation of data and results in comprehensive graphical representations, which are more robust and much faster to produce than in years past. The need to utilize and enhance the ability to use, analyze and share data within a GIS framework has previously been documented in the draft 2010 Comprehensive Water Resource Management Plan and supporting task memoranda going back as far as 2008.

The bi-annual monitoring report should be distributed to other County agencies, NYSDEC, SCWA and water suppliers to support their resources management efforts and should also be made available electronically via the Suffolk County website.

5.5 Public Outreach and Education

Because Suffolk County residents live within the recharge areas for all of our public supply wells and surface water resources, it is critical that all take an active role in protecting these resources. A wide variety of public education and outreach programs are already in place at the federal, state, County and local levels to address topics such as storm water pollution, lawn fertilization, conservation, proper use and disposal of hazardous household wastes and pharmaceuticals and personal care products, etc. However, continued detection of low levels of various contaminants in surface waters and continued inclusion of water bodies on the 303(d) list indicate that a more assertive effort is required.

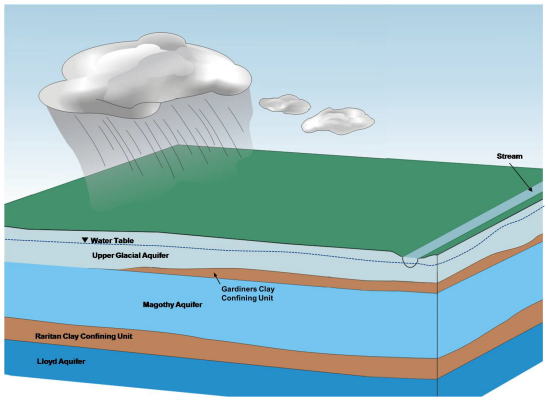
A report prepared in 2005 by the National Environmental Education & Training Foundation (NEETF) entitled Environmental Literacy in America reported that 78 percent of the American public does not realize that runoff from agricultural land, roads, and lawns is now the most common source of water pollution; and nearly half of Americans (47 percent) believe that industry accounts for most water pollution. Similar questions were posed to residents of the Long Island Sound watershed as part of a survey conducted in 2006 by the Stony Brook University Center for Survey Research as part of a USEPA grant. The results were analyzed by resident location; 49 percent of Long Island respondents believed that waste dumped by factories is the main source of water pollution. The role of personal responsibility and environmental stewardship needs to be emphasized in the County's public outreach efforts, and the significance of our surface waters must be more widely conveyed.

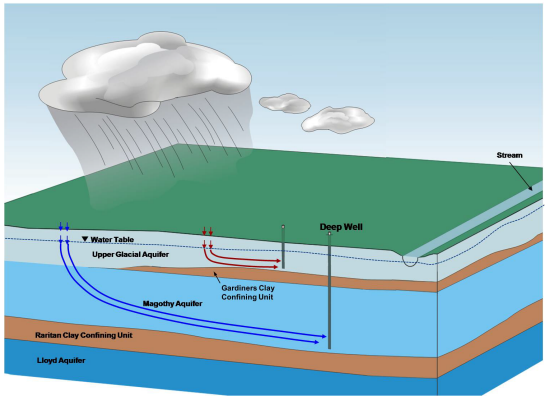
The Task 10 memorandum described a number of existing and overlapping public education programs, and identified a variety of potential enhancements. Overall, the existing programs are reaching a very small percentage of the County's 1.5 million residents. The IBM Smarter Cities Challenge Report (IBM, 2014) also identified the need for the County to engage County residents and visitors to embrace their role as stewards of water quality and motivating them to take action. A more ambitious approach is required and recommended here.

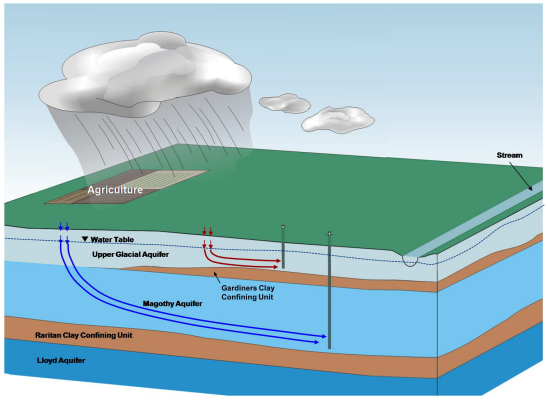
It is recommended that the SCDHS re-establish their public outreach and education program. The coordinator should work closely with the SCDPW (stormwater program), the SCDEE (fertilization program), the water suppliers (conservation program), the LIS, PEP and SSER program coordinators, and the Towns (STOP), to identify opportunities to leverage outreach opportunities and venues and coordinate water resources protection messages. Development of a school-based program is recommended to reach hundreds of thousands of

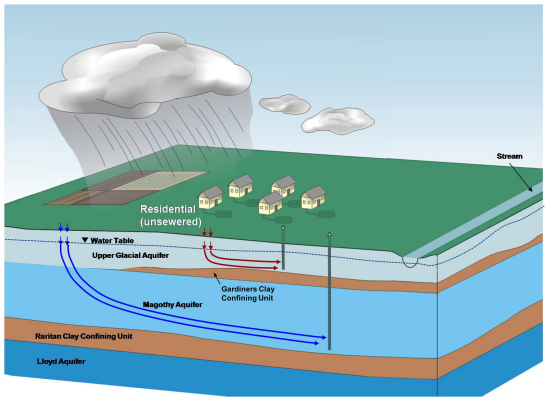
residents annually. Members of this target audience will bring the message home to their families to further disseminate the information and hopefully motivate broad-based changes in behavior throughout the County. As the students themselves age, the information will be part of the knowledge base that motivates their behavior.

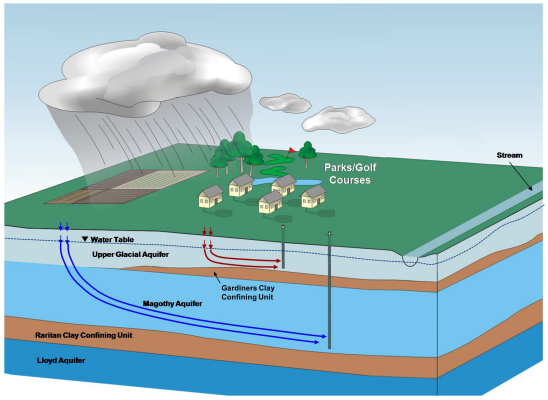
Initially, a series of at least three lesson plans (for primary school, middle school and Earth Science target audiences) should be prepared and provided to all school districts in the County, either for integration into the science curriculum, or for delivery on Earth Day. The 45-minute sessions could be developed using materials already available at http://www.epa.gov/epahome/students.htm, http://water.usgs.gov/education.html; http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=8&minmeasure=1); http://www.classroomearth.org, the National Environmental Education Foundation website (http://neefusa.org/programs/classroom_earth.htm), the Water Environment Federation website or estuary program websites such as longislandsoundstudy.net. Materials obtained from these web-sites could also be modified to PowerPoint based presentations using Suffolk County-specific materials. An example simple set of PowerPoint slides that could be used to introduce the County's source of potable water, how human activity can impact groundwater quality, and groundwater's contribution to stream baseflow is provided by **Figure 5-25.**

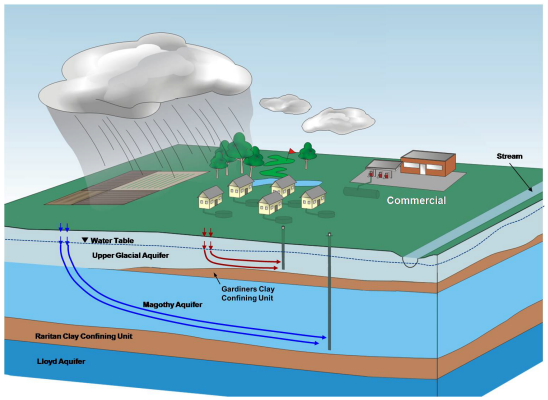


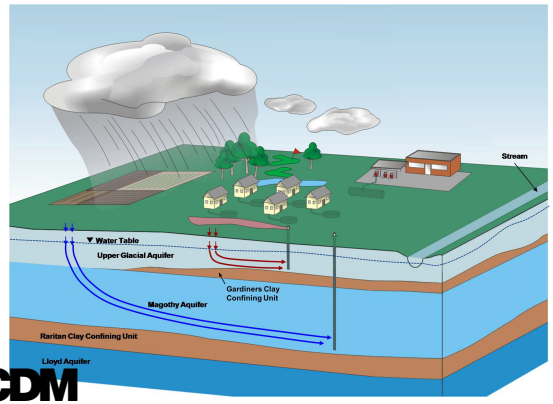


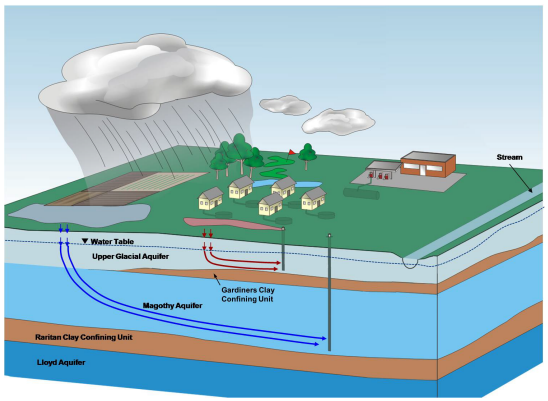


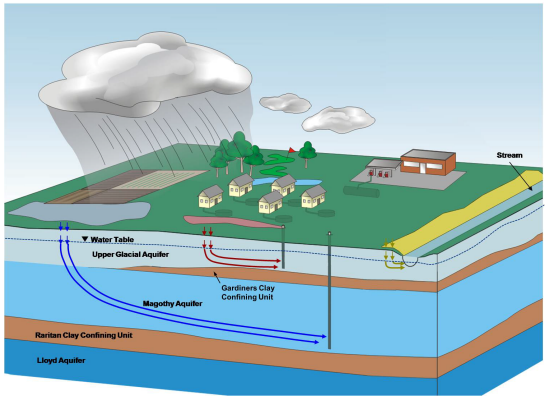












CDM

Suffolk County Comprehensive Water Resources Management Plan
Potential Groundwater Pathways to Supply Wells & Surface Waters

Figure 5-25

Each year's lesson should begin with a brief 'quiz' or survey to assess both the knowledge and the behavior of the student with respect to water resources. The knowledge assessment portion of the survey would include questions such as "Where do you get your water from?" and the behavior assessment section of the survey would pose questions such as "How often do you clean up after your dog?" and "Do you water your lawn every day?". Survey questions should be grade-appropriate.

The lesson plans should address:

- Overview of the importance of clean water;
- Overview of Suffolk County water supply, the Suffolk County aquifer system and water cycle;
- Overview of the County's surface water resources;
- Example of how above-ground activities affect groundwater quality and surface water quality, including introduction to stormwater runoff and wastewater disposal;
- Identification of specific actions that students and their families should take to protect and preserve ground and surface water resources;
- Visual aids and discussion opportunities – kids respond better to seeing things/stories than words on paper;
- Use of hands-on activities, including lab or field work if possible to engage the students, and
- Hands-on homework, such as identifying the nearest storm drain to their home, or completing one of the on-line activities on the USEPA website.

Classes should close with another quiz or survey. While the knowledge assessment questions would remain the same as those evaluated prior to the lesson to assess how effectively the lesson was in communicating the material to the students, the behavior assessment would be slightly different than the pre-lesson assessment. The post-lesson behavior questions would be posed as "how likely are you to clean up after your dog?" and "how often will you water your lawn?".

Both the pre-lesson and post-lesson survey should be comprised of multiple choice questions (e.g. how often do you clean up after your dog would be

answered all of the time, most of the time, some of the time, hardly ever, or never) so that they can be readily scored. The results should be compiled on a grade and district basis, and forwarded to the County's public education coordinator.

The survey results should be monitored to assess the program's success, to identify the knowledge base of each age group, to identify existing behavior's contributing to pollution, and to modify subsequent year's messages to achieve the desired outcomes.

5.6 Summary of Recommendations

Surface water management recommendations are summarized on **Table 5-13.**

Table 5-13 Surface Water Protection Recommendations

Table 5-13
Surface Water Protection Recommendations

Undeveloped Areas

Within the existing Suffolk County Open Space Preservation planning context, parcels within the 25 year contributing area to surface water features should be identified and assigned a high priority for purchase, particularly when there is a significant opportunity to protect and preserve existing surface water quality.

Article 6 should be modified to require one acre density throughout all hydrogeologic zones, ***unless*** provision is made for a higher level of treatment than is provided by a typical on-site wastewater treatment system, or, the development rights from existing undeveloped open space controlled by the developer are transferred, in accordance with SCDHS standards. This would be subject to a zone-specific evaluation considering the extent and location of affected areas, resulting benefits and costs in relation to other management alternatives.

SCDHS Transfer of Development Rights standards should be re-evaluated to ensure protection of areas contributing recharge to surface water resources.

Existing Developed Areas

SCDPW should complete the alternative on-site wastewater management system pilot program.

The results of on-going SCDHS and planned SPDPW wastewater management studies should be used along with the GIS-mappings of areas contributing recharge to surface waters and relationships between density and nitrate levels developed during this study in a County-wide wastewater planning study that considers density, conventional and alternative wastewater treatment collection and treatment systems, alternative on-site systems, and operational and maintenance guidelines for existing on-site systems. Any additional high priority areas within the County where a new approach to wastewater treatment and disposal is required to protect surface water quality, ecosystems and coastal resiliency should be identified.

SCDHS OWM should continue to maintain active involvement with small sewage treatment plant system manufacturers, owners and operators, to maintain compliance with 10 mg/L nitrate effluent limits.

The effectiveness of Local Law 41-2007 in reducing groundwater nitrogen levels should be carefully evaluated and documented. If it does not achieve the objective of reducing fertilization by 10 to 25 percent, Peconic Estuary Program fertilization recommendations should be implemented on a County-wide basis.

Table 5-13
Surface Water Protection Recommendations (continued)

Farmers that participate in County preservation programs, purchase of development rights, and other programs should be required to participate, by agreement, in the AEM program and implement BMPs to reduce nitrogen release to surface waters.

Alternative pest management approaches or products should be identified to provide the agricultural community with safer alternatives to protect both groundwater quality and crops.

VOC Reductions

The SCDHS Office of Pollution Control "Reducing Toxics" capital program should be implemented to identify the sources of observed VOC contamination, develop an approach to reduce contaminant sources and investigate the role of household products. If residential areas are identified as significant sources, the County should respond by:

- Incorporating information on the types of household products that may contain VOCs, and preferred alternatives into the education and outreach program,
- Regulating the use and disposal of products with viable alternatives
- Incorporating information on appropriate use and disposal of household products using VOCs into the public education and outreach and school curricula development programs
- The SCDHS Office of Pollution Control should increase the frequency of facility inspection in accordance with their facility ranking system targets; inspection of facilities within the 25-year contributing area to surface water resources should be prioritized.

PPCPs

To the extent staffing permits, existing analytical methods should be expanded to increase the number of PPCPs analyzed to those identified on the CCL 3.

Findings from other jurisdictions should be reviewed and assessed to guide water management and policy decisions.

Public outreach and education efforts encouraging appropriate disposal of pharmaceuticals should be continued.

Table 5-13
Surface Water Protection Recommendations, continued

Surface Water Monitoring Programs

The existing Beach monitoring program should be continued to protect public health.

The existing Estuary Program Monitoring should be continued.

The Surface Water Monitoring program should be reinstated to assess the causes of use impairments, evaluate stream contributions to estuary contaminant loadings, to assess the relationships between ground and surface water quality, and to monitor the effectiveness of water quality improvement programs.

A study should be conducted to quantify nitrogen transformation and transport from groundwater to surface water bodies to better estimate the impacts of groundwater quality on surface water quality, and to better identify landside nitrogen reduction targets to achieve surface water quality goals.

SCDHS should support the development of TMDLs for impacted water bodies as necessary.

Database Development and Reporting

A new user-friendly, integrated geo-spatially referenced database should be developed to house all well, pumping, water quality, facility, discharge and surface water information.

SCDHS OWR should maintain the database and implement an approach to routinely share data and information with other stakeholders.

Reports on ground and surface water quality should be published annually.

Public Outreach and Education

SCDHS should coordinate with other Suffolk County departments, the three estuary programs and water suppliers to leverage public education and outreach concerning water resources protection, non-point sources, conservation, household hazardous waste, PPCPs, fertilization, etc. SCDHS should work with Suffolk County schools to integrate specific lesson plans into Earth Day and Earth Science curricula throughout the County.

5.7 Implementation

5.7.1 Implementation Framework

The framework for implementation of the surface water resource management recommendations is included in Section 9. The recommendations are intended to provide the framework to guide surface water quality protection in the years ahead, within the context of adaptive management. In addition, a comprehensive summary of estuary program recommendations can be found in Section 6 of this document.

Table 9-1 identifies the "owner", or entity responsible for initiating and coordinating implementation of each key milestone that must be achieved or action that must be taken to fully implement each recommendation, along with other stakeholders or collaborators whose participation will be required. The time frame for implementation of each recommendation is identified as short term (less than five years), medium (five to ten years) or long term (over ten years). Successful implementation of each recommendation is subject to a variety of variables, including funding availability, as well as other factors that will influence the timing of implementation, or even whether the recommendation can be fully implemented (e.g., community support). Most of the key activities associated with protection of surface water quality have already been initiated.

It is the County's intention that this table provide a flexible framework to guide water resource management, acknowledging that implementation of each recommendation is likely to be affected by changing priorities and opportunities and the availability of key resources, including funding. Because the County's surface waters are groundwater fed, implementation of recommendations to improve groundwater quality identified in **Table 9-1** will also help to improve surface water quality. Recommendations to implement wastewater management are explained in detail in Section 8 and a complete set of wastewater management recommendations may also be found in Section 9 of this Plan.

There are numerous direct and indirect costs and benefits associated with various Plan recommendations. A comprehensive analysis of these costs and benefits was out of the scope of this Plan, and should be further explored as implementation of individual recommendations is considered, to the extent practicable. Costs to improve surface water quality considered here are largely linked to the costs of improving the quality of the groundwater that provides a significant component of baseflow to the County's surface water features. In addition, funding will be required to implement a study to assess nitrogen transport/transformation from groundwater to surface water bodies so that the

impacts of groundwater contaminants upon surface water quality can be better quantified, and landside nitrogen reduction targets to achieve surface water quality goals can be established. The three recommended capital projects outlined in Section 3.7.1 and in Section 8 (development of a comprehensive wastewater management plan, the Reducing Toxics program and development of a GIS-based data management program) would also help to protect surface water quality.

Water quality management includes water quality protection through improved methods of collecting, organizing, evaluating and communicating data and facility inspections to County water resource managers and to other agencies and water purveyors. Prevention of releases of contamination to groundwater by improved and more efficient inspection, record keeping and communication helps to protect downgradient surface water resources, through prevention of contaminant releases.

Full implementation of Plan goals is a long-term process requiring coordination and collaboration with agencies and organizations on the federal, state, county and local level, a careful reevaluation of resource allocation issues, and will also necessitate exploring grant opportunities and other innovative and alternative funding mechanisms. Suffolk County should continue to work with state and federal agencies and stakeholders to explore implementation options to cost-effectively execute Plan recommendations.

5.7.2 Implementation Responsibilities

Responsibilities for many of the surface water resources management activities identified are currently shared by a number of agencies, on the federal, regional, state, county, town and local levels. With the regulatory authority provided in the Suffolk County Sanitary Code, SCDHS currently has the primary responsibility for continuing to implement many of the recommendations identified, such as monitoring beaches for the potential presence of pathogens (as indicated by the presence of enterococcus in marine waters). Other key collaborators who will support implementation efforts include SCDEDP, SCDPW, SCWA, USEPA, USGS, NYSDOH, NYSDEC, Towns, Estuary programs and Cornell Cooperative Extension of Suffolk County. Review of water quality data, the number of water body segments on the state's 303(d) list, and continued threats to the marine resources indicate that additional efforts and continued vigilance will be essential to protect and preserve the resources for continued use and enjoyment by future generations. It is essential that the County take a long term view with respect to water resource protection, as there will be no quick-fix solutions available if the current trends are permitted to continue.

The IBM Smarter Cities Report has recommended that water resource management responsibilities be centralized in a single authority. While many other agencies share responsibility for various aspects of water resources management, continue to play very significant roles in water resource protection, and may administer similar overlapping programs, it is recommended that a single agency have primary responsibility for program coordination. Clearly defined roles and responsibilities will help to ensure that the work is completed as required to protect the County's water resources. SCDHS has an established framework for beach and surface water monitoring and data collection, regulatory authority to monitor potential point sources of contamination, and the capability of using powerful tools such as computer models and GIS to evaluate most contemporary water resources issues.

Nonetheless, all agencies involved with water resources management must be responsible for sharing the information and the results of their evaluations to inform and guide programs being implemented under the auspices of County agencies, State and Federal regulators, Town and village governments, and water suppliers. Ready access to accurate information is increasingly important given the ramifications of land use and policy decisions that rely upon accurate and timely data and data interpretation.

5.7.3 Assessment Monitoring

Implementation monitoring has two objectives:

- To monitor implementation of the Plan recommendations, and
- To monitor the effectiveness of the Plan recommendations in achieving the Plan goals and objectives.

It is important to monitor the effectiveness of the Plan recommendations in achieving the stated goals and objectives, focusing on measures of progress that are quantifiable; the USEPA has reported that if indicators cannot be measured, then it is not possible to identify progress towards achieving goals. The effectiveness of these recommendations in achieving water resource protection goals and objectives will be assessed according to key performance indicators, also summarized in **Appendix K**.

Annual monitoring of Plan effectiveness and early assessments of Plan effectiveness will allow the County to modify their approach within an adaptive management framework and make improvements as necessary. The effectiveness of Plan recommendations in improving surface water quality, for instance, can be readily assessed by compiling and reviewing the surface water quality data that is collected by SCDHS and other estuary program

cooperators. Ineffective actions and programs should be discarded and those recommendations that are most effective can be further enhanced.

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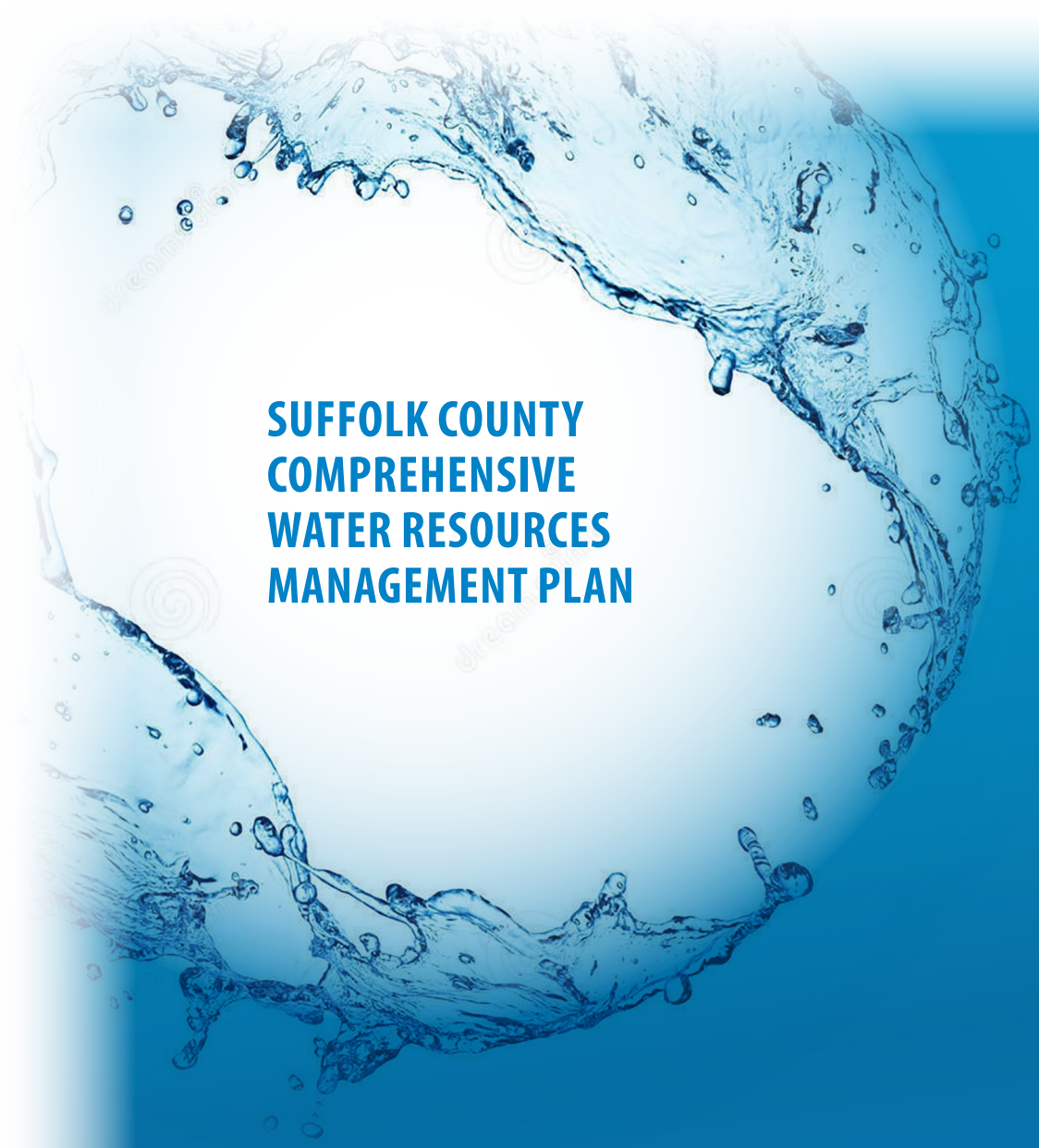


SUFFOLK COUNTY
COMPREHENSIVE
WATER RESOURCES
MANAGEMENT PLAN

Section 6
ESTUARY PROGRAMS

Section 6
Estuary Programs

6.1 Introduction

An estuary is a semi-enclosed coastal body of water that connects to the open sea. It is a transition zone where saltwater from the ocean mixes with fresh water from rivers and land, an area called the watershed. The amount of fresh water flowing into the estuary varies from season to season and from year to year. This variation, together with the daily rise and fall of the tides and the consequent movement of saltwater up and down rivers, creeks, and in embayments creates a unique environment. Estuaries are among the most productive of the earth's ecosystems. More than 80 percent of all fish and shellfish species use estuaries as a primary habitat or as a spawning and nursery ground. Estuaries also provide feeding, nesting, breeding and nursery areas for a wide variety of animals.

Suffolk County borders three major estuarine systems: the Long Island Sound to its north, the South Shore Estuary to its south, and the Peconic Estuary to its east as shown on **Figure 6-1.** All three local estuary programs draw their programmatic boundaries, sometimes called study areas, differently. The Long Island Sound Study (LISS) uses the surface water divide, as defined by USGS Hydrologic Unit Code 02030201, which follows the Harbor Hill moraine through Queens, Nassau, and Suffolk Counties. The Peconic Estuary Program (PEP) boundary is based on the shallow groundwater contributing area determined by Suffolk County and the United States Geological Survey (USGS). The South Shore Estuarine Reserve (SSER) boundary was most likely determined from a combination of watersheds within the Reserve, political boundaries and transportation routes.

Each of these estuaries is unique in both physical characteristics and ecosystem composition as summarized by **Table 6-1**. Wastewater discharges to the estuaries may be found in **Appendix I**. Separately, stakeholders around each of these waterbodies recognized their significance and developed watershed-based management structures to help protect and restore them (**Table 6-2**). Both the Peconic Estuary and the Long Island Sound were nominated and subsequently designated estuaries of national significance by the US Congress, making them part of the USEPA's National Estuary Program (NEP), under the authority of the Clean Water Act. The South Shore Estuary benefits from a similar stakeholder-driven watershed-based management partnership that is designated the South Shore Estuary Reserve by New York State executive law.

SECTION 6 ESTUARY PROGRAMS

Table 6-1 Physical Characteristics of Suffolk County's Three Main Estuaries

Water Body	Length	Surface Area	Mean Depth	Volume
Peconic/Gardiners Bays	~ 40 km	~ 110,000 acres	>> 4.0 m	~ 1.2 billion m^3
Great South Bay	~ 40 km	~ 58,000 acres	<< 2.0 m	~ 0.27 billion m^3
Long Island Sound Estuary	~ 177 km	~ 845,000 acres	~ 20 m	~ 68 billion m^3

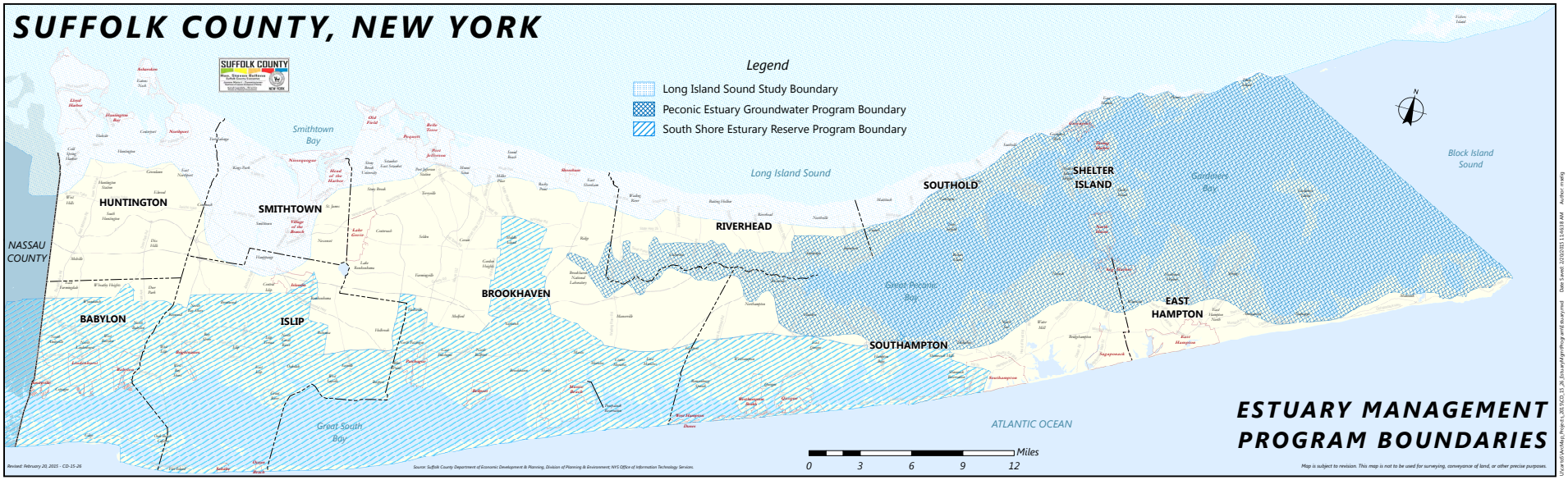
Table 6-2 Watershed-based Management Programs in Suffolk County

Water Body	Program Founded	CCMP	Management Chair	Enabling Legislation
Peconic Estuary Program	1992	2001	US EPA	§320 Clean Water Act
South Shore Estuary Reserve	1993	2001	US EPA	Article 46 NYS Executive Law
Long Island Sound Study	1985	1991; 2014 (draft)	NYS Dept. of State	§320 Clean Water Act

Each NEP and the SSER have a Management Conference (MC) made up of diverse stakeholders including citizens, local, state, and Federal agencies, as well as non-profit, academia, and private sector entities. Using a consensus-building approach and collaborative decision-making process, each MC works closely together to implement the Comprehensive Conservation and Management Plan (CCMP). The MC ensures that the CCMP is uniquely tailored to the local environmental conditions, is based on local input, and supports local priorities.

The benefits of this watershed-based management approach are numerous, and include the ability to generate public support and leverage skills and funding for regional priorities. One study[i] found the networks in NEP areas span more levels of government, integrate more experts into policy discussions, nurture stronger interpersonal ties between stakeholders, and

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Commu



Suffolk County Department of Economic Development & Planning
Estuary Management Program
Boundaries

Suffolk County Comprehensive Water Resources Management Plan

Figure 6-1

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create greater faith in the procedural fairness of local policy than other comparable estuaries (Schneider et al. 2003).

Suffolk County has historically enjoyed very different levels of involvement in these three different programs. Suffolk County was the primary force behind the Peconic Estuary's nomination to the NEP. Since its inception, Suffolk County has not only been a member of the Management Conference, but also hosted the PEP program Office, and administered much of the federal funding on behalf of the program partners. Because the Peconic Estuary sits entirely within Suffolk County's borders, the county had taken a leadership role in many of its initiatives as well. Historically Suffolk County Involvement in PEP has been coordinated through the Department of Health Services.

The Long Island Sound Study is a much larger program, spanning multiple states, and Suffolk County constitutes only a small percentage of its watershed. Involvement of Long Island municipalities in the LISS is generally coordinated through New York State; Suffolk County has not historically been heavily involved in that program.

The South Shore Estuary Reserve program includes Suffolk County on its Reserve Council. In recent years, the SSER has suffered from lack of leadership after its director retired, and staff and attention have been diverted to Superstorm Sandy recovery programs for more than two years, but the NYS DOS hopes to re-invigorate this program during 2015. Historically Suffolk County involvement in SSER has been coordinated through the Department of Economic Development and Planning.

All three programs have similar missions to protect and restore the environmental quality of their respective estuaries. Although each has a long list of locally specific CCMP implementation actions, there are several elements in common, which are also common to Suffolk County's Reclaim Our Waters initiative. Primarily, those include reduction of nitrogen loading to ground and surface waters and protection and restoration of the natural infrastructure that makes our coasts resilient to the impacts of storms and climate change, such as wetlands, seagrass meadows, and healthy sustainable fisheries.

6.2 The Peconic Estuary

6.2.1 Introduction

The Peconic Estuary, situated between the North and South Forks of eastern Long Island, New York, consists of more than 100 distinct bays, harbors,

embayments, and tributaries. The Peconic Estuary System includes the Peconic Estuary and those land areas that contribute groundwater and stormwater runoff to the Peconic River and Estuary, known as the watershed. The Peconic watershed, which includes the areas that contribute groundwater, surface water and stormwater runoff to the estuary, covers an area of 196 square miles. Over 125,000 acres of land and 158,000 acres of surface water are a part of the Peconic Study Area.

The Peconic Estuary supports commercial and recreational fin and shell fishing, although the once abundant Peconic Bay Scallop populations have decreased dramatically during the last 30 years as shown on **Figure 6-2**, resulting in a dwindling population of local "baymen" fishing the waters of the Peconic Bays. Tourism and recreation are central to the local economy, including businesses such as restaurants and marinas that cater to recreational

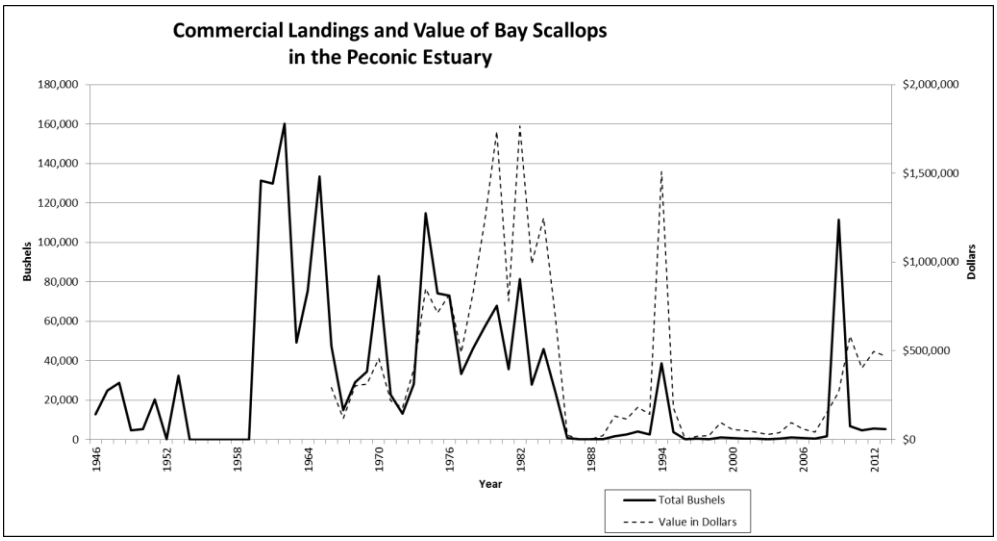
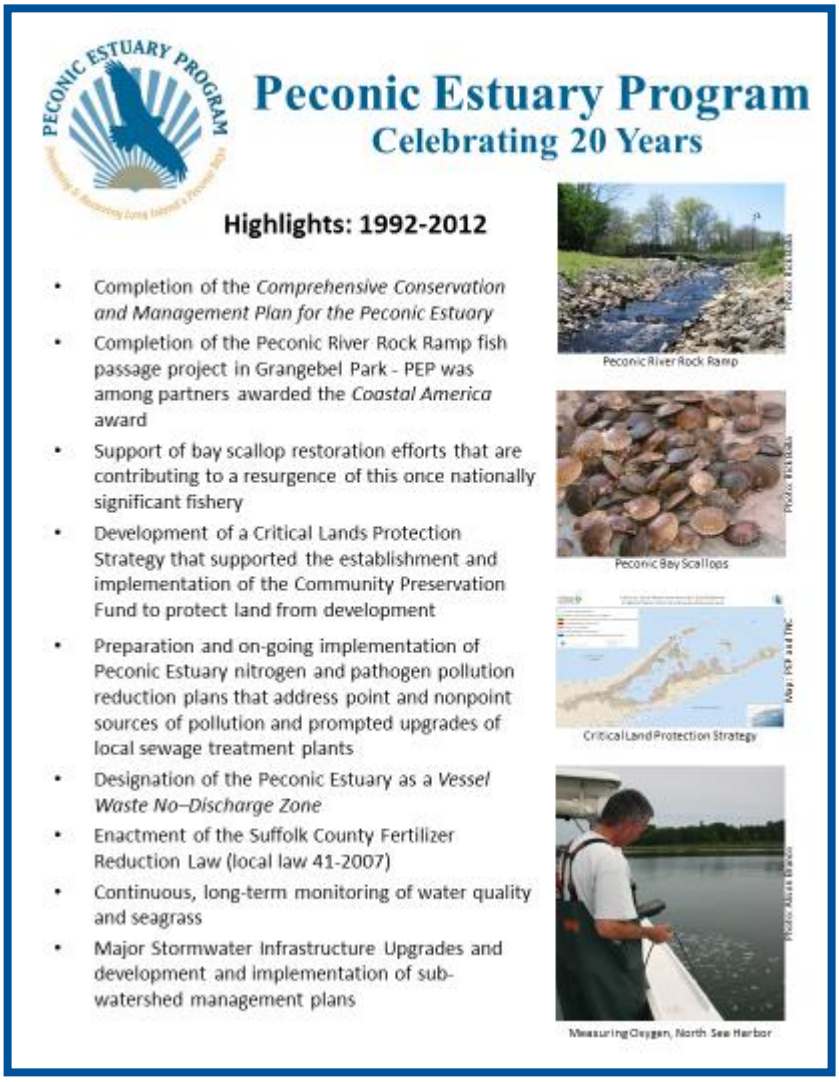


Figure 6-2 Commercial Landings and Value of Bay Scallops from the Peconic Estuary

fishermen, boaters, bathers, hunters, and nature enthusiasts. In 1993, more than 1,100 establishments were identified as "estuarine dependent" and gross revenues for these establishments exceeded $450 million per year (equal to approximately $680 million in 2014). More than 7,300 people were employed in these businesses, with a combined annual income of more than $127 million (equal to approximately $192 million in 2014).

The estuary system features numerous rare ecosystems that are home to many plant and animal species, including several nationally and locally threatened

and endangered plants and animals. The Nature Conservancy has designated the Peconic Estuary System as one of the "Last Great Places" in the Western Hemisphere.



6.2.2 Problem Identification

The Peconic Estuary suffered from a series of harmful algal blooms during the 1980's, devastating eelgrass and shellfish populations, and drawing the region's attention to the water quality in the Peconic Bays. After a Suffolk County led effort to nominate it, in 1992, the Peconic Estuary became the 20th estuary in the nation to receive the designation as an "Estuary of National Significance" by the U.S. Congress, making it part of the US Environmental Protection Agency's (USEPA's) National Estuary Program (NEP). This created the Peconic Estuary Program (PEP), an innovative partnership of local, state, and federal governments, citizen and environmental groups, businesses and industries, and academic institutions tasked with developing a comprehensive, watershed-based management plan to protect and restore the environmental quality of the Peconic Bays. Suffolk County hosts the Peconic Estuary Program Office within its Department of Health Services, Division of Environmental Quality, and has taken a leadership role in the program's implementation for much of its history.

The PEP ***Comprehensive Conservation and Management Plan*** (CCMP) was formally approved on November 15, 2001 by EPA Administrator Christine Whitman, with the concurrence of New York State Governor George Pataki. This plan contains 340 management actions, organized around priority topics including "brown tide", nutrients, habitat and living resources, pathogens, toxic pollutants, and critical lands protection. The CCMP also addressed management and financing for CCMP Implementation and public education and outreach.

In 2015, the Peconic Estuary Program will begin the process of updating this CCMP, adjusting the goals and implementation strategies to adapt to current circumstances, and adding new or emerging concerns that were not included in 2001, such as climate change and coastal resiliency.

The Peconic Estuary Watershed includes portions of six Suffolk County towns (Brookhaven, Riverhead, Southold, Southampton, East Hampton, and Shelter Island) and four villages (Greenport, Deering Harbor, North Haven, and Sag Harbor. The year-round population within the watershed is approximately 100,000, but nearly triples during summer.

Although open space protection has been extremely successful on the East End of Long Island, thanks to programs like the Pine Barrens Protection Act and the Community Preservation Fund, the year-round and seasonal populations put pressure on the area's natural resources and impact water quality. The primary ecological concern in the Peconic watershed is excess nitrogen loading, coming primarily from wastewater and fertilizer (Lloyd, 2014; Total Maximum Daily Load for Nitrogen in the Peconic Estuary Program Study Area, NYSDEC 2007 and Peconic Estuary TMDL Review, USEPA, 2013). This excess nitrogen loading contributes to hypoxia in the Western Estuary and fuels the frequent, and sometimes severe, harmful algal blooms (HABs) that now occur annually in the Peconic Estuary. These contribute to declines in eelgrass habitat and reduced populations of shellfish. Some HABs can even pose a public health threat.

6.2.3 Goals and Objectives

Broadly, the goals of the Peconic Estuary Program were, and still are (***Peconic Estuary Program,*** 2001, pg. 1-2):

- Ensure a healthy and diverse marine community; optimizing opportunities for water dependent recreation.
- Promote the social and economic benefits, which have been associated with the Peconic Estuary System.
- Establish a comprehensive water quality policy, which ensures the integrity of marine resources, habitat, and terrestrial ecosystems while supporting human activities in the Peconic Estuary study area.
- Ensure an effective technical, regulatory, and administrative framework for the continued monitoring and management of the Peconic Estuary study area.

- Achieve zero discharge (from point and nonpoint sources) of toxic pollutants, and particularly of bio-accumulative chemicals.
- Promote an understanding and, thus, appreciation of the value of the Peconic Estuary as an ecosystem and as a mainstay to the East End economy so that it is preserved and restored as one of the last great places in the Western Hemisphere.
- Involve the many and diverse stakeholders in the Peconic Watershed regarding the implementation of the CCMP and in the future direction and decisions affecting the estuary.

In 2013, the PEP Management Conference held a strategic planning session, in which they determined that accelerating the implementation of the Nitrogen TMDL should be the top priority for CCMP implementation for time period 2013-2018. This would involve some new work to allocate the loads among the various sources contributing nitrogen to the estuary via groundwater, and then an update to the TMDL implementation plan to better address the non-point source loads. In 2014, Suffolk County Executive Steven Bellone declared nitrogen reduction to be the top priority of his first administration as well, highlighting the link between water quality and resilient coastlines. Later in 2014, NY State Governor Cuomo also committed to helping Long Island reduce its nitrogen pollution and increase its coastal resiliency. Also during this period, many of Long Island's environmental advocacy organizations joined forces to develop an aggressive media and public information campaign focused on nitrogen pollution.

With the strategic focus of these various entities converging, opportunities for renewed collaboration and join goal setting are abundant. The Peconic Estuary Program was originally created to act as the forum for the kind of joint planning and management that is necessary to finally address the more difficult aspects of nitrogen load reduction on Long Island's East End: on-site wastewater treatment and fertilizer from developed areas and agriculture.

The most important focus areas shared by the Peconic Estuary Program CCMP and Suffolk County's "Reclaim Our Waters" initiative include:

- Wastewater Infrastructure

– Suffolk County is preparing to begin a county-wide wastewater planning study that will help determine which areas are most appropriate for various types of wastewater infrastructure and propose mechanisms to fund and manage the substantial infrastructure upgrades that will be necessary to protect our surface waters from nitrogen pollution. In the Peconic watershed, where 90% of homes utilize on-site wastewater treatment, this will necessitate collaboration among federal, state, county, and local governments to develop funding mechanisms to upgrade these systems. The Peconic Estuary Program can serve as the central planning entity that brings these agencies together and helps towns plan their wastewater management strategies and seek funding to subsidize or incentivize upgrades. The Estuary Program partners can also use the program structure and technical support to help standardize policies and codes across jurisdictions.

- Agricultural Nutrient Loading

– Suffolk County, and many partners, including the Peconic Estuary Program have set out to update the Agricultural Stewardship Plan for Suffolk County. This document will outline goals and recommendations for implementation of programs within the agricultural industry in Suffolk to help farmers reduce their impacts on surface waters while maintaining their profitability.

- Wetlands Restoration & Protection

– Good water quality is critical to maintaining healthy seagrass and wetland populations in our coastal bays and harbors, which are an essential line of defense from coastal storms, rising sea level, and other climate impacts. Both Suffolk County and the Peconic Estuary Program are working to restore degraded wetland and seagrass habitats, and to protect those that remain.

– Suffolk County has initiated a project, in partnership with NY Sea Grant, to develop a plan for monitoring, research, and management of HABs in Suffolk County. PEP staff and partners, including the New York State Department of Environmental Conservation (NYSDEC) and PEP Technical Advisory Committee members, will participate in this process. The resulting plan will inform the update to the PEP CCMP's HAB chapter (formerly called "brown tide"), and PEP will work with its partners to implement the recommendations.

6.2.3.1 Existing Metrics

The Peconic Estuary includes three identified nitrogen impaired water bodies: Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries. In 2007, New York State developed a TMDL for the Peconic Estuary, which sets load reduction targets designed to alleviate hypoxia in the impaired segments. New York State and its partners in the Peconic Estuary Program seeks to have the TMDL fully implemented by 2022. Using modeling, the submittal calculated that in the average pre-implementation year, 5,357,364 pounds of nitrogen entered the Peconic Estuary. According to TMDL modeling, most of this nitrogen, 56%, results from atmospheric deposition. An estimated 41% comes from groundwater (integrating inputs primarily from fertilizer use and on-site wastewater disposal systems), 1% from the Peconic River and seven western tidal creeks, and 1% from three sewage treatment plants.

This document contains discharge limits for permitted point-source discharges of nitrogen into the Peconic Estuary, which were later codified in State Pollution Discharge Elimination System (SPDES) permits issued by NYSDEC, and voluntary suggested reductions for non-point sources. The practical load reduction scenario recommended included a 37.5% reduction from all sources during winter, and a 42.3% reduction from all sources during summer.

The pace of implementation does not appear to be sufficient to meet these goals. In order to achieve the goals of the TMDL by 2022, the pace of implementation will need to be accelerated. Unfortunately, the 2007 TMDL and associated documentation did not provide detailed information on nonpoint source loads for particular sources or land use activities, such as agricultural operations, residential fertilizer use, on-site wastewater disposal systems and golf courses. To some degree, this has made it difficult in the implementation phase to assess the relative priority of sources. It is also important to continue to monitor surface water, groundwater, atmospheric deposition and point sources so that loads, current conditions and trends can be determined and evaluated. Further, there are other important environmental endpoints that are related to nutrient loads that were not fully addressed in this TMDL which emphasized achieving dissolved oxygen standards. These include the presence of harmful algal blooms (both micro algae and macro algae), direct impacts on eelgrass, and achieving human health drinking water standards. The role of nitrogen in these and other endpoints should continue to be evaluated.

The two largest sources of nitrogen to the estuary are atmospheric deposition, which accounts for 56% of the nitrogen, and groundwater which accounts for 41% of nitrogen loading. The EPA has estimated that atmospheric deposition

levels will be below the TMDL target by 2022. Most of the nitrogen in groundwater comes from either onsite wastewater treatment systems or fertilizer. The Peconic Estuary Program Management Committee has created a Nitrogen Workgroup, with members of the Technical Advisory Committee, to refine the allocation of loads and revise the TMDL implementation plan based on this new information. Recent modeling, conducted by the Nature Conservancy (Lloyd, 2014) using Valiela et al.'s NLM model (Valiela et al, 1997), focused on land-based loadings (leaving out the direct-to-water atmospheric deposition in the open bays) and quantifying the sources that contribute to the groundwater-based loads. This study indicates that 24% of the land-based load comes from atmospheric deposition, 26% from fertilizer (including 16.7% from agriculture, 5.7% from lawns, and 4% from golf courses), 6.6% from sewage treatment plans, and 43% from on-site wastewater treatment. This study supports the regional focus on non-point source load reduction, and the investments being made by New York State and Suffolk County in on-site wastewater treatment upgrades.

The TMDL includes other considerations that can be important for managing nutrients, such as shellfish restoration and eelgrass restoration; though no load allocations or reductions are cited. These should also be considered during the update of the implementation plan, as should consideration of other potential bases for nitrogen reduction targets, such as eelgrass health and HABs.

6.2.4 Recommendations

6.2.4.1 Nitrogen: "Public Enemy Number One"

In 2013, PEP's Management Conference agreed that reducing the non-point source nitrogen loading to the Peconic Estuary was the top short-term priority. ***Suffolk County's most important role in implementing the regionally agreed-upon goals articulated in the PEP CCMP is to improve the regulations and incentives that determine non-point source nitrogen loading from on-site wastewater treatment.*** During 2014, Suffolk County began a major initiative to address this, the largest source of nitrogen loading to the Peconic Estuary. It is essential that the county's numerous new initiatives to allow, incentivize, and eventually require improved on-site wastewater treatment throughout the Peconic Estuary watershed continue to progress.

The Peconic Estuary Program's role in this process includes:

- Engagement of the stakeholders on the east end, including local governments and citizens

- Incorporation of East End-specific considerations into Suffolk County's assessment of alternative onsite wastewater treatment systems and the development of a County-wide Wastewater Management Plan

- Public outreach and education about on-site wastewater treatment impacts to the Peconic to generate public support for upgrade initiatives

- Collaboration with Local Government, Suffolk County, New York State and Federal partners to seek funding for incentive programs and technical assistance, and to cultivate legal and policy mechanisms to generate public funding for the necessary upgrades.

- Technical support for Suffolk County efforts from PEP staff and voluntary Technical Advisory Committee members.

In addition to this single most important role, Suffolk County is a key partner in the implementation of many PEP CCMP goals. Below includes CCMP Action items in the high priority categories of HABs, Nitrogen Load Reduction, Habitat and Living Resources, and Pathogen Load Reduction, followed by specific recommendations for the most effective and high priority activities that Suffolk County and PEP will need to collaborate on over the next five to ten years.

6.2.4.2 Nutrients

Collaborative action priorities for Suffolk County regarding nutrients are:

PEP CCMP Actions Re: Nutrient Inputs

N-1. Continue to Use and Refine Water Quality Standards and Guidelines.

N-2. Preserve Water Quality East of Flanders Bay.

N-3. Implement a Quantitative Nitrogen Load Allocation Strategy for the Entire Estuary.

N-4. Control Point Source Discharges from STPs and Other Dischargers.

N-5. Implement Nonpoint Source Control Plans.

N-6. Use Land Use Planning to Control Nitrogen Loading Associated with New Development.

N-7. Ensure that Funding Is Distributed Evenly Between Preservation and Mitigation Projects.

N-8. Integrate PEP Recommendations into Other Programs.

N-9. Sponsor and Coordinate Research and Information Gathering.

N-10. Monitor Conditions within the Estuary System to Determine the Effectiveness of Management Strategies.

- The Peconic Estuary Program has created a Nitrogen Workgroup to re-examine the Nitrogen TMDL and recommend updates to the implementation plan. As that update process progresses, Suffolk County should be actively involved in the development and implementation of those recommendations, particularly with respect to on-site wastewater treatment.

- Suffolk County has embarked on an effort to update its Agricultural Cornell Cooperative Extension and the agricultural producers. This effort should continue and the implementation of the revised plan should be prioritized for funding through County mechanisms and other external sources. PEP should collaborate with county agencies and other partners to seek funding.

- The majority of point-source nitrogen loads to the Peconic Estuary have been reduced, including all of the large sewage treatment plants (STPs). The final remaining improvements needed include the Riverhead STP (which began final upgrades in 2014, with a great deal of funding from Suffolk County) and the Crescent Duck Farm. The PEP and Suffolk County should continue to provide technical and logistical assistance to New York State and the owners to ensure that these point-source upgrades are completed and the associated load reductions are achieved.

- It is recognized that current drinking water safety standards are not sufficient to protect surface waters from nutrient loading. Suffolk County and New York State should work together to continue to evaluate the utility of more restrictive groundwater discharge standards with respect to nitrogen concentrations. They should also consider whether the application of such standards should be extended to a broader range of effluent sizes and types (e.g. individual on-site wastewater treatment systems, agricultural inputs, etc.).

- Suffolk County and PEP should continue to support the Riverhead Sewage Treatment Plant's effort to develop a system to re-use effluent for golf course irrigation at Suffolk County's Indian Island Golf Course.

- PEP has created an inter-municipal coalition of municipalities, including Suffolk County, within the Peconic Estuary watershed who will work together to implement stormwater and nitrogen focused water quality improvement projects. It is important for PEP to

remain engaged with this coalition, and for the County to continue to fund its membership and support the collective efforts.

- PEP and Suffolk County have partnered to develop Subwatershed Management Plans for impaired subwatersheds within the Peconic Estuary, which present conceptual designs and costs for stormwater retrofit projects. These plans should continue to be developed, and their implementation should be prioritized for County and State funding. The PEP should continue to promote green infrastructure solutions that provide more pathogen, and nitrogen, treatment upon infiltration, and Suffolk County should model these best management practices in their own stormwater management program.

- With the assistance of the PEP, Suffolk was among the first in the nation to implement fertilizer use reduction laws. Those regulations need to be re-evaluated for effectiveness and more stringent rules, perhaps governing sales or application rates, should be considered.

- Suffolk County has succeeded in integrating PEP priorities into existing environmental protection programs and priorities (e.g. Water Quality Protection and Restoration Program), but as time has passed and decision makers have turned over, widespread knowledge about the PEP within County government has decreased. Suffolk County and PEP should collaborate to educate county officials, legislators, and advisory committees about the PEP and its role in protecting assets of value to the county, such as surface water quality and coastal habitats.

- Suffolk County is the primary agency responsible for monitoring water quality in the Peconic Estuary. This monitoring effort has become more and more difficult to fund over the years, with the county relying more heavily on federal grant funds to support that effort. The value of this professional and long-term data set is widely understood. PEP and Suffolk County should work with partners who value these data to cultivate enhanced and stable funding for monitoring programs.

- While a great deal of water quality monitoring is occurring, reporting is irregular and sometimes non-existent. PEP must work to require regular reporting as a condition of funding for water quality monitoring. Suffolk County should work to develop regular reporting and analysis mechanisms and develop the necessary skill sets within their existing staff.

PEP CCMP Actions Re: Harmful Algal Blooms

B-1. Ensure Continued Brown Tide Monitoring, Research, Coordination, and Information Sharing (PEP CCMP, 2001)

PEP CCMP Actions Re: Habitat and Living Resources

HLR-1 Use Critical Natural Resource Areas (CNRAs) to Develop and Implement Management Strategies to Protect High Quality Habitats and Concentrations of Special Emphasis.

HLR-2 Manage Shoreline Stabilization, Docks, Piers, and Flow Restriction Structures to Reduce or Prevent Additional Hardening and Encourage Restoration of Hardened Shorelines to a Natural State.

HLR-3 Assess the Impacts of Dredging Activities on Habitat & Natural Resources & Develop Recommendations & Guidelines for Reducing Impacts.

HLR-4 Examine & Promote Methods of Shellfish Harvesting that are Most Compatible with Establishment & Growth of Eelgrass Beds & Vegetated Salt Marshes.

HLR-5 Implement, Enforce, and Encourage the Continuation of Current Policies & Regulations Protective of Wetlands.

6.2.4.3 Harmful Algal Blooms (HABs)

PEP CCMP Actions re: HABs:

Collaborative action priorities for Suffolk County re: **HAB**s are:

- Suffolk County and PEP should continue to work together and with NY Sea Grant to develop a HAB Research, Monitoring and Management Plan.
- Once this plan is completed, Suffolk County and PEP should collaborate to prioritize funding for the resultant recommendations, and to promote their implementation throughout the watershed. It is understood that reduction of nitrogen loading is a necessary management measure that will be recommended during this process, so all recommendations related to that goal will help further this one as well.

6.2.4.4 Habitat and Living Resources

PEP CCMP Actions re: Habitat and Living Resources:

Collaborative action priorities for Suffolk County re: **HABITATS:**

- Suffolk County should continue to support the Suffolk County Aquaculture Lease Program in Peconic and Gardiners Bay. The PEP supports this effort through the Program Director's representation of the Department of Health Services on the Aquaculture Lease Board, by promoting local awareness and support for the program through its public education and outreach initiatives, and by providing technical and project management support to the evaluation of the program and the design of its associated monitoring plan.
- Historically, Suffolk County has implemented many habitat restoration projects on county lands, and financially supported other habitat restoration efforts through capital improvement programs, Water Quality Protection and Restoration Program funding, and by incorporating PEP Habitat Restoration Plan activities in routine maintenance programs. This support for habitat restoration program should continue, and additional ways to prioritize projects of regional significance, such as those listed in the PEP Habitat Restoration Plan, should be sought.

PEP CCMP Actions Re: Habitat and Living Resources

HLR-6 Evaluate Effectiveness of Current Policies in Preserving Eelgrass Habitat & Develop Ways to Provide Increased Protection for Extant Eelgrass.

HLR-7 Develop and Implement an Estuary-Wide Habitat Restoration Plan (HRP).

HLR-8 Develop and Implement Specific Restoration Projects.

HLR-9 Monitor and Evaluate the Success of Restoration Efforts.

HLR-10 Develop an Aquaculture Plan for the Peconic Estuary.

HLR-11 Determine the Suitability of Artificial Reefs in the Peconic Estuary.

HLR-12 Foster Sustainable Recreational and Commercial Finfish and Shellfish Uses of the Peconic Estuary that are Compatible with Biodiversity Protection.

- The PEP regularly collaborates with the Department of Economic Development and Planning (DEDP), and the Department of Public Works (DPW) Vector Control Unit on wetland restoration projects. One project, now in the design phase, at Indian Island County Park will be a significant accomplishment for those groups, creating important wetland habitat in the most impaired western Peconic Estuary, while serving as the first demonstration of Tier 15 of the Suffolk County Wetland Stewardship Strategy.

- Suffolk County and PEP have long collaborated on eelgrass restoration efforts in the Peconic Estuary. As these efforts progress, it will be critical to continually evaluate restoration success and feasibility in the face of warming waters and degraded water quality.

- In the face of rising sea level and increasing storm frequency and severity, the value of wetland and seagrass buffers in protecting coastal properties and residents has come to the forefront of the public consciousness, as well as funding priorities. Suffolk County and PEP should collaborate to take advantage of this opportunity to accelerate the pace of seagrass and wetland restoration.

- While PEP and its local partners have made some strides in preventing new shoreline hardening, climate change impacts and storm recovery efforts have worked to reverse that progress. Suffolk County and PEP should continue to engage regulatory authorities on this issue, promote the benefits of living shorelines, and create demonstration projects on county lands.

PEP CCMP Actions Re: Habitat and Living Resources, continued:

HLR-13 Protect Nesting and Feeding Habitat of Shorebirds.

HLR-14 Protect Sea Turtles and Marine Mammals.

HLR-15 Utilize Land Use Planning, BMPs, and Other Management Measures to Reduce the Negative Impacts of Human Uses and Development on the Estuary System.

HLR-16 Develop and Implement a Living Resources Research, Monitoring, and Assessment Program.

HLR-17 Establish a Working Group to Examine the Role of Grazers and Filter Feeding Organisms in Influencing Water Quality and Productivity to Better Understand Food Web Dynamics and to Develop Management Applications.

6.2.4.5 Pathogens

PEP CCMP Actions re: Pathogen Management:

Collaborative action priorities for Suffolk County re: **PATHOGENS**:

Pathogen management is an area where PEP and its partner organizations have made a great deal of progress. The NYSDEC has issued fairly stringent MS4 general permits and worked to regulate most municipalities within the Peconic Estuary watershed, the Peconic Estuary was designated a no-discharge zone, treatment upgrades have been installed at the last remaining duck farm on Long Island, and sanitary codes were made more stringent.

However, pathogen impairments continue to exist in many areas, necessitating a re-examination of controls on non-point sources.

PEP CCMP Actions Re: Pathogen Management

P-1 Use Existing or Implement New Stormwater Management Regulations to Control Pathogen Loading and Other Forms of Nonpoint Source Pollution.

P-2 Develop Land Use Regulations that Eliminate or Minimize New Sources of Stormwater Runoff.

P-3 Use Construction Site Guidelines which Eliminate or Minimize Stormwater Runoff.

P-4 Develop Land Use Regulations that Eliminate or Minimize New Sources of Stormwater Runoff.

P-5 Demonstrate and Implement Technologies to Remediate Stormwater Runoff.

P-6 Enhance Existing Septic System Controls and Implement New Best Management Practices.

P-7 Provide Pumpout Facilities and Encourage their Use.

P-8 Establish Vessel Waste No Discharge Areas.

P-9 Use Administrative and Regulatory Measures to Control Pollution from Boaters and Marinas.

- Cesspools and septic systems that do not conform to modern standards are still abundant due to "grandfathering" provisions in the sanitary code. Because a great deal of the Peconic Watershed, especially along the coast, was developed before newer sanitary standards were in place, this remains a largely un-measured, but potentially important source of pathogens. It is imperative that New York State and Suffolk County work together to quantify this potential threat and then revise codes and policies appropriately to handle those residential sources that were not address by updating the sanitary code.

- Stormwater MS4 permitting addresses only surface water discharges of stormwater. While that works well in many areas, the relatively permeable soils of Long Island allow easy groundwater infiltration of stormwater, with little or no treatment. Near the coastline, where groundwater travel times are insufficient to diminish pathogen loads, this creates another potential non-point source, which is unregulated under the current system. PEP and Suffolk County have partnered to develop Subwatershed Management Plans for impaired subwatersheds within the Peconic Estuary, which present conceptual designs and costs for stormwater retrofit projects. These plans should continue to be developed, and their implementation should be prioritized for County and State funding. The PEP should continue to promote green infrastructure solutions that provide more pathogen, and nitrogen, treatment upon infiltration, and

PEP CCMP Actions Re: Pathogen Management, Continued

P-10 Promote the Use of Best Management Practices to Control Pathogen Loadings from Marinas, Mooring Areas, and Boatyards.

P-11 Ensure Adequate Disinfection at Sewage Treatment Plants.

P-12 Monitor Effluent from the Corwin Duck Farm.

P-13 Identify Sources and Loadings of Nonpoint Sources of Pathogens.

P-14 Develop and Implement Nonpoint Source Control Plans for Pathogens.

P-15 Obtain Funding to Address Stormwater Runoff.

P-16 Conduct Water Quality Monitoring.

Suffolk County should model these best management practices in their own stormwater management program.

- PEP has created an inter-municipal coalition of municipalities, including Suffolk County, within the Peconic Estuary watershed who will work together to implement stormwater and nitrogen focused water quality improvement projects. It is important for PEP to remain engaged with this coalition, and for the County to continue to fund its membership and support the collective efforts through its stormwater management program.

- Suffolk County's Beach and water quality monitoring programs are critical to quantifying the pathogen impairments that exist in the Peconic Estuary, to nominating waters to be designated as impaired by NY State. This monitoring should be continued and supported by Suffolk County funding and Federal grants, like the Beach Act grant.

6.2.5 Implementation

Large-scale reduction of non-point source nitrogen loads to the Peconic Estuary, and the other high priority recommendations discussed above, will require substantial financial and human resources. Options for the implementation of the type of large-scale, integrated wastewater and drinking water management system that will be necessary to solve our region's non-point source pollution problems are discussed in chapters 1, 2, 3, 5, and 7. The discussion below summarizes the programmatic infrastructure and funding opportunities that are created or enhanced through Suffolk County's partnership in the Peconic Estuary Program, a federally-funded NEP. It should be noted that many of these advantages are applicable to the Long Island Sound Study (LISS, also an NEP) and the South Shore Estuary Reserve (SSER, a New York State program) as well.

6.2.5.1 Programmatic Mechanisms

The National Estuary Program was founded on the principle that water quality protection is best achieved by managing on a watershed scale, with all levels of government collaborating with one another, and with a diverse range of stakeholders impacting and impacted by water quality. The Peconic Estuary Program Management Conference structure facilitates this collaborative management. The PEP Management Conference offers regular opportunities for the USEPA, NYSDEC, Suffolk County, and local government to meet along with representatives of the Citizens Advisory Committee and Technical Advisory Committee. It is essential that this structure and the associated opportunities for regular communications, are used to keep all levels of government informed about one-another's efforts toward CCMP

implementation. It is also an opportunity to engage the technical community, and leverage technical expertise between levels of government. Additionally, the robust stakeholder engagement offered by the PEP Management Conference, Citizens Advisory Committee, and Public Education and Outreach Programs offer the opportunity to build citizen support for regional and local initiatives. All of the government entities who partner on the Peconic Estuary Program, including Suffolk County, should make use of this stakeholder engagement framework to develop programs that reflect local priorities and have community support.

Beyond the Peconic Estuary Program's own Management Conference structure, the PEP has worked with local communities to develop additional collaborative mechanisms. Most significantly, all 6 towns and 3 of the villages within the Peconic Estuary watershed, plus Suffolk County and New York State's Department of Transportation have initiated an Inter-municipal Agreement (IMA) which allows these municipalities to jointly fund a coordinator, seek outside funding, and collaboratively implement water quality improvement initiatives. This coalition intends to work together on the many stormwater management program elements that benefit from consistency across jurisdictional boundaries and economies of scale. Beyond stormwater management, the group intends to seek opportunities to jointly examine other water quality issues, especially on-site wastewater management. The IMA provides the legal mechanism for these municipalities to jointly implement optional and required water quality management efforts, fund a coordinator and other join activities, and to jointly apply for external funding. The annual

Both of these collaborative mechanisms provide opportunities for coordination among agencies, regular meetings focused on water quality interests, the ability to solicit technical expertise and public input. Because all of Suffolk County's "Reclaim Our Waters" initiatives can benefit from engagement in these activities.

6.2.5.2 Funding Mechanisms

Inter-municipal Agreement (IMA)

As mentioned above, the IMA among east end towns, villages, Suffolk County and New York State provides a mechanism for joint funding of coordination and collective activities. This joint funding is accomplished via a dues structure, and is currently limited to a maximum total budget of $100,000. While the dues funds could provide funding for water quality initiatives, the more significant opportunity provided by the IMA is the ability of these municipalities to leverage local funding and jointly apply for external funding. Other similar coalitions on Long Island, such as the Hempstead Harbor

Protection Committee, have received many millions of dollars in grants for water quality and related public outreach initiatives through a similar mechanism.

Community Preservation Fund

The Community Preservation Fund is a real-estate transfer tax of 2% applied in the five East End towns, all of which intersect the Peconic Estuary watershed. This fund was initially developed, through NY State legislation, with the involvement of the Peconic Estuary Program partners, including Suffolk County, as a mechanism to purchase open space on the East End to protect community character, including safe drinking water and healthy coastal ecosystems. This fund generates millions of dollars annually. Because of its success, the availability of quality parcels for purchase is beginning to diminish. As the East End towns begin to examine the future of this program, they will likely consider whether stewardship of preserved lands and other water quality improvement initiatives could be eligible uses of this fund in the future. The Peconic Estuary Program has begun to discuss this opportunity with the East End towns and intends to continue working with interested towns as they develop recommendations for any future changes to this program.

Watershed Improvement Districts

Currently, Long Island towns have the authority, via New York State legislation, to designate *Watershed Improvement Districts*, subject to referendum, to generate tax revenue for the purposes of water quality protection. The New York State legislature has discussed similar legislation that would give this authority to Suffolk County as well, but that has not yet been enacted. The watershed improvement district concept presents a unique opportunity to designate a district based around the Peconic Estuary, the purpose of which would be to improve water quality in the Peconic Estuary. This type of funding could be utilized for wastewater treatment upgrades or other water quality improvement programs.

State Revolving Fund

The State Revolving Fund (SRF) allows municipalities to access low-cost loans for capital improvements and other programs. This funding source would be appropriate to finance the substantial on-site wastewater treatment upgrades that are needed on the east end. The existence of a recognized estuary of national significance, the USEPA- approved TMDL for Nitrogen and Pathogens, and the identification of non-point source nitrogen load reduction as a top priority for PEP CCMP implementation all help to justify SRF requests. New York State's partnership in PEP and concurrence on the regional priorities

in the PEP CCMP will help support potential future requests for SRF funding for Water Quality initiatives in the Peconic Estuary.

New York State Water Quality Improvement Program and Suffolk County Water Quality Protection and Restoration Program

The fact that the R*eclaim Our Waters* priorities were previously included in the PEP CCMP, as described above, means that they are necessarily prioritized for funding under both the New York State Water Quality Improvement Program (WQIP) and the Suffolk County Water Quality Protection and Restoration Program (WQPRP). Though neither of these funding sources provide steady annual funding, they do offer periodic opportunities to fund water quality improvement initiatives. In the past, both sources have provided funding for large-scale sewer infrastructure and should be further explored for on-site wastewater treatment upgrades and for planning studies to facilitate programs for those types of upgrades.

Next Steps for PEP

Beginning in 2015, PEP intends to focus attention on building the program's financial resources and conducting an update to the CCMP, possibly by way of a 5-year Action Plan. This update will build consensus around current priorities developed during recent strategic planning, like non-point source nitrogen loading, update some outdated aspects of the CCMP goals, like "brown tide", and re-examine the goals in light of climate impacts.

6.2.6 Education and Outreach

The PEP CCMP outlines Public Education and Outreach as a primary function of the Program. Annually, PEP typically allocates $50,000 to $100,000 to public education and outreach. This funding supports the Citizens' Advisory Committee and numerous public education and engagement initiatives that vary from year to year in order to keep pace with current program priorities. This outreach program and existing committee structure can work to the

advantage of Suffolk County as new water quality initiatives come on line. The PEP can serve as a mechanism to educate the public about county programs, about their personal responsibilities regarding water quality (for example fertilizer application and septic system maintenance) and can generate support for wastewater upgrades and the funding mechanisms that will support them.

PEP should work closely with LISS and the SSER to leverage funding and to generate consistent messaging across Long Island about water quality problems and their potential solutions.

6.3 Long Island Sound

6.3.1 Introduction

The analysis presented below focuses on the new insights and recommendations contained in the LISS CCMP Update, and how they relate in a broad sense from a local government perspective to Suffolk County's *Reclaim Our Water* initiative and the Draft CWRMP. *Reclaim Our Water* is a comprehensive initiative to improve the quality of groundwater and surface water and restore wetland health through the reduction of nitrogen pollution from sanitary waste that would be primarily achieved by the provision of wastewater collection and treatment infrastructure in targeted areas, and by installing new and advanced on-site septic systems in locations not served by sewers.

The Long Island Sound Estuary is much larger than either Great South Bay, or the area in Peconic and Gardiners Bays where Suffolk County has an underwater land ownership interest, as shown in **Table 6-1**.

This Long Island Sound watershed drains an area of more than 16,000 square miles, covering virtually the entire state of Connecticut, portions of New York, Massachusetts, New Hampshire, Vermont, and Rhode Island as well as a small area at the source of the Connecticut River in Quebec, Canada. Only 210 square miles of this watershed land area is located along the north shore in Nassau and Suffolk Counties (1.3% of the total). Hence, the LISS is not Suffolk-centric. The New York State Dept. of Environmental Conservation (NYSDEC) is the principal player in coordinating the participation of New York's cities, counties and other local jurisdictions in LISS CCMP activities. The level of resources committed to the LISS and its relatively long history distinguish this national estuary from the Peconic Estuary Program and New York's South Shore Estuary Reserve

The analysis is based primarily on preliminary information contained in the following two draft reports.

- USEPA Long Island Sound Office, Draft Comprehensive Conservation and Management Plan Update - Investing in a Regional Asset, September 2014, Stamford, CT. (LISS CCMP Update)
- USEPA Long Island Sound Office, Draft Comprehensive Conservation and Management Plan Update - Investing in a Regional Asset, Supplemental Document, Implementation Actions, September 8, 2014, Stamford, CT. (LISS CCMP Update Actions).

Other information sources that where reviewed to determine the current status of the LISS are listed below.

- J.S. Latimer et al. (eds.), Long Island Sound - Prospects for the Urban Sea (Chapter 7, Synthesis for Management), 2014, Springer Series on Environmental Management, New York, NY.
- Protection & Progress, 2011-2012 Long Island Sound Study Biennial Report.
- Sound Update, Newsletter of the Long Island Sound Study, Winter 2013-2014 issue.

- Suffolk County Dept. of Health Services, Draft Suffolk County Comprehensive Water Resources Management Plan, January 2011 (CWRMP):

- Section 5.0 Surface Water Resources

- CDM Technical Memorandum Task 6.2 Coastal Marine Resources (June 21, 2007)

- CDM Technical Memorandum Task 6.3 Estuary Study Recommendations (November 11, 2008)

6.3.2 Background and Problem Identification

In 1988, the LISS Management Conference began work on a CCMP for protecting and improving the health of the Sound while ensuring compatible human uses with the Sound ecosystem. In 1994, the States of Connecticut and New York and the USEPA approved the LISS CCMP, which addressed six priority problems: (1) low dissolved oxygen (hypoxia), (2) toxic contamination, (3) pathogen contamination, (4) floatable debris, (5) the impact of these water quality problems and habitat degradation and loss on the health of living resources, and (6) land use and development resulting in habitat loss and degradation of water quality. The CCMP outlined actions to improve the quality and health of the waters and habitats of Long Island Sound.

Significant progress has been made in implementing the CCMP over the last 20 years.

- An innovative, bi-state pollution budget called a Total Maximum Daily Load (TMDL) to reduce nitrogen pollution to Long Island Sound was developed. (A TMDL establishes the maximum amount of a pollutant that may be introduced into a waterbody while ensuring that water quality standards are met.)

- By the end of 2013, reductions of nitrogen from publicly owned wastewater treatment facilities (WWTFs) achieved 88 percent of the reduction goal established in the 2000 dissolved oxygen TMDL, which means 98,000 fewer pounds of nitrogen discharged to LIS every day, as compared to amounts discharged in the early 1990s. This translates into a reduction of 35 million pounds per year of nitrogen discharged from 106 WWTFs located in the LIS watershed. (Six WWTFs in Suffolk County discharge treated effluent to LIS.)

- Many indicators of the health of Long Island Sound are trending positive. Levels of many contaminants have declined in the water,

sediments, and wildlife. These reductions may be starting to have an effect. The maximum area of hypoxia (or low dissolved oxygen levels in the water), which averaged 208 square miles between 1987 and 2000, decreased to 176 square miles between 2000 and 2013. The summer of 2012 was a relatively severe year, while in the summer of 2013, water quality monitoring of LIS recorded the third smallest area of hypoxia in the past 27 years. While the stark difference between 2012 and 2013 highlights the high amount of inter-annual variability in hypoxia, there is a general trend of improvement over the last decade.

- The Long Island Sound Futures Fund program is administered by the EPA LISS Office and the National Fish and Wildlife Foundation. This program supports stewardship, habitat restoration, education and water quality improvement projects in local communities. Annual funding levels vary and are included in the LISS budget. A project investigating decentralized wastewater treatment in the hamlet of Orient in the Town of Southold has been funded under this program.

- The LISS has also developed a Sentinel Monitoring for Climate Change Strategy; projects funded under this program will help to provide early warnings of climate change impacts on LIS estuarine and coastal ecosystems. One project of interest is the creation of Coastal Erosion Hazard Area maps for the coastal bluffs found along the north shore of Suffolk County.

- Understanding how LIS functions has improved greatly, thanks to extensive citizen involvement, monitoring and scientific discoveries. Many emerging issues, including sea level rise, effects of Super Storm Sandy, planning for community and ecosystem resiliency, stormwater management, and aquaculture (shellfish and seaweed culture for nutrient bioextraction) have come to the forefront of social and environmental issues in LIS. Furthermore, the theory behind managing large ecosystems has also evolved.

- There is also greater appreciation of the value of natural habitats that provide a variety of goods and services through provision of flood and storm protection, water filtration, recreation, commercially and recreationally important fish and bird populations, carbon sequestration, and other functions. The financial value of goods and services provided to the region's economy by Long Island Sound Basin's natural systems ranges between $17 billion and $36.6 billion annually. Treated as a capital

asset, the value of these natural systems, calculated using a standard 4% discount rate with a lifespan of 100 years, is $690 billion to $1.3 trillion.

The LISS CCMP is currently being updated in order to incorporate this new knowledge and to make the CCMP effective over the next 20 years.

The information base for the LISS CCMP Update was buttressed by the preparation of Long Island Sound: Prospects for the Urban Sea (Latimer et al. 2013). This book reviewed the extensive inventory of scientific research reports published and environmental data collected over the last 35 years. It presents a synthesis of the science that describes the state-of-the-art in understanding the current condition of Long Island Sound and potential future impacts on its resources and ecology. Excerpts from this book that are particularly relevant to Reclaim Our Water and the north shore of Suffolk County are quoted below:

- …the Sound's embayments are relatively understudied, and little is known about their interaction with the main basins.
- Groundwater contributions of N can be a perplexing problem especially in the sandy, porous soils of Long Island. …further research is needed to understand the relative importance of groundwater sources of N, their origin (e.g., contributions of

subsurface disposal compared to fertilizers), and the transport mechanisms in ground water…

- They highlight nutrients as a "pervasive and disrupting" problem – one clearly associated with human presence, lifestyle, and economy, with cultural eutrophication showing few signs of improvement and at greater risk from a changing climate.

- …nutrient inputs to LISS for all major input categories (WWTFs, atmospheric deposition, tributaries) have decreased significantly in several watersheds. …Trends in concentrations or fluxes of N in groundwater also are much less definitive, but there is a clear evidence of increase groundwater concentrations of N in Suffolk County…

- …reduced nutrient delivery to receiving water through groundwater sources can be delayed for years after effective control practices are put into place.

- Sewage discharges, whether from septic systems or WWTFs, remain a threat to the Sound, and solutions warrant innovative and forward thinking. Hypoxia, harmful algal blooms, shellfish bed closures, fish consumption warnings, and swimming restrictions all are linked to sewage. Long Island's groundwater aquifer, in particular, is threatened severely by sewage and land use.

- Eliminating discharge of polluted storm water into the Sound is also a necessary long-term goal.

All in all, the book ends with a positive note:

- The outlook for the future of the quality of the Sound, its waters, ecological functioning, and aesthetic pleasures is actually quite positive, particularly if we eliminate sewage pollution.

Ten recommendations for enhancing management of Long Island Sound were advanced; they integrate ecosystem based management, sustainability, long-term climate change and resiliency concerns. These recommendations are listed below.

- Embrace sustainability

- Prioritize management of existing pollution sources and impairments

- Establish baselines of historical condition and magnitudes of change
- Integrate climate change across programs
- Enhance positive feedback loops
- Improve eutrophication and ecological modeling and monitoring
- Design adaptive management framework
- Conduct marine spatial planning
- Improve data management interpretation
- Reconnect people to the Sound.

6.3.3 Themes, Goals, Targets, Outcomes, Objectives and Strategies

The LISS CCMP Update is organized around four themes: Clean Waters and Healthy Watersheds, Thriving Habitats and Abundant Wildlife, Sustainable and Resilient Communities; and Sound Science and Inclusive Management. Each theme has a long-term goal that describes the desired result, as follows.

Clean Waters and Healthy Watersheds - Attain water quality objectives by reducing contaminant and nutrient loads from the land and the waters impacting Long Island Sound**.**

Thriving Habitats and Abundant Wildlife - Restore and protect the LIS's ecological balance in a healthy, productive, and resilient state for the benefit of both people and the natural environment.

Sustainable and Resilient Communities - Support vibrant, informed, and engaged communities that use, appreciate, and help protect LIS.

Sound Science and Inclusive Management - Manage LIS using sound science and cross-jurisdictional governance that is inclusive, adaptive, innovative, and accountable.

Throughout the four themes, the LISS CCMP Update incorporates integrative principles that have emerged as key challenges and environmental priorities. These include resiliency to climate change, long-term sustainability, environmental justice, and ecosystem-based management.

The LISS CCMP Update is built around a framework developed to achieve theme goals. This framework is comprised of ecosystem targets, specific outcomes, objectives, strategies, and implementation actions. The level of

detail associated with this framework is intense. All told, there are 20 ecosystem targets, 15 outcomes, 39 objectives, 103 strategies and 136 recommended implementation actions discussed in the LISS CCMP Update. (Specific mention of Suffolk County is infrequent in the LISS CCMP Update. Indeed, a search of "Suffolk County" and "SCDHS" yielded only two hits in the entire LISS CCMP Update Actions report, which contains detailed descriptions for each of the 136 recommended actions.) For the purposes of this analysis, focus has been directed to the Clean Waters and Healthy Watersheds theme only, and how it relates to the Reclaim Our Water initiative.

6.3.3.1 Existing Metrics

Clean Waters and Healthy Watersheds

Ecosystem-Level Indicators and Targets

The following indicators and targets have been developed in order to measure overall progress toward the ***Clean Water and Healthy Watersheds*** **(WW)** goal.

Hypoxia: By 2035, achieve a measurable reduction in the zone of hypoxia in LIS from pre-2000 Dissolved Oxygen TMDL averages as measured by the 5-year running average size of the zone.

Nitrogen loading: Attain WWTF nitrogen-loading at the recommended 2000 Dissolved Oxygen TMDL allocation level by 2017 and maintain the loading cap. Have all practices and measures installed to attain the allocations in nonpoint source inputs from the entire watershed by 2025.

Water clarity: By 2035, improve water clarity as defined by the LISS report card to support healthy eelgrass communities.

Pervious Cover: Through green infrastructure and low impact development, maintain or increase the area of pervious cover in the watershed in 2035 relative to a 2010 baseline.

Riparian buffer extent: By 2035, increase natural vegetation within 300 feet of any stream or lake by 10 percent compared to 2010 baseline of 65 percent.

Open space extent protected: Preserve 21 percent of the Connecticut land, or 673,210 acres, by 2023; maintain or increase protected land within the LIS coastal boundary by 2035.

Outcome 1-1: Contaminant and nutrient loads from land-based sources in the watershed of LIS are reduced.

Objective 1-1a: To reduce contaminant and nutrient loads from point and nonpoint sources

Strategy 1-1a1: Evaluate and reduce contaminant and nutrient contributions from Combined Sewer Overflows and from Municipal Separate Storm Sewer Systems (MS4s), incorporating climate change and sea level rise in planning, regulation and best management practices (BMPs)

Strategy 1-1a2: Evaluate and reduce contaminant and nutrient loads from WWTFs, conveyance systems and other associated sewer lines

Strategy 1-1a3: Develop pathogen TMDL or alternate control plans for LISS harbors, coasts, and embayments using the existing pathogen TMDL

Strategy 1-1a4: Continue enhanced implementation of existing 2000 TMDL for nitrogen in LIS and embayments, and adapt and revise as appropriate based on monitoring, modeling, and research findings

Strategy 1-1a10: Improve and manage decentralized, package, and on-site wastewater treatment systems (OSWTSs) to reduce contaminant and nutrient loading

Outcome 1-2: The negative impacts of contaminants and nutrients in the waters and sediments of LIS and tributaries/embayments are reduced.

Objective 1-2c: To improve understanding of the sources of nutrients and contaminants and how they interact with the ecosystem and human health

Strategy 1-2c1: Understand drivers and impacts of harmful algal blooms (HABs) and develop and implement methods to minimize the impact on ecosystem services

Outcome 1-3: Research, monitoring, and modeling to support attainment of water quality objectives is maintained and improved.

Objective 1-3b: To research, monitor, and assess water quality and factors that contribute to water quality change

Strategy 1-3b4: Research, monitor and assess HABs and their impacts on water quality

Objective 1-3c: To improve access and usage of information, databases, and resources and incorporation of data into management actions

Strategy 1-3c1: Support collaboration between LISS partner organizations including upper basin agencies/partners to improve utility of monitoring data

6.3.4 Recommendations

As stated earlier, the primary focus of this analysis is the Clean Waters and Healthy Watersheds theme. Twelve selected Implementation Actions pertaining to this theme are listed below. (Details on all of the 136 actions can be found in the LISS CCMP Update Actions report.)

- WW-4 Encourage wastewater treatment plant upgrades, combined sewer overflow mitigation and elimination (where possible) to support goals and targets of LISS programs.
- WW-5 Continue enhanced implementation of the LIS TMDL for dissolved oxygen and evaluate revision of those TMDL targets.
- WW-6 Modify the reporting requirements of MS4 communities to improve dissolved oxygen TMDL implementation tracking and to better quantify the success of control measure actions.
- WW-7 Improve and enforce pesticide/herbicide/fertilizer regulations and other Best Management Practices (BMPs) for agriculture and urban turf.
- WW-10 Develop a nonpoint source and stormwater tracking system tool for the LIS watershed.
- WW-14 Develop improved policies for package/decentralized wastewater treatment facilities and on-site septic systems.
- WW-15 Improve understanding, management and design of denitrifying on-site wastewater treatment systems to reduce nitrogen and pathogens.
- WW-16 Modify septic system use and siting policies to accommodate climate change and sea level rise (SLR).
- WW-17 Improve efficiency and resiliency of existing/new waste treatment systems including septic, WWTF and stormwater infrastructure to accommodate SLR.
- WW-23 Identify and recommend removal or protection of sensitive infrastructure in the coastal zone (e.g., oil tanks, pump/power

stations, etc.) and work to enact legislation to prevent future siting of such infrastructure in vulnerable coastal floodplains.

- WW-25 Monitor and track occurrences and contributing factors of biotoxin and HAB outbreaks.
- WW-39 Assess sources of nutrient and pathogen contamination to LIS embayments.

6.3.5 Implementation

The public comment review period for the LISS CCMP Update ended in early November 2014. According to Mark Tedesco, Director, LISS Office, the goal is to complete technical edits to the revised, final LISS CCMP Update by the end of 2014, and then produce a "public" version for release in early 2015. Formal approval of the LISS CCMP Update by the Connecticut Dept. of Energy and Environmental Protection, the US EPA and the NYS DEC may occur at a high-level event in spring 2015.

The LISS CCMP Update has a 20-year horizon and includes specific implementation actions organized by theme to help attain the plan goals and ecosystem targets. In addition to the work of ongoing programs, these specific, tactical actions will carry out the strategies over the next five years. Review and

development of implementation actions every five years will allow for adaptive management and inclusion of emerging scientific and technological advances.

The Federal Government through provisions in the Clean Water Act, has charged EPA with providing overall coordination of and support for the regional effort. The legislation supporting these efforts includes the Long Island Sound Improvement Act and the Long Island Sound Stewardship Act. The federal fiscal year 2014 budget provided approximately $4.5 million for the LISS. The LISS CCMP Update recommended that annual funding be increased to a level of $10 million. The States of Connecticut and New York will estimate the federal and state funds needed over the next 20 years to meet statewide needs, including additional Long Island Sound-specific project needs.

Next Steps for LISS

The Long Island Sound Study intends to finalize their CCMP Update in 2015, and will then return their programmatic focus to implementation.

6.3.6 Education and Outreach

The EPA LISS Office is located in Stamford, CT. For New York State, New York Sea Grant located at Stony Brook University provides public outreach support. The LISS has numerous committees (Policy; Executive Steering; Management; Citizens Advisory; and Science and Technical Advisory Committees) and work groups (Five State/EPA TMDL; Habitat Restoration; Nonpoint Source, Pollution and Watersheds; Sentinel Monitoring for Climate Change; and Stewardship Work Groups) that help to implement the LISS CCMP. The LISS also maintains an active website that provides access to all aspects of the CCMP Update process, schedules, reports, newsletters, etc. (http://longislandsoundstudy.net).

6.4 South Shore Estuary

6.4.1 Introduction

The analysis presented below focuses on the ***Long Island South Shore Estuary Reserve Comprehensive Management Plan,*** dated April 2001, the ***Partners for Progress – Long Island SSER Comprehensive Management Plan Accomplishments 2003-2005*** and any new insights and recommendations contained in the ***Long Island SSER Comprehensive Management Plan Implementation Status Report 2006-2010***, dated November 2011, and how it relates in a broad sense from a local government perspective to Suffolk County's Reclaim Our Water initiative and the ***Draft Comprehensive Water Resources Management Plan*** (2011). Reclaim Our Water is a comprehensive initiative to improve the quality of groundwater and surface water and restore wetland health through the reduction of nitrogen

pollution from sanitary waste that would be primarily achieved by the provision of wastewater collection and treatment infrastructure in targeted areas, and by installing new and advanced on-site septic systems in locations not served by sewers.

6.4.1.1 Overview of the Long Island SSER

The ***Long Island South Shore Estuary Reserve Comprehensive Management Plan*** (CMP), dated April 2001, was prepared pursuant to the Long Island South Shore Estuary Reserve Act (Article 46 of the Executive Law), to establish a consensus-based blueprint for the protection and restoration of the estuary's natural, cultural and economic-related resources. The CMP contains recommended actions focused on improving water quality, restoring and protecting living resources, expanding public use and enjoyment of the estuary, sustaining and expanding the estuary-related economy and increasing education, outreach and stewardship in the Reserve.

To assist the Council, the New York State Department of State Division of Coastal Resources (now the Office of Planning and Development), working through partnerships with local governments and federal agencies, gathered and analyzed information on land and embayment uses, the estuarine economy, water quality, living resources, and other aspects of the Reserve. Much of this information was analyzed by the Department of State through geographic information systems technology, and the analyses have served as a basis for the implementation actions offered in the CMP. Important data was also supplied by the towns and counties in the Reserve as part of assessments of their nonpoint source management practices conducted in conjunction with the Department of State. All of this information is presented in the series of technical reports and working papers referenced in Appendix A to the CMP.

The South Shore Estuary Reserve is home to about 1.5 million people. The anchor of the region's tourism, seafood and recreation industries, the Reserve stretches from the western boundary of the Town of Hempstead to the middle of the Town of Southampton. South to north, the Reserve extends from the mean high tide line on the ocean side of the barrier islands to the inland limits of the mainland watersheds that drain into Hempstead Bay, South Oyster Bay, Great South Bay, Moriches Bay and Shinnecock Bay.

6.4.2 Problem Identification

Human population growth and burgeoning development in the Reserve, especially since World War II, had and continues to have a dramatic effect on the estuary. Most habitat loss in the Reserve has been the result of the filling of low-lying lands in the western portion of the Reserve for residential and commercial uses. Other development activities, including construction of

canals, roads and bridges, have also destroyed or degraded habitats. According to the NYSDEC's 1996 Priority Waterbody List, stormwater polluted by elevated levels of fecal coliform bacteria, excessive nutrients and sediment has affected the viability of fish populations in the Reserve's tributaries and has closed over 34,000 acres of hard clam beds in its bays.

For purposes of planning and description, the South Shore Estuary Reserve is conveniently viewed as three sub-regions: the western bays, Great South Bay and the eastern bays. The Great South Bay and the Eastern Bays sub-regions are located within Suffolk County and will be the focus of this discussion.

Great South Bay is the largest shallow estuarine bay in New York State, with extensive back barrier and tidal creek salt marshes, eelgrass beds, and intertidal flats. Most marshes in the sub-region are ditched, with many mainland marshes impaired by fill and bulkheads or restrictions to tidal flow. The watershed of Great South Bay can be described as "developing," in contrast to the more fully "developed" western bays region, and development is generally less intense and open areas more extensive. Like the western bays sub-region, Great South Bay has extensive impervious surfaces in its watershed. For this reason, nonpoint source pollution from stormwater runoff is the primary issue.

Nutrients, sediment and coliform bacteria are the principal pollutants carried by stormwater runoff into the sub-region's tributaries and ultimately Great South Bay. Vessel waste discharges and waterfowl are also contributors to the bacterial load. Elevated levels of coliform are responsible for the closure of 10,711 acres of shellfish beds in Great South Bay and the periodic closure of three of its bathing beaches. Nutrients and sediments in stormwater runoff threaten fishing, fish propagation and fish survival in the sub-region's tributaries and coves. Hydromodifications - alterations of water level and stream flow - and lowering of groundwater levels also have significant effects on fishery resources in tributaries.

The shallow eastern bays - Moriches and Shinnecock - are distinguished by the presence of inlets, strong tidal exchanges between the ocean and the bays, and minor inflows of lower salinity water from the Peconics through the

Shinnecock Canal. Salt marshes and dredged material islands of the eastern bays support significant nesting colonies of terns, gulls, and wading birds. Shallow water areas are highly productive, especially the salt marshes and intertidal flats that fringe the barrier islands and the estuarine habitats around the tributary mouths.

Although the watershed of Moriches and Shinnecock Bays is the least developed in the Reserve, elevated levels of fecal coliform bacteria from polluted stormwater runoff have closed 6,075 acres of shellfish beds. Sediment and excessive nutrients in stormwater runoff have affected fish survival in tributaries, and organic nutrients play a role in the brown tide outbreaks in the sub-region. Agriculture occurs in this sub-region to some degree, with potential impacts on water quality from sediments, fertilizers and pesticides.

6.4.3 Goals and Objectives

There are five recommended actions that the CMP focused their efforts. They include:

1. Improve and Maintain Water Quality
2. Protect and Restore Living Resources
3. Expand Public Use and Enjoyment
4. Sustain and Expand Estuary-related Economy
5. Increase Education, Outreach and Stewardship

The discussion below will be directed to the first recommended action listed above: Improve and Maintain Water Quality.

Water quality in the South Shore Estuary Reserve is important to everyone on Long Island. Poor water quality diminishes recreational and economic opportunities.

Nonpoint source pollution is the primary water quality concern in the South Shore Estuary Reserve. Polluted stormwater runoff alone is the principal source of nonpoint pollution in 48 of the 51 waterbody segments in the Reserve with use impairments. Elevated levels of coliform bacteria in stormwater runoff, an indicator of the potential presence of pathogens, are responsible for the closures of shellfish beds and bathing beaches. Sediment and excessive nutrients in stormwater runoff have pronounced negative effects on the Reserve's living resources.

Point sources of pollution - municipal wastewater treatment plants, inactive hazardous waste sites and active and inactive solid waste disposal facilities - are not as widespread and are comparatively less significant sources of pollution than nonpoint sources, but still cause water quality degradation in their immediate areas. Point sources are regulated and monitored through the State Pollution Discharge Elimination System (SPDES) permit program.

Improving water quality in the Reserve is dependent on federal, State and local governments, and private sector partners, implementing a strategy that:

1) Identifies opportunities and develops schedules to protect lands that provide significant pollutant abatement functions;

2) Designs and undertakes projects that retrofit existing storm sewer and other conveyance systems to remove pollutants from storm water;

3) Adopts nonpoint source pollution best management practices; and

4) Increases education and outreach to modify resident and user behavior.

In keeping with Article 46 of Executive Law, the Council established as one of its goals the need to "achieve and maintain the water quality necessary to preserve and rehabilitate resources of the estuary." Attaining this ambitious water quality goal depends upon the cooperative efforts of many players -- federal, State, and local governments, non-governmental organizations, resource users and residents.

Recommendations presented in the SSER CMP provide for the implementation of a strategy to control nonpoint source pollution and to further evaluate the effects of point sources. They include: reduce and control nonpoint source pollution; enhance point source controls; implement the Environmental Protection Agency's Storm Water Phase II Final Rule; and address scientific information needs.

Two of the most significant pollutants in the South Shore Estuary Reserve are elevated levels of coliform bacteria and excessive concentrations of certain nutrients. Nonpoint sources of nutrients include fertilizers from lawns and agricultural lands; wildlife, waterfowl and pet wastes; and on-site wastewater treatment systems. The ***Summary Report: South Shore Estuary Reserve Water Quality Workshop*** (1999) also determined that human development of the margins of the estuary's bays and tributaries had increased nutrient loading and resulted in an increased level of eutrophication. The seasonal occurrence of hypoxic conditions associated with excess nutrients and dissolved oxygen highlights this concern. Although the shallow waters of the

South Shore bays are well mixed (which discourages oxygen depletion), low levels of dissolved oxygen (hypoxia) are typical along the northern margins of the bays and in the tributary mouths, with tributaries showing clear signs of seasonal hypoxia, a serious threat to aquatic life in these areas.

As nonpoint source pollution originates from land use and water-based human activities, the Council's strategy calls on municipalities within the Reserve to assume a leadership role in reducing and controlling nonpoint pollution by exerting their legal authority to influence such activities, and preserving high quality waters from future pollution. The strategy presents corrective and preventive actions that local governments can take, supported by State and federal programs and grants and augmented by the efforts of non-governmental organizations, to reduce and control nonpoint source pollution.

The strategy's corrective and preventive measures fall into four management approaches: 1) identifying opportunities and developing schedules to protect lands that provide significant pollutant abatement functions; 2) designing and undertaking projects that retrofit existing storm sewer and other conveyance systems to remove pollutants carried by stormwater; 3) adopting nonpoint source pollution best management practices; and 4) increasing education and outreach to modify resident and user behavior. The degree to which each of the four approaches may be institutionalized in a municipality will depend upon local circumstances.

Several steps are fundamental to the implementation of the corrective component of the strategy. First, the distribution and relative magnitude of nonpoint source pollution in each watershed should be identified by municipalities. Satellite imagery of land cover has been used with soils, topography and distance to surface water data to identify nonpoint pollution potential for the entire Reserve (see map at end of this chapter). This information will help focus implementation of site-specific stormwater remediation projects and water quality monitoring efforts.

Next, municipalities should characterize their watersheds. These characterizations should include a delineation of sub-watersheds or contributing areas, and the location and condition of storm sewer outfalls and stormwater conveyance systems through which pollutants in stormwater are discharged. Existing drainage and runoff patterns should be accounted for in this delineation.

An assessment of the likelihood of correcting discharge problems through infrastructure retrofit improvements should also be included. The likelihood of improvement and value of the receiving water resources are two key factors to be considered in setting priorities and are essential to preparing watershed

management plans, a follow-up step that would establish the basis for the design of cost-effective corrective projects. Environmental Protection Fund Local Waterfront Revitalization Program grants are available to assist in this phase of the process.

6.4.4 Recommendations

The Council offers the following recommendations to achieve and maintain water quality in the South Shore Estuary Reserve. In an effort to reduce and control nonpoint source pollution, Recommendations 1 through 13 call for corrective actions in the form of remediation projects to manage storm water as it moves across the landscape and preventive actions that control the level of pollutants that enter stormwater runoff and the Reserve's bays and tributaries. Many of these preventive actions involve the implementation of best management practices by municipalities in the Reserve. In an effort to address point sources of pollution, Recommendations 14 through 17 call for enhancements to existing source controls. Recommendations 18 through 21 relate to the Environmental Protection Agency's Storm Water Phase II Final Rule. Recommendations 22 through 24 identify information gaps that need to be addressed within the next three years in order to move toward fulfillment of the Council's vision for Long Island's South Shore Estuary Reserve.

6.4.4.1 Recommendations to Reduce and Control Nonpoint Source Pollution

1. Complete assessments of nonpoint source pollution management practices and identify and implement needed preventive measures based on priorities.

The six towns and two counties in the Reserve have already completed assessments of their current nonpoint source pollution control practices. Villages in the Reserve and relevant State agencies should conduct similar assessments of their nonpoint control practices and identify gaps in those practices. Towns should consider assisting villages within their borders with the completion of such assessments.

2. Spatial analysis of land cover, soils, topography and satellite imagery should be used by municipalities in the Reserve to determine the distribution and relative magnitude of nonpoint source pollution in their communities.

Comprehensive spatial analysis of land cover, soils and topography by the NYS Department of State has resulted in a nonpoint pollution potential model. The model identifies the potential distribution and relative magnitude of nonpoint

source pollution and should be used by municipalities as they develop watershed plans that address management of nonpoint source pollution.

3. Complete specific watershed analyses to determine localized distribution and magnitude of nonpoint pollution, and prepare watershed plans and retrofit improvement designs for cost-effective nonpoint source pollution control projects.

A watershed analysis involves identifying and setting priorities for improvements to storm sewers and other runoff conveyance systems. It should also: examine the overall watershed character, including existing drainage and runoff patterns; evaluate the benefits and feasibility of correcting runoff problems through road infrastructure improvements; and identify opportunities for preservation of high quality waters from future pollution. This information could be supported with data from targeted water quality monitoring programs.

Based on the results of watershed analyses, watershed plans should identify significant nonpoint source contributing areas and identify and set priorities for site-specific projects for stormwater remediation. Designs for these projects should be developed according to the practices from either the USEPA's ***Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*** or the NYSDEC's Management ***Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State.*** The latter is incorporated by reference into the *New York State Coastal Nonpoint Pollution Control Program*, a compendium of nonpoint pollution control and abatement practices currently implemented in New York State.

4. Implement priority stormwater remediation projects in significant nonpoint source contributing areas identified in individual municipal watershed plans.

Stormwater remediation projects can be implemented through a mix of local resources, such as general funds, capital improvements programs, special bond initiatives, or municipal work crews, and State funding mechanisms such as the 1996 New York State Clean Water/Clean Air Bond Act and the Environmental Protection Fund. In some instances, federal dollars may be available to fund projects through the Transportation Enhancement Act (TEA-21), section 319 of the federal Clean Water Act, and through the proposed authorization for the Coastal Nonpoint Source Pollution Control Program.

5. Municipalities should periodically report to the Council on progress made and problems encountered in implementing the water quality

component of this plan in an effort to enlist its aid in identifying sources of technical assistance and potential funding.

A system of reporting to the Council by municipalities should be established to measure Reserve-wide progress against objectives, and to enable early detection and resolution of Reserve-wide problems. The Council could also serve as a clearinghouse of information and techniques that would be shared with individual South Shore Estuary Reserve municipal stewards.

6. Adopt best management practices to control drainage, erosion and sedimentation prior to and during construction.

In an effort to reduce levels of hazardous and toxic substances associated with construction activities from contaminating stormwater runoff, Southampton, Hempstead and Babylon should incorporate into their site plan review regulations, and Nassau County into its subdivision regulations, management practices that: 1) control erosion and sedimentation before and during site preparation and construction; and 2) minimize detrimental effects on the water quality of waterbodies before and during site preparation and construction. These practices are found in NYS Department of Transportation design specification documents and the NYSDEC's ***Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State***; the former document is also incorporated by reference in *New York State Coastal Nonpoint Pollution Control Program*. Additionally, all towns should immediately ensure that their land use regulations address construction activities that disturb from one to less than five of acres of land in advance of the permit conditions that will be required by the Environmental Protection Agency's Final Storm Water Phase II Rule.

7. Adopt best management roadway operation and maintenance.

To reduce the significant water quality impacts of stormwater runoff from existing roads, highways and bridges, all towns in the Reserve should formally adopt roadway operation and maintenance practices from portions of NYS Department of Transportation procedural manuals and NYS Department of Environmental Conservation's *Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State*.

8. Institute appropriate best management practices to reduce the contamination of stormwater runoff by hazardous materials, fertilizers, herbicides and pesticides, household hazardous wastes, and wildlife and pet wastes.

- To reduce the impacts caused by stormwater runoff contaminated by activity-specific nonpoint sources of pollution, the following practices should be instituted:

- To mitigate and prevent spills of petroleum products and hazardous materials, all towns in the Reserve should: a) incorporate standards from the National Fire Protection Association and Environmental Conservation Law Article 27 for generation, storage, application, handling and disposal activities before, during and after site preparation and construction into site plan review regulations, and local law; b) incorporate U.S. Occupational Safety and Health Administration standards and procedures pertaining to spill cleanups into site plan review regulations, subdivision requirements and local law; and c) train an emergency spill response team in these standards and procedures.

- To address excessive fertilizer, herbicide and pesticide use as part of management of turf grass in public and private areas, all towns in the Reserve should educate citizens, contractors, construction workers, and owners and managers of private facilities on the importance of carrying out best management practices, including soil testing, use of integrated pest management, organic gardening and lawn care.

- To reduce the amount of wildlife and pet wastes entering waterbodies, Babylon, Hempstead and Southampton should undertake multi-component education programs that discourage the feeding of waterfowl, and Brookhaven and Southampton should institute "pooper-scooper" laws.

9. Adopt marina and recreational boating best management practices, and educate marina patrons about specific best management practices.

To reduce elevated levels of fecal coliform bacteria and toxic substances associated with existing marinas, all towns in the Reserve should incorporate into local law practices from the NYS Coastal Nonpoint Pollution Control Program, the NYSDEC ***Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State*** and the National Fire Protection Association ***Fire Protection Standard for Pleasure and Commercial Motor Craft***. Such efforts should include adoption of appropriate regulations and practices that mitigate the impacts of vessel waste discharges. The imposition of best management practices on private marinas should be balanced against the provision of incentive subsidies such as tax relief and public funding for rehabilitation.

All Reserve towns except Southampton need to target outreach efforts at marina patrons in an effort to reduce solid waste reduction and encourage recycling, while all towns except Babylon need to target outreach efforts on fish cleaning practices at sites designated for that purpose.

10. Adopt best management practices for the siting and design of new and substantially redeveloped marinas.

To reduce levels of fecal coliform bacteria and toxic substances associated with new marinas, all towns in the Reserve should incorporate siting and design practices from the NYS Coastal Nonpoint Pollution Control Program and the NYSDEC ***Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State*** into site plan review.

These practices should be applied to new and expanding private marinas and to public marinas through formally adopted planning approval procedures. The imposition of these practices on private marinas undergoing redevelopment should be balanced against the provision of incentive subsidies such as tax relief and public funding for rehabilitation.

11. Adopt best management practices to restore and create wetlands.

To reduce the water quality impacts of existing hydromodification activities, all towns in the Reserve should adopt into local operation and maintenance procedures those practices from the NYSDEC ***Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State*** for restoring and creating wetlands. All towns except Southampton need to adopt those practices from the catalogue that address improvements to stream corridors and the restoration of riparian habitat and vegetation.

12. Adopt best management practices to protect wetlands and streams.

To prevent the water quality impacts of new private hydromodification activities, all towns in the Reserve should incorporate into their site plan review, practices from NYS Department of Transportation design specification documents and the NYSDEC ***Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State*** to protect wetlands and streams, and control erosion and sedimentation before and during site preparation and construction. These practices also should be formally adopted into local operation and maintenance procedures and applied to municipal hydromodification activities as well.

All towns also should formally adopt into local operation and maintenance procedures those practices from NYS Department of Transportation procedural manuals and NYSDEC's ***Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State*** that address the clearing of debris from streams and culverts.

13. Adopt best management practices that reduce the environmental effects of on-site wastewater treatment systems (OWTS).

To reduce the water quality impacts of on-site wastewater treatment systems, Suffolk County should work with Babylon, Islip and Brookhaven to develop and implement on-site system management strategies that include a regulatory and incentive program for periodic inspections and pumpouts of OWTS, require upgrades of OWTS as part of substantial residential and commercial redevelopment, and establish a public education component that informs system owners of proper use and the maintenance necessary for proper operation. Southampton should institute a similar public education program.

The Town of Brookhaven should enforce those provisions of its town code that address new and replacement systems in special flood areas and that establish design criteria for systems in coastal high hazard areas. Southampton should fully implement those provisions of its town code that require inspections of systems at five-year intervals and remediation as necessary, amend those provisions to allow inspections by private individuals certified by the Town, and establish such a certification program. Additionally, Southampton should extend its requirement of OWTS upgrades whenever wetland permits are issued for expansions and additions to commercial establishments.

The Council offers the following recommendations to address actual and potential point source pollution. The recommendations are based on, respectively: a water quality initiative provided for in the federal Clean Water Act; comments from Council members; and completed South Shore Estuary Reserve technical reports. Implementation of these actions will take the concerted effort of State, federal and local governments.

6.4.4.2 Recommendations to Enhance Point Source Controls

14. Determine point and nonpoint source controls to reduce loadings of pathogens, nutrients and toxic substances contributing to water quality problems in the Reserve's tributaries and bays.

In order to determine point and nonpoint source controls necessary to address water quality problems associated with nutrient enrichment, pathogens or toxic substances, a systematic and sequential process must be followed. First,

water quality data in the Reserve's tributaries and bays must be evaluated. Based on this evaluation, the NYS Department of Environmental Conservation will identify any specific waterbodies that should be included on its 303(d) list of impaired waterbodies that require the development of Total Maximum Daily Loads. In accordance with recently promulgated federal regulations, the next 303(d) list is expected to be finalized in April 2002. Later, for those waterbodies identified on the 303(d) list, the Department of Environmental Conservation will develop Total Maximum Daily Loads (TMDLs) in accordance with the schedule included in the list. TMDLs will identify reductions in point and nonpoint sources of pollutants necessary to meet water quality standards. Finally, the Department of Environmental Conservation, the Department of State, the Council and local governments should work together to implement any load reduction actions identified in the TMDL allocations.

15. Re-examine the need, benefits and feasibility of upgrading the municipal sewage treatment plants discharging into the estuary or relocating their outfalls to the Atlantic Ocean.

TMDL wasteload allocations for the waterbodies receiving discharges from wastewater treatment plants that discharge secondarily treated effluent should be used to determine whether upgrades of the municipal wastewater plants to tertiary treatment are necessary.

16. Ensure Compliance with Existing State Pollution Discharge Elimination System (SPDES) permits.

The compliance of point source discharges into the Reserve with current SPDES limits and conditions should be investigated. Based on the results, existing and future infrastructure or operational needs necessary to ensure compliance should be identified. The NYS Department of Environmental Conservation, the Department of State, the Council and local governments should then work together to assure that the needs identified are met.

17. Prevent the future contamination of sediments through continued implementation of existing programs that address the management of hazardous waste, and remediate identified areas of contaminated sediments where the sources of contamination and impairments to living resources and/or uses are known and well documented, mitigation action is feasible, and funds are available.

National Fire Protection Association and Environmental Conservation Law Article 27 standards regulate hazardous waste generation, storage, application, handling and disposal activities before, during and after site preparation and

construction. Practices in previously cited documents are designed to manage nonpoint source pollution. Areas of contaminated sediments that potentially impair waterbodies in the Reserve should be tested to determine required actions, and, if necessary, should be remediated on a priority basis when funding becomes available.

6.4.4. 3 Recommendations to Implement EPA's Storm Water Phase II Final Rule

18. The NYSDEC should designate as "urbanized areas" under the EPA's Storm Water Phase II Final Rule those portions of the Reserve not so designated by the Bureau of Census.

The Phase II Final Rule requires nationwide coverage of all small municipal separate storm sewer systems that are located within the boundaries of a Bureau of Census-defined "urbanized areas" based on the latest decennial Census. All of Nassau County has been designated as an "urbanized area." It is anticipated that most of the Suffolk County portion of the Reserve also will be designated as "urbanized areas" based on Census data. The NYSDEC, as the permitting authority, should ensure that this stormwater management program applies throughout the entire Reserve by designating those parts of the Reserve not considered "urbanized areas" on the basis of Census figures.

19. All municipalities in the Reserve designated as "urbanized areas" under the Environmental Protection Agency's Storm Water Phase II Final Rule should immediately begin to prepare to meet Phase II permit conditions and secure the necessary permits by the mandated deadline.

The National Pollution Discharge Elimination System permitting authority (the NYSDEC) will issue general permits for Phase II designated small municipal separate storm sewer systems and small construction activity by December 9, 2002. Designated municipalities must obtain permit coverage within 90 days of permit issuance. The permitting authority may phase in coverage for municipalities with populations under 10,000 on a schedule consistent with a State watershed permitting approach. Permitted municipalities must fully implement their stormwater management programs by the end of the first permit term, typically a five year period. Permit conditions will include at least six program elements: public outreach and education; public participation and involvement; illicit discharge detection and elimination; construction site runoff control; post-construction runoff control; and pollution prevention. All municipalities should immediately start the process to meet permit requirements. The implementation actions offered in this plan will help municipalities establish a foundation upon which to base their efforts at meeting the required permit conditions.

20. Information and education programs need to be developed and conducted for municipal officials on implementation of the Environmental Protection Agency's Phase II Final Rule.

A cooperative information and education program will facilitate the timely implementation of the Phase II Final Rule by municipalities in the Reserve. Such a program should include: an overview of why the Phase II Storm Water Program is necessary; who is covered by the rule and what the rule requires to manage small municipal separate storm sewer systems and small construction activity; and the Phase II program approach, the schedule for implementation, and the Environmental Protection Agency's "tool box" of materials available to ensure that program implementation is effective and cost-efficient.

21. Institutional arrangements for implementation of the Phase II Final Rule need to be established.

Implementation of the Phase II Final Rule will be the responsibility of counties, towns and villages in the South Shore Estuary Reserve. In an effort to address the reality of overlapping municipal authorities and to make implementation of the rule workable, the Departments of State and Environmental Conservation and municipalities in the Reserve should work together to identify optimal ways to develop stormwater management districts and explore the feasibility of those options.

6.4.4.4 Recommendations to Address Information Needs

22. Implement a coordinated water resources monitoring strategy that monitors water quality in the Reserve's tributaries and bays, and evaluates the extent to which management actions are successful in achieving water quality goals.

The Coordinated Water Resources Monitoring Strategy for the South Shore Estuary Reserve proposed a two-tiered program for monitoring the physical, chemical, biological and human-induced conditions of the Reserve and its watershed. Tier 1 monitoring is designed to establish baseline data on water quality in the Reserve's bays and tributaries, identify and assess trends in water quality, and evaluate the extent to which desired uses of the Reserve's water resources are met. Tier 1 efforts include monitoring the occurrence of brown tide blooms in the Reserve's waters. Tier 2 monitoring activities are in general short-term investigations, more intensive in temporal and /or spatial scale, and designed to test specific hypotheses regarding water quality or ecological issues in the South Shore Estuary Reserve.

The monitoring strategy builds on existing monitoring programs and offers recommendations for improved coordination among agencies conducting those programs. It calls for the hiring of a program manager, the implementation of a quality assurance/quality control program, and centralized data analysis and reporting.

23. Develop a hydrologic model of the Reserve.

Once strategic information is developed from the coordinated water quality monitoring program (Recommendation 22, above), a hydrodynamic model addressing groundwater underflow, tributary inputs, water circulation, currents, dispersion and residence times would add to the capability of refining and enhancing management strategies. Such a model would need to identify the potential hydrodynamic and water quality impacts, ecological consequences and long-term environmental fate of toxic substances, coliform bacteria, nutrients, and other pollutants to the bays to be of value. The model would be used to test the potential effects of alternative locations for wastewater outfalls and predict the water quality consequences of a storm-related island breach or inlet closure. Coupled with land use and water quality monitoring data through a GIS system, the model would be of use to local governments for understanding water quality impacts of alternative land use decisions.

24. Further investigate the hypothesis that brown tide blooms are related to the ratios of available dissolved organic and inorganic nitrogen.

Additional data are needed to further test the hypothesis that brown tide is related to inputs and the ratios of available dissolved organic nitrogen and dissolved inorganic nitrogen from groundwater, sediment nutrient flux, and other sources. Such research could also shed light on other ecological processes such as the influence of trace metals and pesticides. This research effort could also provide valuable information on conventional water quality and living resource management issues. Effective enhancement of hard clams, scallops, oysters, finfish, crustaceans, and submerged aquatic vegetation will be difficult until this harmful algal bloom is better understood.

6.4.5 Implementation

Building on what has already been accomplished by the State, local governments and the Reserve's Council, the implementation actions presented below provide the necessary road map to fulfilling the recommendations offered and assuring the long-term health of the Reserve. The actions target efforts where the greatest potential exists for halting further degradation of the

Reserve's natural resources and realizing improvements to them, and where multiple goals and objectives of the Council can be achieved.

The actions focus attention where problems have been clearly identified and where the existence of motivated partners assures a higher likelihood of success. They are organized and presented according to outcomes they will fulfill.

Table 6-3 South Shore Estuary Study Recommendations to Reduce Nonpoint and Point Source Pollution

South Shore Estuary Study Recommendations to Reduce Nonpoint and Point Source Pollution

Outcome 1: Reduced nonpoint source pollution.

1-1 Construction of stormwater abatement projects in significant nonpoint source contributing areas associated with closed shellfish beds, impaired living resources, and bathing beaches that experience periodic closures due to water quality concerns.

1-2 Amendment of county and local government codes and regulations to include best management practices.

1-3 Implementation of on-site wastewater treatment (septic) system maintenance and upgrades.

1-4 Implementation of Agricultural Environmental Management.

1-5 Completion of assessments of municipal nonpoint pollution management practices.

1-6 Development of watershed action plans.

1-7 Preparation for compliance with the Environmental Protection Agency's Stormwater Phase II Final Rule.

1-8 Exploring the feasibility of stormwater management districts.

Outcome 2: Reduced Point Source Pollution

2-1 Assessment of inactive hazardous waste sites.

2-2 Assessment of abandoned and closed landfills.

2-3 Exploring regulation of private petroleum tanks less than 1,100 gallons.

2-4 Evaluation of need for wastewater treatment plant upgrades and outfall relocations.

2-5 Expansion of Village of Patchogue Sewer District.

Table 6-4 South Shore Estuary Study Recommendations to Increase Shellfish Harvest and Protect and Restore Coastal Habitat

South Shore Estuary Study Recommendations to Increase Shellfish Harvest and Protect and Restore Coastal Habitat

Outcome 3: Increased harvest levels of hard clams and other estuarine shellfish species.

3-1 Population assessment and seeding of hard clams and other shellfish species.

3-2 Feasibility of Islip hatchery expansion.

3-3 Increasing grow-out of shellfish.

3-4 Enhancement of hard clam habitat through shell augmentation.

3-5 Evaluation of potential spawner sanctuaries.

3-6 Creation of a Reserve shellfish management forum.

Outcome 4: Coastal habitats protected and restored to support shellfish, finfish and coastal bird populations.

4-1 Restoration of tidal wetlands.

4-2 Coordination of wetland restoration efforts.

4-3 Restoration of anadromous fish.

4-4 Habitat restoration in tributaries.

4-5 Evaluation and restoration of eelgrass beds.

4-6 Vegetation management for coastal birds.

4-7 Recognition of shorebird reserves.

4-8 Increased protection of marine turtle populations.

4-9 Management of upland ponds.

4-10 Augmentation of streamflow.

Table 6-5 South Shore Estuary Study Recommendations to Preserve Open Space and Improve Knowledge for Ecosystem Management

South Shore Estuary Study Recommendations to Preserve Open Space and Improve Knowledge for Ecosystem Management

Outcome 5: Open space preserved to sustain community character and protect water quality and habitat.

5-1 Development of a Reserve open space acquisition and protection action strategy.

5-2 Analysis of small parcel open space opportunities.

5-3 Use of a land trust to assist local acquisition efforts.

5-4 Implementation of local open space plans.

5-5 Acquisition of open space.

Outcome 6: Improved knowledge for ecosystem management.

6-1 Monitoring water quality.

6-2 Land use build-out analysis.

6-3 Determination of additional point and nonpoint source pollution controls.

6-4 Determination of sediment composition in Reserve tributaries and bays.

6-5 Monitoring landfill performance and compliance.

6-6 Analysis of existing information on leaks and spills.

6-7 Development of a Reserve-wide hydrologic model.

6-8 Monitoring the ecosystem.

6-9 Study of hard clam biology.

6-10 Assessment of additional tidal wetland sites for restoration.

6-11 Completion of baseline inventory of eelgrass distribution.

6-12 Undertaking research on flooding and erosion.

6-13 Expansion of brown tide research.

Table 6-6 South Shore Estuary Study Recommendations to Increase Public Use of the Estuary, Sustain Water-Dependent Businesses and Thriving Maritime Centers

South Shore Estuary Study Recommendations to Increase Public Use of the Estuary, Sustain Water-Dependent Businesses and Thriving Maritime Centers

Outcome 7: Increased public use of the estuary and expanded tourism.

7-1 Expanding public access and recreation facilities at existing sites.

7-2 Creating new public access and recreation opportunities.

7-3 Expansion of existing interpretive centers and development of new ones.

7-4 Establishing a South Shore Estuary Reserve Coastal Heritage Trail.

Outcome 8: Water-dependent businesses sustained.

8-1 Provision of adequate infrastructure to support existing and new water-dependent uses.

8-2 Development of a dredging and dredged materials management plan.

8-3 Dredging for safe navigation.

8-4 Planning for local waterfront development.

8-5 Improving local waterfront regulation.

Outcome 9: Maritime centers thrive.

9-1 Preparation of maritime center action plans.

9-2 Implementation of maritime center action plans.

9-3 Promotion of maritime centers.

Table 6-7 South Shore Estuary Study Recommendations to Increase Public Use of the Estuary, Sustain Water-Dependent Businesses and Thriving Maritime Centers

South Shore Estuary Study Recommendations to Heighten Public Awareness of the Estuary and Advance Council Partnerships

Outcome 10: Heightened public awareness of the estuary.

10-1 Supporting a Reserve web site.

10-2 Updating education resource directory.

10-3 Creation of an access guide.

10-4 Production of South Shore video.

10-5 Working with outreach partners.

10-6 Identification of professional development opportunities for teachers.

10-7 Supporting the existing network of entities that conduct education programs on board watercraft.

10-8 Identification of potential mentors.

10-9 Establishment of a clearinghouse for student research.

10-10 Establishing an awards program.

10-11 Designation of bird conservation areas.

10-12 Undertaking a native landscaping pilot program.

10-13 Creation of a homeowner certification program.

Outcome 11: Actions advanced through Council partnerships and office.

11-1 Promotion and oversight of plan implementation.

11-2 Establishment and operation of Reserve office.

Projects to Improve and Maintain Water Quality

Implementation Outcome 1: Reduced Nonpoint Source Pollution

The primary water quality concern in the SSER is nonpoint source pollution. Stormwater runoff transports pollutants, which impairs living resources, deteriorates the SSER related economy, and diminishes the public's use and enjoyment. Reducing nonpoint pollution requires improved policies and regulations, adopting best management practices, completing watershed management plans, and encouraging watershed-friendly practices through education and outreach.

Implementation Outcome 2: Reduced Point Source Pollution

Point sources of pollution—typically discrete and discernible pipe outfalls that discharge directly into surface waters—are generally not widespread, but can cause significant water quality impacts in their immediate areas. Point sources of pollution are regulated and monitored through the State Pollution Discharge Elimination System (SPDES) permit program.

The Long Island SSER Comprehensive Management Plan Implementation Status Report- April 2001- July 2003, called on local governments in the Reserve to assume a leadership role in reducing nonpoint source pollution. Under the priority goal of Improving and Maintaining Water Quality, most of the work effort was focused on stormwater runoff inventories, stormwater abatement projects and plans; the creation of a stormwater runoff work group, watershed studies for Ketchams Creek, Beaver Dam Creek and Mud Creek; and baseline water quality monitoring efforts. An analysis of historical stream flow and nitrogen data was published by the USGS to aid in the understanding of the effects of urbanization on the South Shore tributaries and bays.

In 2006, the report entitled, ***Partners for Progress*** was prepared by the LI SSER Council, which outlined the SSER CMP Accomplishments from 2003-2005. Under Outcome 1: Reduced Nonpoint Source Pollution, most of the work effort was focused on stormwater runoff infrastructure mapping and abatement projects. The development of Watershed Management Plans was also undertaken for Brown's River, Green's Creek, Swan River, Quantuck Creek and Forge River.

As chair of the South Shore Estuary Reserve Council (SSERC), the New York State Department of State (DOS) collaborates extensively with SSERC members and others to achieve coastal resource protection and waterfront revitalization within the SSER. Together the DOS and SSERC successfully advanced nonpoint source pollution projects and best management practices for improved surface water quality, while protecting habitats, and ensuring a high level of public estuary use with increased opportunities for regional tourism.

According to the ***Implementation Status Report 2006-2010,*** from January 1, 2006 through December 31, 2010, New York State supported 94 projects in the SSER that are advancing state and regional priorities resulting in significant implementation of the SSER CMP for water quality protection, habitat restoration, and estuary-related economic support. Many of the projects were funded through the Environmental Protect Fund (EPF), leveraging more than $31.6 million in federal and local government funds for a total of more than $74.9 million toward SSER CMP implementation in these areas:

Improve and Maintain Water Quality: 34 projects funded ($15.3 million)

Protect and Restore Living Resources: 27 projects funded ($28.2 million)

Expand Public Use and Enjoyment of the SSER: 25 projects funded ($12.3 million)

Sustain and Expand the Estuary-related Economy: 6 projects funded ($18.1 million)

Increase Education, Outreach and Stewardship: 2 projects funded ($756 thousand)

Coupled with state agency technical assistance to local governments and SSER partners, these projects implement specific SSER CMP recommendations for watershed management plan development, water quality assessment, improved stormwater management, marine species restoration, maritime trail and signage development, historic building restoration and preservation, and shoreline erosion control. An additional 119 projects/activities supporting SSER CMP priorities reported to the DOS and funded entirely by counties, city, towns, villages, or non-governmental organizations resulted in more than $59.8 million toward advancement of CMP implementation actions. Not all projects, or amounts for projects, may have been reported. The combined total for New York State-assisted and reported partner-funded projects in the SSER between 2006 and 2010 is more than $134.8 million.

The 2006 – 2010 Significant Accomplishments listed below are for the projects undertaken to ***Improve and Maintain Water Quality***.

Municipalities throughout the SSER completed 20 stormwater improvement projects, including installation of more than 2,000 new catch basins, catch basin inserts or other devices, to capture, filter and reduce pollutants from reaching SSER bays. Thirteen of these projects mitigated stormwater impacts by altering drainage patterns, installing sediment reduction/filtering features and, where appropriate, improving water flow. In addition to improved water quality in the estuary, these projects protect habitats from degradation.

All SSER municipalities completed assessments of their nonpoint management practices to comply with the US EPA Municipal Separate Storm Sewer System (MS4) requirements. In addition, municipalities embarked on 12 stormwater management/watershed planning projects, which include evaluating existing watershed conditions, mapping stormwater conveyance systems, identifying and prioritizing mitigation projects, developing an implementation strategy, identifying best management practices, and preparing construction plans, specifications and estimates.

Municipalities have increased efforts to sweep streets, clean catch basins, remove settleable solids from swirl separators, and maintain stormwater infrastructure on a regular basis. Eight new street sweepers and vacuum eductor trucks were purchased to provide additional stormwater infrastructure

cleaning capability to remove pollutants and sediments from entering the south shore estuary.

SSER municipalities increased capacity to improve water quality by adding seven new pumpout vessels and one land-based pumpout facility to eliminate discharge of septic waste from recreational boats into south shore bays by removing and properly disposing of waste. It is estimated that the new pumpout vessels collected more than 200,000 gallons of boater septic waste between 2006 and 2010. Numerous federal, state and municipally operated land-based pumpout facilities continued receiving recreational boater septic waste. In 2009, the existence of adequate pumpout facilities enabled the USEPA to declare the SSER a Vessel No Discharge Zone under the federal Clean Water Act.

SSER enabling legislation charged the SSERC with reviewing the effectiveness of the SSER CMP's implementation actions and to make revisions accordingly. Water quality impairments and habitat degradation remain pressing issues. Emerging sea level rise and climate change threats will affect the SSER and questions about shoreline sustainability remain unanswered. Reviewing progress over the past 10 years as well as defining specific implementation actions necessary over the next decade to minimize flooding and erosion threats and enhance biological viability are all priorities.

Leading the effort to protect the estuary's future, the DOS is preparing a Long Island South Shore Estuary (SSE) Amendment to the NYS Coastal Management Program for Water Quality Improvement, Habitat Protection, and Climate Change Adaptation. An SSE Amendment will achieve greater collaboration between the SSERC and partners to protect and restore critical coastal resources, enable SSE communities to adapt to climate change, and focus on critical areas where further actions are needed to benefit the SSE. With expertise in interpreting scientific information into sound coastal resource management the DOS is well positioned to facilitate partnerships, coordinate multi-level interaction between constituents, and replicate successes across the SSE.

The SSE amendment will provide state, federal and local governments with new information and current scientific knowledge to improve decisions affecting the SSE's health. It will be based on the DOS and SSERC's knowledge of the region, as well as pertinent information generated from the Oceans and Great Lakes Ecosystem Conservation Council and other initiatives such as the NYS Seagrass Task Force, NYS Sea Level Rise Task Force and NYS Climate Action Council.

Suffolk County funded and partner-funded projects/activities that are being implemented to improve and maintain Great South Bay water quality are summarized on **Tables 6-8** through **6-10.**

Table 6-8
Suffolk County Projects to Improve and Maintain Great South Bay Water Quality

Watershed Boundary Delineations, 2006
Suffolk County Soil and Water Conservation District determined the surface flow watershed boundaries for Mud Creek, Swan River and Forge River in Brookhaven Town. These boundary delineations help identify best management practices in each watershed.

Removal and Disposal of Obsolete Underground Petroleum Storage Tanks
Suffolk County Water Quality Protection and Restoration Program, 2008. Total project cost: $111,000
Suffolk County is removing and disposing of 24 underground petroleum storage tanks throughout the county to protect soil and water from potential petroleum contamination. The tanks are obsolete due to conversion to natural gas heating fuel or because the buildings served by the tanks are scheduled for demolition.

Suffolk County Water Quality Protection and Restoration Program, 2008. Total project cost: $70,000
Suffolk County is developing standard operating procedures for inspecting petroleum and chemical tanks and preventing leaks. The manual will standardize design, operation and environmental compliance for underground and above ground tanks to help prevent soil and groundwater contamination.

Stormwater Remediation, Yaphank Lakes and Carmans River
Suffolk County Water Quality Protection and Restoration Program, 2009. Total project cost: $200,000
Suffolk County is implementing stormwater runoff improvements at four discharge points along a 1.4-mile stretch of CR 21 in Brookhaven Town to prevent pollutants from entering the Yaphank Lakes and Carmans River. Project includes a detailed topographic survey and drainage system reconnaissance; preparing design alternatives, including information on flow rate, pollutants of concern, and construction cost/benefit analysis; preliminary design and necessary permits; and final construction plans, specifications, and estimates.

Local Law Adopted, 2008
Fertilizer Nitrogen Pollution Reduction: Suffolk County adopted a local law to reduce nitrogen pollution from fertilizer. The law prohibits applying fertilizer during cold months and on most county-owned properties year-round, and includes training requirements for licensed landscapers and educational programs at the retail level. The legislation is an important step toward restoring SSER water quality.

Table 6-9 New York State-Assisted Projects to Improve and Maintain Great South Bay Water Quality

Babylon (T)	Digitization of Babylon Drainage Infrastructure
Babylon (T)	Carlls River Watershed Environmental Clean-up
Babylon (V)	Purchase of Street Sweeper to Implement Stormwater Management Program
Babylon (V)	Purchase of Drain Cleaning Equipment to Implement Stormwater Management Program
Brightwaters (V)	Stormwater Infrastructure Mapping with Pollutant Mitigation Assessment
Islandia (V)	Implementation of Required Stormwater Laws
Islip (T)	Implementation of Green's Creek and Brown's River Watershed Management Plan
Islip (T)	Tariff Street Stormwater Mitigation
Patchogue (V)	Wastewater Treatment Plant Reconstruction and Expansion
Bellport (V)	Former Bellport Gas Station Remediation (Suffolk County project)
Brookhaven (T)	Illicit Discharge Reporting and Response Program
Brookhaven (T)	Tuthills Creek Watershed Management Plan
Brookhaven (T)	Swan River Watershed Management Plan Implementation
Brookhaven (T)	Pine Neck Boat Ramp Drainage Implementation
Brookhaven (T)	Beaver Dam Creek Watershed Management Plan
Brookhaven (T)	Stormwater Remediation to Narrow Bay at County Rd. 46, William Floyd Parkway (segment 1) (Suffolk County project)
Brookhaven (T)	Upgrade Waste Water Treatment System in the Lower Forge River Watershed (Suffolk County Soil and Water Conservation District project)
Brookhaven (T)	Forge River Watershed Management Plan
Brookhaven (T)	Forge River Total Maximum Daily Loads

Table 6-10 Projects to Improve and Maintain Great South Bay Water Quality with Other Cooperators

National Park Service, U.S. Department of the Interior, Fire Island National Seashore (FINS)
Groundwater-Submarine Aquifer Relationship Study, Ongoing
FINS, in cooperation with the United States Geological Survey (USGS), is examining the nature of groundwater and surface water interactions and associated nutrient fluxes along the Great South Bay shoreline by measuring quantity, quality, and variability of submarine groundwater discharge at representative locations. Results will be used to help limit groundwater as a source of nonpoint pollution.

U.S. Army Corps of Engineers (USACE)
Forge River Watershed Ecosystem Restoration and Flood Damage Reduction Reconnaissance Study, 2008; and Feasibility Study, 2009
Total project cost: $3,100,000 (USACE: $1,600,000; Brookhaven Town funds: $1,500,000)
USACE completed a Section 905 (b) Reconnaissance Study for the Forge River watershed which confirmed a federal interest in participating in a cost-shared Feasibility Study to evaluate environmental restoration improvements to the Forge River watershed. USACE completed a Forge River Feasibility Study Project Management Plan, which made recommendations for integrated and enhanced existing water quality monitoring and implementation efforts that contribute to a healthy Forge River. Brookhaven Town matched funds for the Feasibility study.

Babylon
Green Homes Septic Assistance Program, 2010
Babylon Town is implementing its *Green Homes Septic Assistance Program,* which allows residents to install modern and efficient septic systems with no upfront costs. The Town will apply a benefit assessment to the property that will pay up to $12,000 for the upgraded system. Participants save money by having to perform maintenance on their systems less frequently. The program was first implemented in the Carlls River area as the high water table minimizes the ground's leaching capability. System upgrades can result in a 50 percent reduction in nitrogen loads to groundwater resources.

With the SSERC, the DOS will continue to pursue opportunities to improve and protect the SSER with strong technical assistance and leadership.

Next Steps for SSER

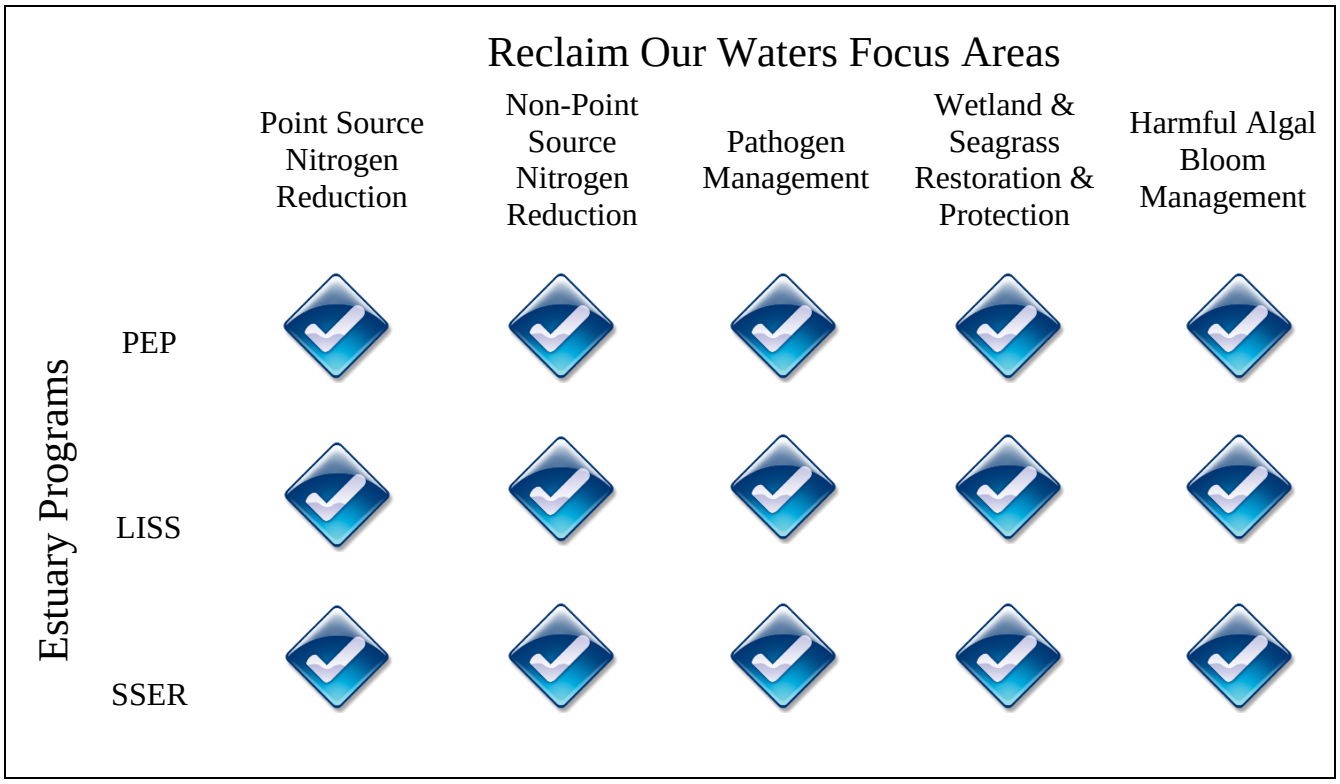
At the present time, the Department of State Office of Planning and Development (OPD) is working on the following three SSER CMP water quality initiatives in Suffolk County:

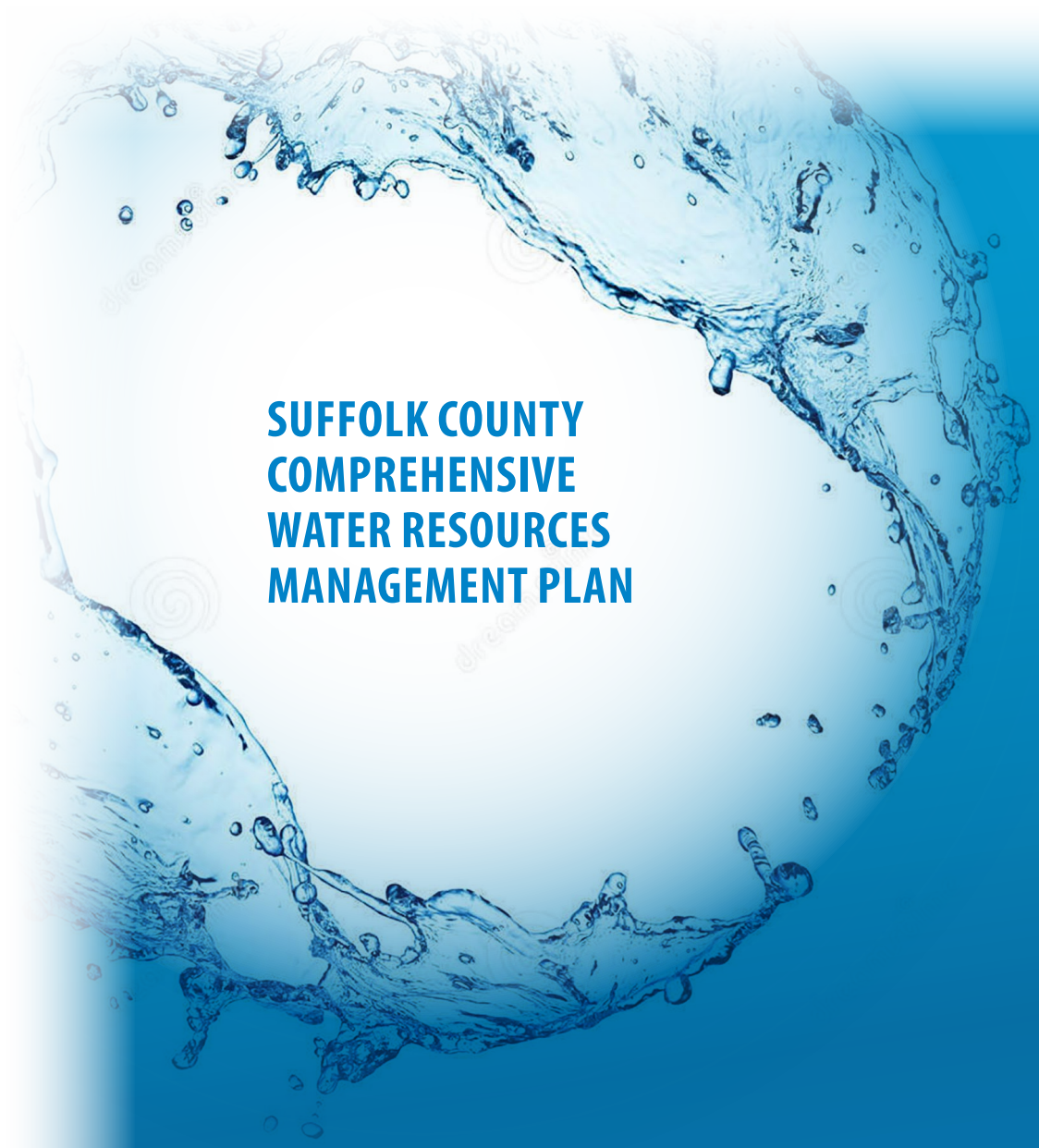
- The Long Island South Shore Estuary Reserve Eastern Bays Project: Nitrogen Loading, Sources and Management Options is in final stages of completion by Stony Brook University School of Marine and Atmospheric Sciences.
- Coordinated Water Resources Monitoring Strategy Update for the SSER was started in October 2014 by the United States Geological Survey (USGS) and will take two years to complete.
- Evaluate Innovative/Alternate Sewage Disposal Systems within the SSER is proposed for a contract with Suffolk County Department of Health Services in 2015.

The SSER Office continues to be in operation, but without a Director at the present time. According to the Long Island SSER Office, OPD anticipates the preparation of the next SSER CMP Implementation Status Report for 2011-2014 in 2015. With regard to updating the SSER Comprehensive Management Plan, the OPD is evaluating how to proceed.

6.5 Summary

All three of the major estuaries surrounding Suffolk County are well served by stakeholder-driven consensus-building management frameworks focused on improving water quality and habitats in their respective estuaries. Suffolk County is uniquely positioned where the many common goals of these three regional programs intersect. Suffolk County could serve as a coordinating entity among these three programs where the top priority common goals, most importantly the reduction of non-point source nutrient pollution which is also the top priority for Suffolk County, can be enhanced through collaboration and joint implementation. This would, in turn, reinforce Suffolk County's role as a key partner in CCMP implementation for all three estuary programs.


Reclaim Our Waters Focus Areas
Point Source Nitrogen Reduction
Non-Point Source Nitrogen Reduction
Pathogen Management
Wetland & Seagrass Restoration & Protection
Harmful Algal Bloom Management
Estuary Programs
PEP
LISS
SSER



SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Section 7
COASTAL RESILIENCY

Section 7
Coastal Resiliency

"As an island that juts out into the Atlantic, we are as vulnerable to climate change as any place in the world.... This is not an academic exercise for Long Island.... This is an existential challenge we are facing."
-Steve Bellone (https://www.youtube.com/watch?v=erqy9_230Ns&sns=em)

Figure 7-1 Distressed Dolphin – Gilgo Beach, Long Island ***(photo by Jedidiah Dale)***

Superstorm Sandy made it personal. Perched on the coastline, as so many Long Islanders are, we're the proverbial canaries in a coal mine. We've been watching sea level rise and beach erosion for some time now. Sandy pressed the pedal of climate change to the metal and blew away long-standing dunes, surging over depleted wetlands on its way to steamroll Long Island's 'mainland,' leaving billions in damage in its wake. Down the coast, calamity burned one hundred ten Breezy Point houses to the ground. "*Never send to ask for whom the bell tolls*," Donne wrote. "*It tolls for thee*."

Figure 7-2 Exposed Sub-foundation of Old Gilgo Coast Guard Station after Sandy Swept Away 8 Foot Depth of Sand

We now know that 900 mile-wide Superstorm Sandy was the largest Atlantic storm in recorded history fueled by unprecedented late-season, ocean-expanding warmth (+5°F) augmented by elevated levels of atmospheric moisture which was driven into a most unusual left turn by a "3-sigma" blocking high over Greenland following the largest Arctic sea ice melt in human history plus the unprecedented near total melt during four days in July, 2012 of the Greenland ice sheet. Note the elements of climate change contributing to storm intensity: elevated atmospheric temperature, warmer, expanded ocean waters, increased precipitation, sea-level rise compounded by land subsidence, and coastal degradation. Whither coastal resiliency?

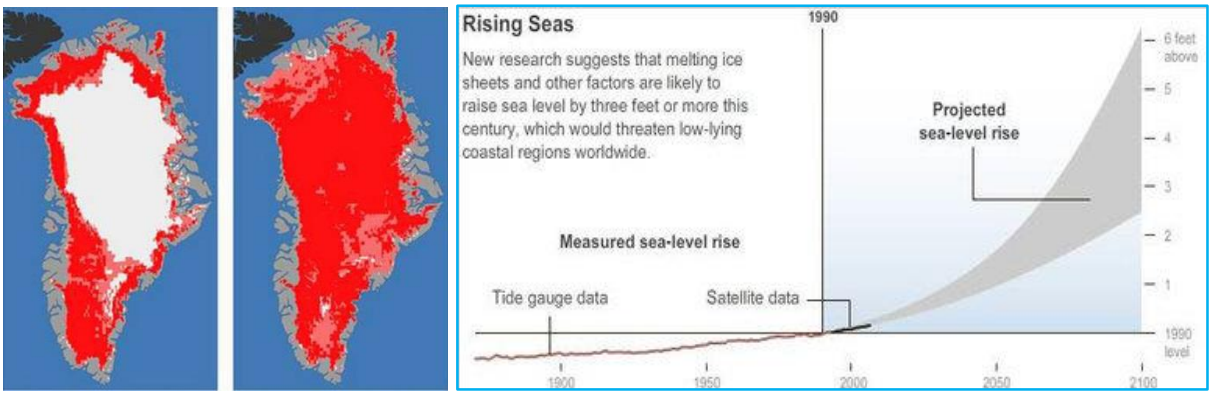


Figure 7-3 In advance of Sandy, NASA Satellite Images of Unprecedented Greenland Ice Sheet Melt from July 8-12, 2012, Melt Area Going from 40% of the Ice Sheet to 97% (Previous Maximum 55%)
NASA; CNES; Center for Remote Sensing of Ice Sheets, U Kansas

7.1 Coastal Facts

According to the National Oceanic and Atmospheric Administration (NOAA) 39% of the United States' population, 123 million people, live in coastal counties, and that number is expected to rise to 134 million by 2020, on the basis of an analysis NOAA conducted with the United States Census Bureau. The United States Commission on Ocean Policy weighs in with a larger percentage – 52% living in less than 25% of the United States land mass in coastal communities (www.oceancommission.gov).

The United States was founded on the coast, and more than ever, coastal regions remain key to the U.S. economy. "Shore adjacent counties comprise 37% of overall employment on just 17.5% of United States land area" (another variation). Coastal states account for 81.5% of the U.S. population and 83.4% of economic output. In 2012, the coastal zone counties accounted for 51% of employment in coastal states, 42% of total national employment, 57% of gross domestic product (GDP) in coastal states, 48% of national GDP. U.S. coastal states together produce a GDP larger than that of any other single country (National Ocean Economics Program, www.oceaneconomics.org). "Predictions suggest that 25% of homes within 500 feet of the coast could be lost to erosion in the next 60 years, at a potential cost of $530M each year." (C. Landry, "Coastal Erosion as a Natural Resource Management Problem: The State of Economic Science and Policy," Center for Coastal Systems Informatics and Modeling, East Carolina University, 2010) While beach replenishment averaged $0.14B/year, coastal tourism and recreation alone contributed $78.5B/year to the U.S. GDP.

Table 7-1 Employment and GDP in Coastal Communities – Nationwide and New York State

Region	Employ-ment (million)	GDP ($trillion)	Population (million)	Land Area (million sq. miles)
United States (national)	131.7	$15.57	313.9	3.54
All coastal states	107.3	$12.99	255.8	2.02
Coastal States % U.S.	81.5%	83.4%	81.5%	57.0%
Shore-adjacent counties	48.8	$6.60	116.5	0.62
Shore-adjacent % U.S.	37.0%	42.4%	37.1%	17.5%
Watershed counties	67.0	$8.73	162.3	1.06
Watershed % U.S.	50.9%	56.1%	51.7%	30.0%

	Employment	Wages ($billion)	GDP ($billion)
State	8,563,653	$536.7	$1,205.9
Shore-adjacent	6,506,129	$442.1	$1,015.8
Shore-adjacent % of State	76.0%	82.4%	84.2%

US employment, GDP, population & land area vs coastal areas, www.oceaneconomics.org; 2012 New York shore-adjacent counties, 2012 population 75.5%

7.2 Coastal Vulnerability/Sea Level Rise

We are moving into uncharted and, to a significant degree, uncharitable waters. Sea level rise is a Sandy-like storm surge in slow motion—an inexorable, decade-by-decade phenomenon that hardly creates a sense of immediate crisis. Under normal, everyday circumstances, 3 feet separate the water level and the top of the quay. Should even the most moderate predictions of sea level rise be accurate, levels will rise 2 feet between now and 2100, leaving but a foot between the water level and the top of the quay. Less moderate predictions warn of a sea level rise of 6 feet. The most recent report from the Intergovernmental Panel on Climate Change (IPCC, 2013) predicts that climate warming will cause a mean increase of 1.4 to 2.4 feet in sea level by 2100. The National Research Council (2012) predicts an even larger increase of 1.7 to 4.6 feet by 2100.

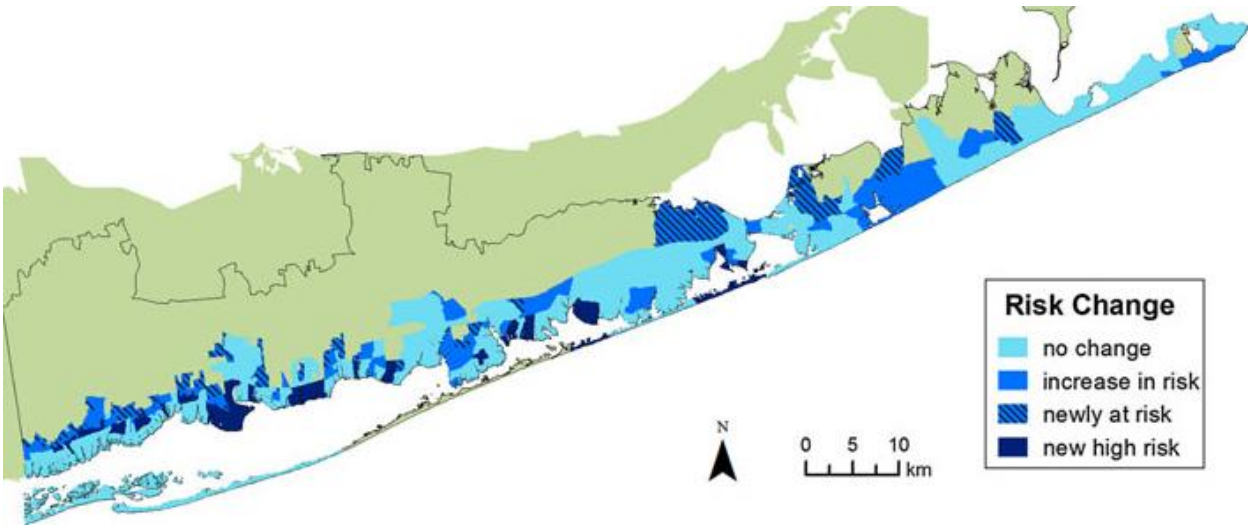


Figure 7-4 Predicted Future Storm Surge Risk Resulting from Sea Level Rise

"Modest and probable sea level rise (.5 meters by 2080) vastly increases the numbers of people (47% increase) and property loss (73% increase) impacted by storm surge." (C. Shepard, et al, "Assessing future risk: quantifying the effects of sea level rise on storm surge risk for the southern shores of Long Island, New York," Nat Hazards 60:727–745, 2012). Recent observations concerning climate change include:

- Temperatures in the Northeast have increased by almost 2˚F (0.16˚F per decade), and precipitation increased by approximately five inches, or more than 10%, 0.4"/decade (K. Kunkel, et al, 2013: "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 1," Climate of the Northeast U.S. NOAA Technical Report NESDIS 142-1, 2013).

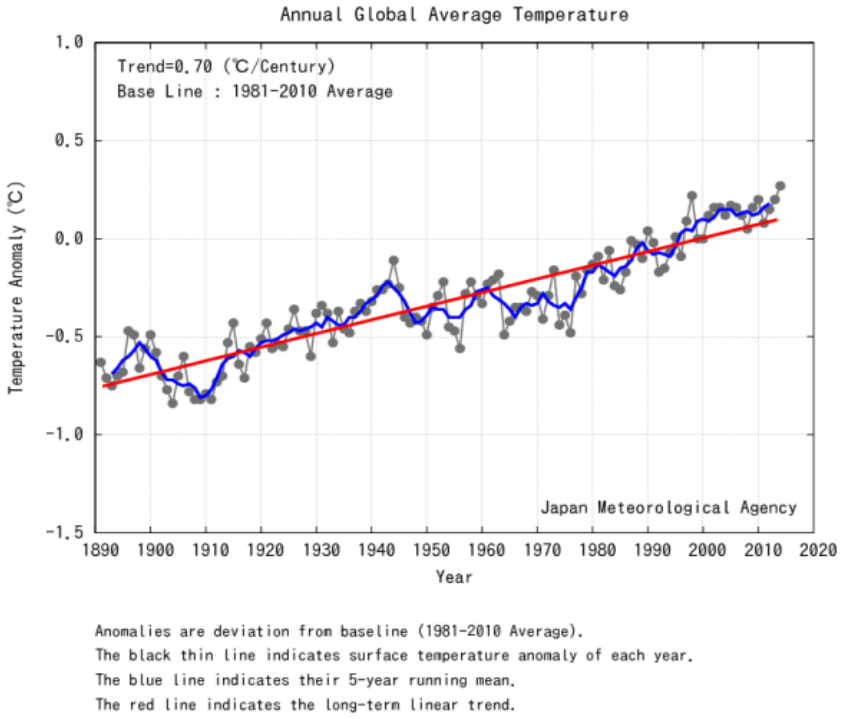


Figure 7-5 Increase in Average Global Temperature

- Coastal flooding has increased due to a rise in sea level of approximately 1 foot since 1900.

- Sea level rise of two feet, without any changes in storms, would more than triple the frequency of dangerous coastal flooding throughout most of the Northeast. Sea level rise along most of the coastal northeast exceeds the global average of approximately 8 inches and is expected to exceed the global average rise due to local land subsidence, with the possibility of even greater regional sea level rise if the Gulf Stream weakens, as some models suggest (J. Church, et al., "Understanding Sea-Level Rise and Variability," Blackwell, 2010).

- The New York State Sea Level Rise Task Force Report to the Legislature (2010) observes that local sea levels are affected by ocean currents, gravitational forces, prevailing winds, and rise and fall of the land mass, i.e. subsidence, with the coastal land mass of New York slowly sinking at 1.35 mm/year (http://www.ngs.noaa.gov/CORS_Map/).

- **R**ecent research suggests that changes in ocean circulation in the North Atlantic – specifically, a weakening of the Gulf Stream – may also play a role (A. Sallenger, et al., "Hotspot of accelerated sea-level rise on the Atlantic coast of North America," Nature Climate Change, 2, 884-888, doi:10.1038/nclimate1597, 2012).

- Recently, there has been a steeper rise in extreme precipitation in the Northeast than in any other region in the United States. The rate of increase from 1895 to 2011 has been 0.4"/decade (Horton et al., 2014). But from 1958 to 2010, the Northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events (P. Groisman, "Recent trends in regional and global intense precipitation patterns. Climate Vulnerability," R. Pielke, Sr., Ed., Academic Press, 2013).

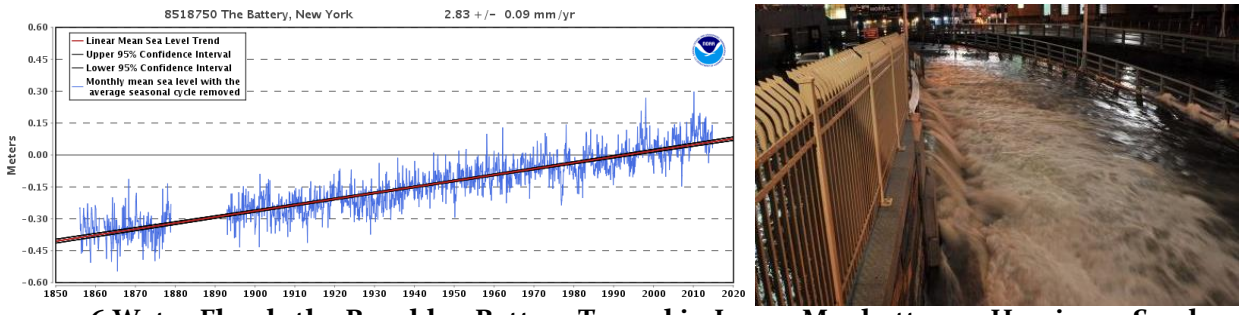


Figure 7-6 Water Floods the Brooklyn Battery Tunnel in Lower Manhattan as Hurricane Sandy Pounds 10/29/12

Gauges at the New York City Battery indicate that sea level in the 2000s is 4 to 6 inches higher than in the early 1960s. Mean sea level data from 1856 to 2013 is equivalent to a change of 0.93 feet in 100 years.

Table 7-2 Sea Level Projections – Montauk Point Region/"Climate Change in New York State"

Baseline (2000-2004) 0 inches	Low Estimate (10th Percentile)	Middle Range (25th to 75th Percentile)	High Estimate (90th Percentile)
2020s	2 in	4 to 8 in	10 in
2050s	8 in	11 to 21 in	30 in
2080s	13 in	18 to 39 in	58 in
2100	15 in	21 to 47 in	72 in

Source New York State Energy Research and Development Authority (Sept, 2014)

- As ocean temperatures continue to rise, the range of suitable habitat for many commercially important fish and shellfish species is projected to shift northward. For example, cod and lobster fisheries south of Cape Cod are expected to have significant declines. (P. Frumhoff et al., "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment," Ch. 3: 'Marine impacts' Union of Concerned Scientists, 2007)" Hospitable habitats will be shrinking for some species, like coldwater brook trout, and expanding for others like warmwater bass.

- Beach and dune erosion, both a cause and effect of coastal flooding, is also a major challenge in the Northeast (F Buonaiuto, et al. 2011 "Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation in New York State," Ch. 15: Coastal zones, 2011, M. Phillips & A. Jones, "Erosion and tourism infrastructure in the coastal zone: Problems, consequences and management." Tourism Management 27:517-524, 2006).

- Since the early 1800s, there has been an estimated 39% decrease in marsh coverage in coastal New England (K. Gedan, et al., 2009: "Centuries of human-driven change in salt marsh ecosystems." Annual Review of Marine Science, 2009). Impervious surfaces and coastal barriers such as seawalls limit the ability of marshes to expand inland as sea levels rise. (R. Nicholls, & A. Cazenave, 2010: "Sea-level rise and its impact on coastal zones," Science, 328, 2010).

- Temperatures are warming across New York State, with an average rate of warming over the past century of 0.25 °F per decade.

- Vector-borne diseases are an on-going concern. Most incidents of Lyme disease in the U.S. occur in the Northeast. Several studies have linked tick activity and Lyme disease incidence to climate, specifically abundant late spring and early summer moisture (G. McCabe & J. Bunnell, "Precipitation and the occurrence of Lyme disease in the northeastern United States," Vector-Borne and Zoonotic Diseases, 4, 2004). West Nile Virus (WNV) is another vector-borne disease likely to be impacted by climate changes because longer, warmer summers would favor increases in the duration and intensity of virus activity. The human population in the northeast subject to infestations of the Asian Tiger mosquito (ATM), is projected to increase from the current 5% to 16% in the next two decades and from 43% to 49% by the end of the century (I. Rochlin, et al., "Climate change and range expansion of the Asian tiger mosquito (Aedes albopictus) in northeastern USA: Implications for public health practitioners," PLoS ONE, 8, e60874, doi:10.1371/journal.pone.0060874, 2013). This range expansion is significant because this species, besides being a significant biting pest, is a competent vector for WNV and tropical viruses such as dengue (DEN) and Chikungunya (CHIKV). The ATM was the likely vector for a local case of DEN in Suffolk County in 2013, demonstrating that the appearance and expansion of the ATM in the northeast brings with it the possibility of DEN and CHIKV transmission where it previously had not been a concern. Higher average sea level and increased frequency of intense coastal flooding may change populations of mosquitoes associated with coastal wetlands such as the WNV and Eastern Equine Encephalitis (EEE) vectors Culex salinarius and Aedes sollicitans. The management of coastal wetlands to improve coastal resiliency needs to take into account how management efforts could impact associated mosquito species.

- Northeast Farms, subject to the most substantial increase in heavy rainfalls in the country, directly suffer crop damage, in addition to the fact that wet springs can delay planting which delays harvest dates and reduces yields (J. Hatfield, et al., "Climate impacts on agriculture: Implications for crop production" Agronomy Journal, 103, 2011). In the future, farmers may also face insufficient water as summers become hotter and growing seasons lengthen. (K. Hayhoe, et al., "Past and future changes in climate and hydrological indicators in the US Northeast," Climate Dynamics, 28, 2007) (D Wolfe, et al., 2011: Ch. 7: Agriculture. Responding to Climate Change in

New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation in New York State," Ch 7: Agriculture Blackwell Publishing, 2011).

- Increased weed and pest pressure associated with longer growing seasons and warmer winters will present earlier arrival and increased populations of some insect pests such as corn earworm. The "invasive" weeds with the so-called C3 photosynthetic pathway, benefit more than crop plants from higher atmospheric carbon dioxide, and become more resistant to herbicide control (L. Ziska & K. George, "Rising carbon dioxide and invasive, noxious plants: Potential threats and consequences. World Resource Review, 16, 2004). Glyphosates, like Roundup, the most widely-used herbicide, lose their efficacy with weeds nourished by increased carbon dioxide (L. Ziska, et al., 1999: "Future atmospheric carbon dioxide may increase tolerance to glyphosate," Weed Science, 47, 1999).

- The impacts of sea level rise and coastal flooding on infrastructure are summarized by **Table 7-3** on the following page.

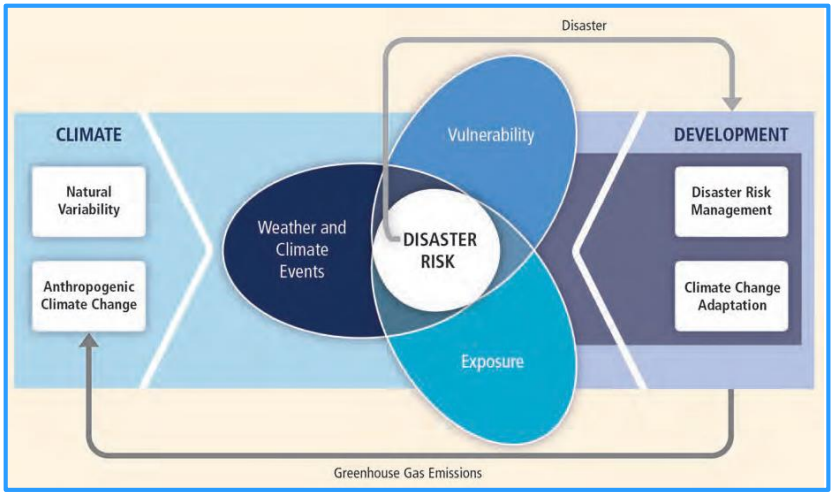


Figure 7-7 Intergovernmental Panel on Climate Change Summary for Policymakers
(C. B. Field, et al, 2014)

It should be noted that there are discrepancies in estimates in terms of sea level rise over the past century which, in turn, impacts projections for the coming century. A team of researchers from Harvard and Rutgers report in Nature that sea level rise over the 20th century may, in fact, be 5 inches rather than 6 inches. This small difference of one inch translates into a huge difference in water, on the order of two quadrillion gallons. If these findings are correct, it goes a long way in explaining where all this water could conceivably have come from as it was not explicable in terms of ice melt or expanding oceans due to warming (C. Hay, et al., "Probabilistic reanalysis of twentieth-century sea-level rise," Nature (2015), doi:10.1038/nature14093).

Table 7-3 Impacts of Sea Level Rise and Coastal Floods on Coastal Infrastructure

Table 16.1. Impacts of sea level rise and coastal floods on critical coastal infrastructure by sector. Sources: Horton and Rosenzweig 2010,[51] Zimmerman and Faris 2010,[52] and Ch. 25: Coasts.

Communications	Energy	Transportation	Water and Waste
Higher average sea level			
• Increased saltwater encroachment and damage to low-lying communications infrastructure not built to withstand saltwater exposure • Increased rates of coastal erosion and/or permanent inundation of low-lying areas, causing increased maintenance costs and shortened replacement cycles • Cellular tower destruction or loss of function	• Increased coastal erosion rates and/or permanent inundation of low-lying areas, threatening coastal power plants • Increased equipment damage from corrosive effects of saltwater encroachment, resulting in higher maintenance costs and shorter replacement cycles	• Increased saltwater encroachment and damage to infrastructure not built to withstand saltwater exposure • Increased coastal erosion rates and/or permanent inundation of low-lying areas, resulting in increased maintenance costs and shorter replacement cycles • Decreased clearance levels under bridges	• Increased saltwater encroachment and damage to water and waste infrastructure not built to withstand saltwater exposure • Increased release of pollution and contaminant runoff from sewer systems, treatment plants, brownfields, and waste storage facilities • Permanent inundation of low-lying areas, wetlands, piers, and marine transfer stations • Increased saltwater infiltration into freshwater distribution systems
More frequent and intense coastal flooding			
• Increased need for emergency management actions with high demand on communications infrastructure • Increased damage to communications equipment and infrastructure in low-lying areas	• Increased need for emergency management actions • Exacerbated flooding of low-lying power plants and equipment, as well as structural damage to infrastructure due to wave action • Increased use of energy to control floodwaters • Increased number and duration of local outages due to flooded and corroded equipment	• Increased need for emergency management actions • Exacerbated flooding of streets, subways, tunnel and bridge entrances, as well as structural damage to infrastructure due to wave action • Decreased levels of service from flooded roadways; increased hours of delay from congestion during street flooding episodes • Increased energy use for pumping	• Increased need for emergency management actions • Exacerbated street, basement, and sewer flooding, leading to structural damage to infrastructure • Episodic inundation of low-lying areas, wetlands, piers, and marine transfer stations

Source: Climate Change Impacts in the United States – The Third National Climate Assessment

7.3 Coastal Resiliency & Risk Management

The National Research Council (NRC) defines *resilience* as "the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events." Our coasts have always held both economic and intrinsic value for Long Islanders, but it is only recently that we've come to appreciate the expanse of its defensive role. In "Reducing Coastal Risk on the East and Gulf Coasts, (2014)" the NRC, in a broad five-year roadmapping of issues for the U.S. Army Corps of Engineers, identifies two strategies for managing coastal storm risks, one remaining in place, the other for retreating (p xi):

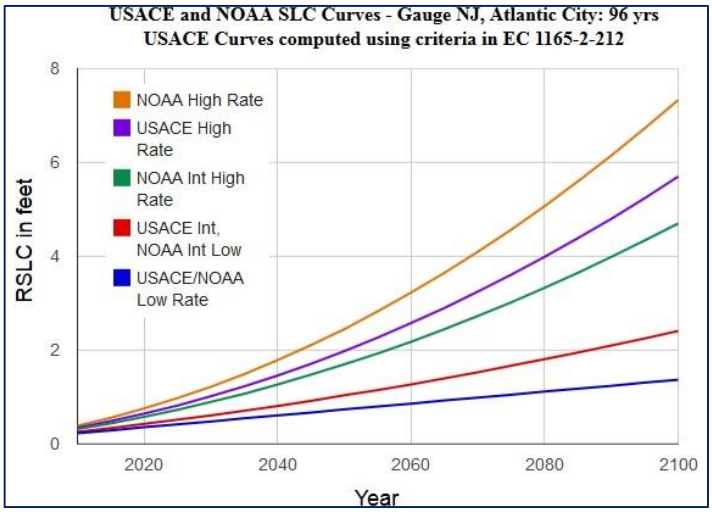
1. "One set of strategies aims to reduce the probability of flooding or wave impact. These include hard structures, such as seawalls, levees, flood walls, and storm surge barriers, and nature-based risk reduction strategies, such as beach nourishment, dune building, and restoration or expansion of natural areas, such as oyster reefs, salt marshes, and mangroves."

2. "Another set of strategies aims to reduce the number of people or structures in areas at risk or to make them less vulnerable to coastal storms. These include design strategies, such as elevating or floodproofing buildings and "nonstructural strategies" such as relocation and land-use planning to steer future development or redevelopment away from high hazard areas…."

To date, provision of substantial post-disaster aid has largely trumped proactively managing risk. But as NRC observes, "Given the existing investment, strategic importance, and intrinsic desirability of living in coastal areas, it is unrealistic to believe that we will abandon most of these areas in the foreseeable future." At this point, it is incumbent upon us to deploy "Strategies that reduce the consequences of coastal storms, such as hazard zoning, building elevation, land purchase, and setbacks, have high documented benefit-cost ratios… between 5:1 and 8:1 for nonstructural and design strategies that reduce the consequences of flooding." From 2004 and 2012, federal funds for such strategies constituted but 5% of disaster relief funds, compounded by a lack of alignment of risk, reward, resources, and responsibility across innumerable federal agencies.

7.3.1 Strategic Retreat/ Staying Put

"At one point, you have to say maybe Mother Nature doesn't want you here. Maybe she's trying to tell you something," Gov. Andrew Cuomo observed, in earmarking $400M for a buyout program of vulnerable coastal houses in early February, 2013. By mid-October, 2014, there were only 505 takers for a total of $212M. Given the market value of many of the buyout houses, the $420K selling price was a distinct premium over market, but one which, nonetheless, did not attract significant uptake, the vast majority of those eligible opting to stay put.



http://www.globalchange.gov/browse/sea-level-rise-tool-sandy-recovery

Figure 7-8 Sea Level Rise Projections

Rolling Easements (2009), as defined by EPA's James Titus "are government regulations or transfers of property rights that decrease or eliminate the continued use and enjoyment of coastal property as sea level rises." With "rising sea level inundating low-lying lands, eroding beaches, and exacerbating coastal

flooding,…" rolling easements, aka 'strategic retreat,' are proffered as a primer on "approaches for ensuring that wetlands and beaches can migrate inland, as people remove buildings, roads, and other structures from land as it becomes submerged." It comes with the caveat that the proposed tools are not what *should* be wielded, but what *could* be. 'Rolling easements' would "allow wetlands, beaches, and other coastal habitats to migrate naturally as the sea encroaches inland; move people out of harm's way; and prevent new construction in vulnerable areas." The three ways "to limit the portion of our coast eventually subject to shore protection are:

1. Setbacks. Prevent development of some lands vulnerable to sea level rise, either through regulation or by purchasing land (or development rights) from the current owners.

2. Rolling easements. Make no effort to restrict land use but prevent shore protection of some coastal lands either through regulation or by transferring any right to hold back the sea from owners inclined to do so to organizations that would not.

3. Laissez-faire. Make no effort to prevent either development or shore protection, but curtail government subsidies for both, and hope that eventually the forces of nature and economics will lead owners to allow their lands to be submerged.

Table 7-4 Summary of Recorded Rolling Easement Options (J Titus, EPA, 2009)

Interest	Who can own or enforce it?	Type of Purpose	Objective	Caveat
Shoreline migration conservation easement	Government or land trust	Conservation or recreation	Prohibit shore protection. May also have provisions for removing homes.	May be costly to enforce unless carefully drafted.
Legal covenant	Developer, maybe a neighbor	Any	Prohibit shore protection or provide for access to migrate inland. But court cannot enforce the agreement; only awards provable damages for failure to comply.	Strict rules for when covenant can be created known as "privity." Damages only.
Equitable covenant (equitable servitude)	Developer, maybe a neighbor	Any	Prohibit shore protection or ensure that access migrates inland.	Easier to create than legal covenant, but court may decide not to enforce if harm to owner is greater than benefit to neighbor.
Future interest in land[1]	Anyone	Limit duration of land ownership	Terminate ownership when sea rises or shore retreats enough to submerge parcel.	Abolished in some states. Careful drafting needed to show purpose.
Rolling affirmative easement	Neighbor or state	Any	Access along the shore migrates inland; remove structures that block access	Must be clear about intention to migrate inland.
Rolling boundary	Neighbor	Any	Boundary between landowners migrates with shore; preserve width of road or conservation buffer.	Few examples other than for public trust lands.
Abate nuisance or quiet title in court	Neighbor or state	Abate nuisance or enforce a right	Private owner asks court to prevent shore protection or allow access along shore based on common law.	Requires a court to make new law, which courts usually decline.
Rolling conservation easement[2]	Government or land trust	Conservation or recreation	Amend existing conservation easements to also prohibit shore protection.	May be costly to enforce unless carefully drafted.
Transferable development rights[3]	Government	Any	Compensate owner who yields land to rising sea, with right to develop new coastal lot.	Difficult to define where to transfer the development.

Typical characteristics of rolling easements along eroding beaches may include:

- No shoreline armoring;
- A rolling design boundary (e.g. dune vegetation line), seaward of which the owner's property rights are reduced;
- No new structures seaward of the rolling design boundary;
- Encouragement or requirement to remove preexisting structures when erosion leaves them seaward of the rolling design boundary;
- Warnings about the policy to prospective buyers of coastal property;
- Provisions for public access; or
- An indication whether beach nourishment and adding sand to dunes are allowed.

Maine, Massachusetts, and Rhode Island have each adopted some form of "rolling easement" to ensure that wetlands or dunes migrate inland as sea level rises thus reducing the risk of loss of life and property.

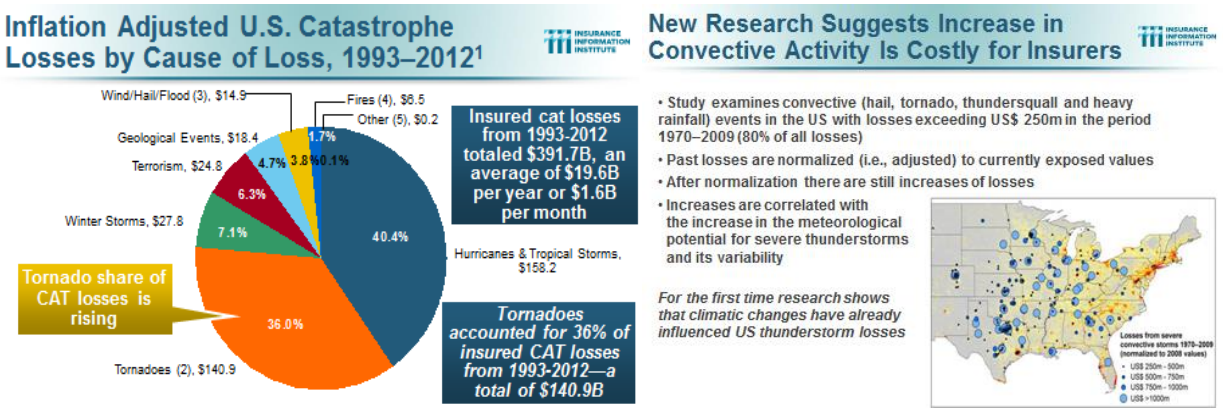


Figure 7-9 Tornado-related Loss is on Par with Hurricanes for Inland Areas that are Far Less Densely Populated than Coasts

From 30,000 feet, rolling easements certainly seem sensible in principle. Down at ground zero, however, how will it work in practice? "The big thinkers have emerged in force since Hurricane Sandy. Environmentalists and academics call for a retreat from rising tides and vulnerable seashores. FEMA pores over flood photos, redefining the areas of highest risk. And city engineers and lawyers revisit building and zoning codes. All hope to ensure that whatever rises from the debris can survive future assaults by extreme weather….

"But for all the policy debates, the actual decisions that will shape these communities are already being made by individual homeowners across New York and New Jersey, providing reason to be skeptical that any

cohesive, unified vision of a rebuilt coastline will eventually emerge (D Halbfinger, "*On Ravaged Coastline, It's Rebuild Deliberately vs. Rebuild Now*," NY Times, 12/21/12)."

While New York's buyout program got just beyond the halfway mark of its objective with decided price enticement, the Governor's Office for Storm Recovery reported on 10/15/14 that 9,554 households were for elevation. Core Logic's real estate database places these after-the-fact figures in advance of Sandy's land fall on 10/29/12 with Suffolk County, according to Core Logic, host to four of the top ten vulnerable zip codes dollar-wise in the greater NY/NJ metro area, and six of the top twenty-five.

Rank	Zip Code – Area Name	Properties Affected	Total Structure Value
2	11795 – West Islip, NY	1,348	$2,002,034,875
3	11706 – Bay Shore, NY	897	$1,714,557,225
7	11901 – Riverhead, NY	477	$1,268,159,500
8	11789 – Oakdale, NY	1,178	$1,137,802,500
22	11757 – Lindenhurst, NY	3,044	$649,684,250
24	11978 - Westhampton Beach, NY	1,119	$608,256,870

Figure 7-10 Long Beach, Long Island Elevation
Ed Wright's home withstood storm, having been built on pilings while 18 neighbors' homes are obliterated.

Vulnerable coastal properties are not just primary assets in most cases, they also constitute substantial revenue streams for local municipalities that would otherwise become extremely strapped if they were left with large numbers of properties abandoned in 'strategic retreat'. Given that 76% of New York housing is shore-adjacent the challenges of sea level rise, in this context alone, are daunting.

The most delimiting aspect of strategic retreat is existing infrastructure compounded by the inflexibility of related federal disaster funding provisos. On Long Island, owing principally to the gravity factor, sewage treatment plants (STP), have been stationed in proximity to the coast. The 70 million gallon per day (mgd)

capacity Bay Park STP with average flow 50 mgd was overtopped by Sandy and went off-line for 56 hours, spewing over two hundred millions of gallons of raw and partly raw sewage into channels and waterways and backflowing into homes.

Bergen Point Wastewater Treatment Plant on Great South Bay

FEMA has allocated $789M to remediate Bay Park above and beyond pre-Sandy condition, even as estimates from other sources peg the tab at double, to which a $690 ocean outfall needs to be added to divert the secondary-treated effluent away from bay and wetlands. In the realm of rolling easements, this would be the opportune time to decommission the coastal plant and relocate further inland, beyond future storm surges. But that plant is needed back on line yesterday and all the associated costs of relocating labyrinthine connecting pipes and pumps places the cost out of reach and fails to factor for the time it takes to do an engineering project of this magnitude. There are any number of policy proposals that make sense in the long run, but toilets need to be flushed now.

7.3.2 Fire Island to Montauk Point (FIMP)

The Fire Island to Montauk Point (FIMP) project (area shown by **Figure 7-11**), on the drawing boards since 1964 in various iterations, was allocated $700M by the Superstorm Sandy relief bill. Preliminary projections approximate $450M going for road and house elevations, with 7 million cubic yards (cy) of sand borrowing from the Atlantic going to a $207 million, 19 mile-long, 9.5 foot berm to 15 foot dune line interfaced with beach nourishment, plus $60M for green infrastructure projects.

The U.S. Army Corps of Engineers (USACE) has concluded that, "As a consequence of the historically severe coastal erosion during Hurricane Sandy, the dune and berm system along Fire Island is now depleted and particularly vulnerable to overwash and breaching during storm events, which increases the potential for devastating storm damage to shore and particularly back bay communities along Great South Bay and Moriches Bay.... The effects of Hurricane Sandy on the barrier island have made project implementation within the Fire Island Inlet to Moriches Inlet imperative to restore and augment the barrier island to a level to provide storm damage protection to both the barrier island and back bay inhabitants. ("Fire Island Emergency Stabilization Project," USACE-NY Dist., 12/13).

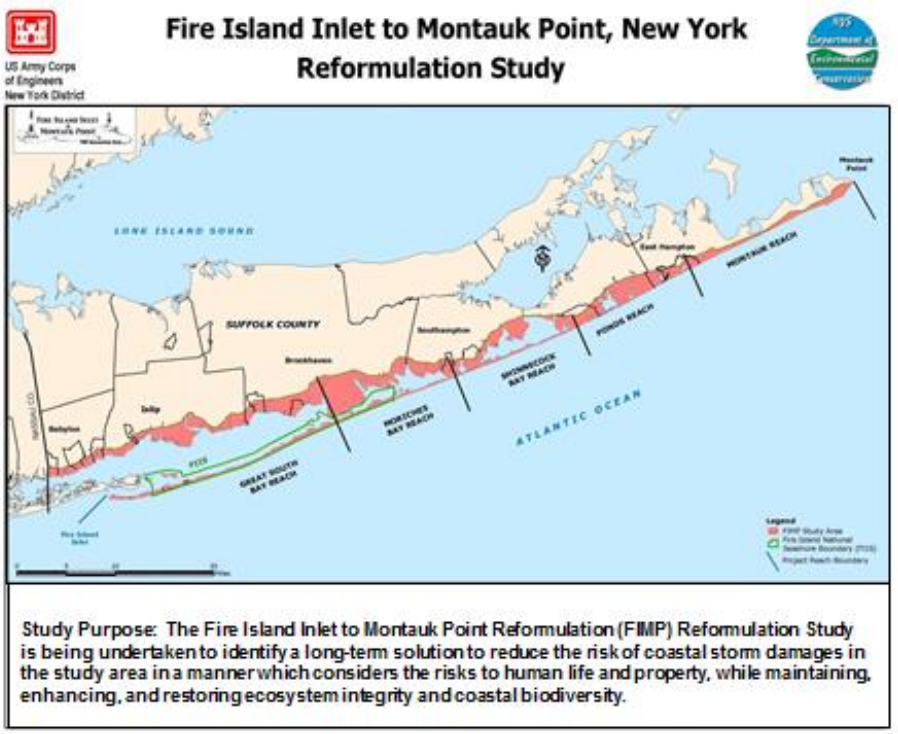


Figure 7-11 Fire Island to Montauk Point Reformulation Study Area
(*Source: USACOE 2006, Final Report Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York Reformulation Study*)

On September 11, 1964, Congress established 26 miles of Fire Island as Fire Island National Seashore (*Public Law 88-587*). Today, Fire Island National Seashore encompasses marine and upland habitat, 17 residential communities, New York's only federally designated wilderness. Fire Island National Seashore stretches 31 miles from Democrat Point and Robert Moses State Park on the west to Moriches Inlet on the east. A barrier island, it stands facing the Atlantic Ocean while protecting the waters of Great South Bay and the mainland of Long Island. Sitting on the fringes of the largest population concentration in the United States, Fire Island is a place rich in marine life, waterfowl, and other wildlife. It is a place to enjoy recreational pursuits, as well as a little solitude. In 1980, a 7-mile stretch from Smith Point West to Watch Hill was designated by Congress as wilderness, accessible only by foot, the only area in New York State to be honored in this manner.

The boundaries of the seashore extend 1,000 feet into the Atlantic Ocean and 4,000 feet into the Great South and Moriches Bays. The islands and marshlands adjacent to Fire Island are also included in the Fire Island National Seashore (FIIS). A General Management Plan (GMP) and the Final Environmental Impact Statement (EIS) on the General Management Plan were accepted in 1978, and have served as the basis for park management. The GMP is currently under revision, but not yet finalized.

The management strategy for the FIIS recognizes that significant areas of shorelines and back lands on Fire Island have been affected by human manipulation and population growth and now support stable

communities. One of the planning premises is "Fire Island is a culturally manipulated barrier island system, and it cannot be managed as if natural processes had been totally unimpeded." National Park Service (NPS) policies generally allow for manipulation of the existing environment: 1) when directed by Congress, 2) in some emergencies when human life and property are at stake, or 3) to restore native ecosystem functioning that has been disrupted by past or ongoing human activities. Fait accompli.

The authorizing law for the Fire Island National Seashore also contains specific language that requires that any plan for shore protection within the boundary of Fire Island National Seashore be mutually agreeable with the Secretary of the Interior and the Secretary of the Army, as a requirement for the project to proceed. Superstorm Sandy's damage to Robert Moses State Park was severe: most of the Park's beaches were significantly eroded by severe wind, wave, and tidal action, and a portion of the Park's iconic traffic circle was destroyed.

Long Island's Atlantic-facing shores are blessed with two lines of defense – barrier beaches and wetlands. The iconic Fire Island is among those formidable barriers. Robert Moses State Park, at the western end and Smith Point County Park at the eastern end attract over four million visitors per year. In between, the FIIS, New York's only federally designated wilderness, stretches over 26 miles of marine life and upland habitat with 17 communities of 4,500 houses nestled along its perimeter. With its 1,000 miles of tidal shoreline, Suffolk is especially focused on mitigating the risk posed periodically by surrounding waters, especially in the wake of Hurricane Sandy.

Table 7-5 FIMP Annual Cost for Non-Structural and Beach Nourishment Plans

(5.125% interest over 50 yrs.)

	Plan 3.a	Plan 3.g / (TFSP)
Cost Category	Inlet Mgmt, BCP 13 @SB, NS2R, 15ft Dune @ GSB & MB	Inlet Mgmt, BCP 13 @ SB, BCP 9.5 @ OPWA, MFT, & SPCP, NS3R, 15 ft Dune @ GSB & MB
Beach Fill	$160,200,000	$139,200,000
Nonstructural	$407,200,000	$550,800,000
Road Raising	$14,900,000	$14,900,000
Total First Cost	*$582,400,000*	*$705,000,000*
Total IDC	$26,600,000	$29,400,000
Total Investment Cost	*$609,000,000*	*$734,400,000*
Interest and Amortization	$34,000,000	$41,000,000
Operation & Maintenance	*$9,300,000*	*$8,900,000*
Renourishment	*$12,900,000*	*$11,000,000*
Subtotal	*$56,200,000*	*$60,900,000*
Annual Breach Closure Cost	*$0*	*$1,000,,000*
Major Rehabilitation	*$0*	*$0*
Total Annual Cost	*$56,200,000*	*$61,900,000*

The most credible of objections raised by some who favor unconditional strategic retreat from coastal areas relates to concerns of near-shore sand borrowing for beach nourishment. This concern was underscored by the storm mitigation of underwater ridges of the seafloor off Long Island. John Goff, from the Institute for Geophysics at the Jackson School of Geosciences at University of Texas, Austin detected these rows of sand ridges, comparable to underwater sand dunes up to 10 feet high that run parallel to shore for as far as a half-mile. "I think of these ridges as kind of cushioning the blow," Goff notes. "After the hurricane, they were still there and there wasn't any substantial erosion of the shore face (http://www.jsg.utexas.edu/news/?p=5028)."

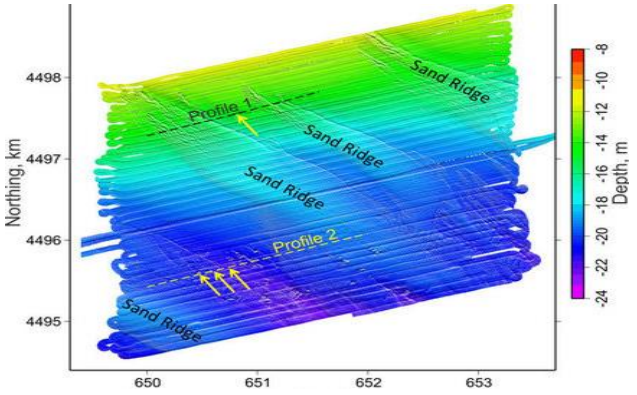
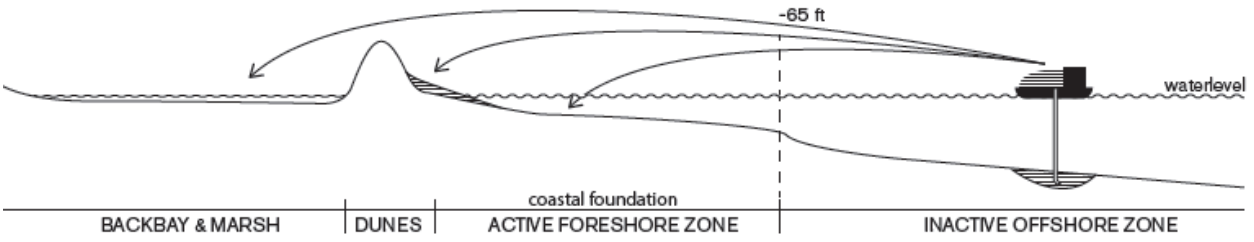


Figure 7-12 Stratigraphy of the Shallow Seabed Using Ultra-high Resolution Seismic Reflection Systems (CHIRP)

In April 17th comments to USACE, the U.S. Geological Survey (USGS) stated that "the coastal sediment budget is vastly improved from the preliminary DEA (Draft Environmental Assessment)." Joe Vietri, Corps Chief of Planning Policy, assures that the initial borrow area will be low impact and that future sites will be selected in close consultation with USGS and the Minerals Management Service: "This is a single, one time fill placement to stabilize this vulnerable section of shoreline while we complete the entire Reformulation effort."



At present, beach nourishments are taken from the active foreshore zone and do not result in a net sand addition to the active zone. Future nourishments are to be taken from the (inactive) offshore zone, which will result in a net sand addition to the active zone.

Most of the Corps' efforts related to coastal risk mitigation within the last two decades have focused on beachfront areas, with a heavy reliance on beach nourishment as the primary means of coastal risk reduction (p. 59)…. Pre- and post- storm surveys following Hurricane Sandy in New Jersey in 2012 revealed that both beach width and dune height were critical in preventing breaches and overwash, even in locations that were not nourished (Coastal Research Center, 2013). A well-maintained dune in Seaside Park survived the storm, while dunes in nearby municipalities that did not have aggressive dune-building programs suffered overwash, leading to the loss of many homes (Committee on U.S. Army Corps of Engineers, "*on the East and Gulf Coasts,*" National Research Council, p74, 2014)

The value of beach fill and dune building in protecting against moderate-energy hurricanes was dramatically revealed in North Carolina as a result of Hurricanes Bertha and Fran in 1996 and Dennis and Floyd in 1999. Hurricanes Dennis and Floyd caused no damage to buildings behind three USACE-constructed dune projects, but damaged or destroyed over 900 buildings located outside the project dunes (Rogers, 2007). Federal Insurance Administration claims for damage caused by storm surge and wave attack and overwash resulting from Hurricanes Bertha and Fran revealed far less damage to structures in locations protected by USACE beach nourishment projects than in adjacent unprotected locations (USACE, 2000a). Dunes constructed on barrier islands, however, could reduce the possibility for overwash or breaching, potentially lessening the likelihood of bay flooding. ("*Reducing Coastal Risk," op cit.,* p75)

Interagency workshops were co-hosted in the summer of 2013 by the US Army Corps of Engineers and the School of Marine and Atmospheric Sciences at Stony Brook University to identify opportunities for restoration and enhancement of coastal processes and habitats. Dune habitat was considered essential for storm risk reduction, though cost/benefit should be closely scrutinized. Rehabilitation and creation of wetlands in the lagoonal systems drew strong support, with the caveat that improved water quality is elemental to long-term success. Concentration of Corps efforts on three large restoration areas – Great South Bay, Smith's Point, and Shinnecock Bay, shown on **Figure 7-13,** was deemed the best bang for the buck environmentally with the greatest likelihood of success.

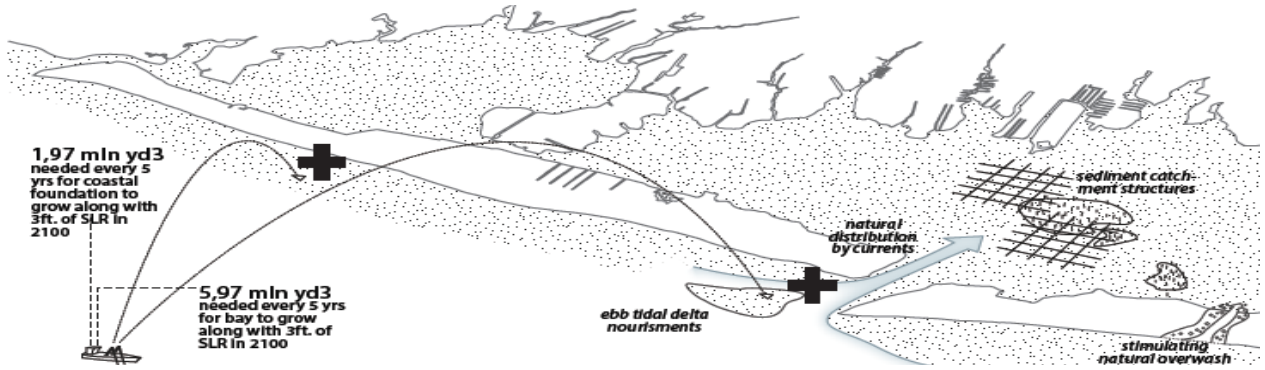
The group strongly supported the creation and/or rehabilitation of wetlands for shoreline of the lagoonal systems both on the mainland and barrier beaches, as they afford storm protection and ecological functioning. Wetlands buffer the impact of storm induced waves, accommodate sea level rise, provide habitat for shorebirds and other species, and reduce the impact of pollution. Wetlands restoration on the backside of the barrier islands would allow for some overwash fans that would then develop into wetlands. Buying shoreline properties to create relatively large land tracts on which to construct restoration projects would be particularly beneficial for storm risk reduction. To facilitate restoration of near shore transport processes and marsh transgression and development, bulkheads and groins should be removed.

Figure 7-13 Proposed Restoration Areas

Improved water quality is key to wetland enhancement and elemental to so-called soft storm mitigation solutions such as the introduction of oyster reefs or clam beds. Breach enhanced cross-bay circulation, rationalized coastal land use and reduction of pervasive cesspool/septic nitrogen pollution is also key. There was a call for Corps review of its breach policy. Elements of FIMP green infrastructure that will need to be evaluated include:

- Do soft solutions work?
- Does bayside marsh reduce flooding?
- How much does marginal water quality impact marsh development?
- Will oyster reefs used as wave attenuators survive in marginal water quality?
- What are the long-term benefits of breaches?
- Are artificial dunes as effective as natural dunes?
- Can artificial dune technology be improved?

7.3.3 Rebuild by Design



The schematic above proposes a way of 'growing along with sea level rise.' It is one component of "Living with the Bay, *A Comprehensive Regional Resiliency Plan for Nassau County's South Shore*" that was awarded $125M by Rebuild by Design, sponsored by U.S. Housing and Urban Development (HUD). "Living with the Bay" was conceived by the Interboro Team, which includes the 'Dutch contingent' from Deltares, TU Delft, Bosch Slabbers and Palmbout Urban Landscapes (http://www.rebuildbydesign.org/project/interboro-team-final-proposal/).

Interboro posits that, "to grow along with 3 feet of sea level rise in 2100, both the coastal foundation that holds the beach and dunes in place and the bay bottom need extra sediment. The coastline protecting the urban areas will need 1.97 million cubic yards every five years and the bay demands 5.97 million cubic yards every five years to grow along, unless islands are allowed to shift landwards. Sediment inflow toward the bay can be stimulated by ebb-tidal delta nourishments, stimulating natural overwash and breaches, and by improving the catchment of sediment, for example by catchment structures."

As a phase one project, Interboro proposes to manage a dynamic coastline with the installation of a sand engine in Jones Inlet that will feed the littoral drift westward to Long Beach. The sand engine, or sand motor, has been deployed in the Netherlands along the coast at Zuid-Holland to Ter Heijde where a huge volume of sand has been deposited. The expectation has been that wind, waves and current will spread, gradually shaping the coast and fully incorporating into broader, safer beach/ dunes. "The Sand Motor - Passionate Research" depicts how the Netherlands project is working (https://www.youtube.com/watch?v=wtY4_QXcVsM&feature=youtu.be). The Dutch expended 70M euros ($100M in July 2011 exchange rate) for 21.5M cubic meters (28M cubic yards). The December 2013 FIMP report allocates $74.4M for 6.99M cubic yards or $3.6/cubic yard for the Dutch/Sand Engine/ approach versus $10.7/cubic yard for the USACE/FIMP engineered beach and dune. Though apples/oranges, tracking comparisons between beach dynamics five to ten to twenty years out would be illuminating.

Longshore Migration of Sediment

On Long Beach Island to the west of Jones Inlet, the Interboro team proposes building a system of ditches along the medians of north/south streets so that the rising water from Hewlett Bay can recede back into the ocean instead of flowing up onto land and destroying property. Moreover, it is their sense that drowning of the marshland will only be stopped when plates grow along with sea level rise which will:

- Work with ebb-tidal delta nourishments that function as local sand-engines;
- Stimulate natural distribution via currents by influencing the tidal prism;
- Create sediment catchment structures;
- Stimulate natural over-washes; and
- Make use of the natural sediment transport along the coastline and the existing sediment surplus at the top of the barrier islands.

The outer road is slightly heightened, increasing the safety for the houses behind it. An open wadi system buffers the rainwater.

"The **Eco-Edge** is, in essence, a strategy that can be incorporated within the whole bay area. Long Beach Barrier Island is highest at the ocean side, with an elevation of approximately 12 feet, and lowest at the bay-shore, with an elevation of approximately 6 feet, just barely above the high tide water level in the bay. On the ocean side, we propose to build on the ongoing work by USACE and complement the beach replenishment and dune construction along the ocean shore. On the bay shore, we propose a smart recreational dike landscape that over time is able to protect the entire bay shore. The dike landscape consists of 6 to 8 protective compartments (ring levees) that over time can be built successively. As a second component of our project, we propose a system of stormwater retention parallel to the beach and the bay, in the form of controlled open flooding areas that double as open space resources. As a third component, we propose to improve the local network perpendicular to the beach, recreational levee, and

central boulevard, so that the streets provide more water storage and more filtering water…. The Long Beach sewage treatment plant can be decommissioned once the ocean outfall for the Bay Park sewage treatment plant is in place.

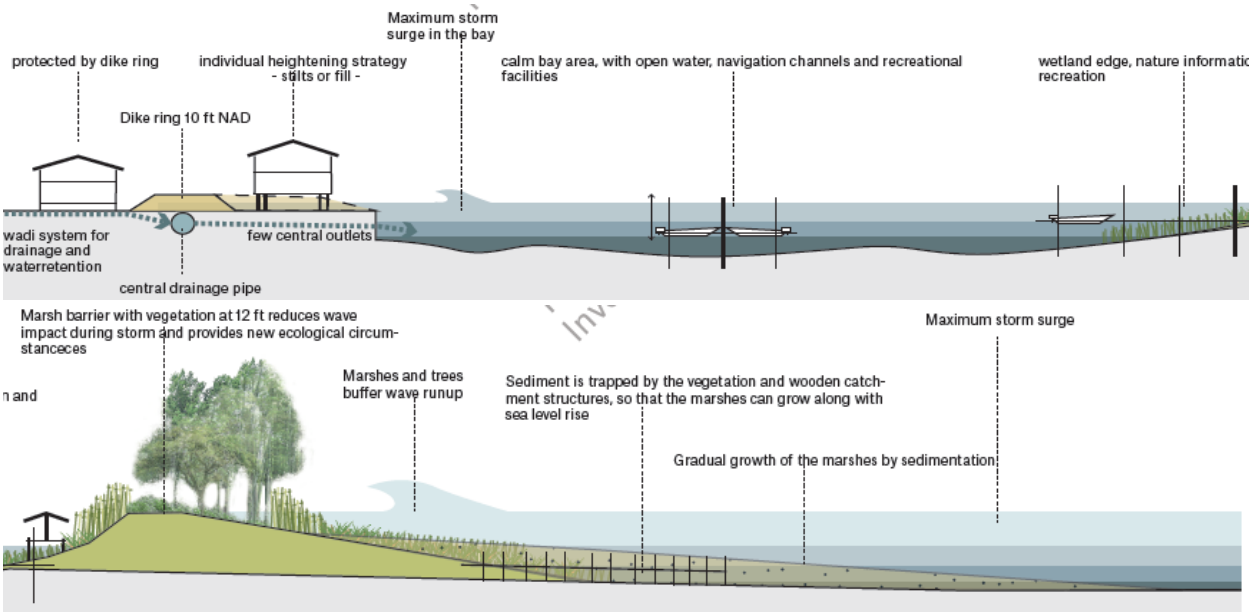
"The flood risk within the bay is not just a story of high water levels but also one of low-lying areas and the lack of sediment. The strategy on the large scale shows that nourishing the ebb-tidal delta and the channels can supply the sediment demand within the bay. The wooded marsh ridges help to catch this sediment and allow the vulnerable marshes to grow. The constructed ridges provide a habitat that is almost not present within this area. On top of that, they also reduce the surge by 2 feet and the wave run up by another 2 feet. The dike ring is not just a structure. It creates a new water drainage system with retention ponds and swales.

"It designs with nature, constructing higher ridges and low-impact sediment catchment structures (simple wooden structures) and providing enough sediment on the ebb-tidal delta and in the channels. The tides and currents will disperse the sediment, and the "right" sediment particles will fall in the right places. It combines water retention with water safety. Dike rings provide new rainwater storage possibilities alongside and beneath them. They can drain, retain, and store water. It creates high evacuation roads. It combines the individual heightening strategies with a "backbone' structure (the dike ring) so that the investment is beneficial for a larger area. This approach consists of three levels (http://www.rebuildbydesign.org/project/interboro-team-final-proposal/):

- The larger system from which the design provides sediment;
- The eco edge/marshes that reduce the surge by 2 feet and the wave impact by at least 50 percent and
- The dike rings that keep the communities safe and allow them to restructure the urban fabric/individual parcels to bring them to a safe level."

Note that the cost estimate for the (partial) projected total for 'Living with the Bay' comes in at $1,874M. With less than 7% of the interim estimate in hand, Interboro is clearly obliged to cast about for other potential funding/financing which they identify as:

- Tax Increment Financing (TIF),
- Insurance receipts,
- Specific tax or fee, i.e. 'stormwater tax' and
- The 'availability payment' model of Public-Private Partnerships (evaluated in greater detail in Section 2 "Ways & Means").



This cross-section demonstrates how measures are interconnected and, thus, optimize the environment.

7.3.4 New York Rising Community Reconstruction Program

The New York Rising Community Reconstruction (NYRCR) Program "empowers the State's most impacted communities with the technical expertise needed to develop thorough and implementable reconstruction plans to build physically, socially, and economically resilient and sustainable communities." The NYRCR Program, announced by Governor Cuomo in April of 2013, allocates more than $650M to that end for 102 communities severely damaged by Hurricane Irene, Tropical Storm Lee, and Superstorm Sandy. NYRCR Oakdale/West Sayville is one of eight such communities in Suffolk County. $3M has been allocated for resiliency projects and another $3M was awarded for the "Best Use of Green Infrastructure to Bolster Resilience" as illustrated in the following pages.

PROPOSED PROJECT: "Living" Marsh – Grand Canal Levee Improvement

Project Description

"The purpose of the project is to improve tidal exchange to an approximately 87-acre salt marsh wetland area so as to increase its capacity to absorb storm surges and stormwater runoff as well as provide an improvement in the health of the wetlands, including a reduction of invasive species.

"The wetland, owned by New York State and known locally as the Pickman-Remmer Wetlands, was closed off from regular tidal exchange by the creation the Grand Canal in Oakdale. As a result, approximately, 31% (27 acres) of this marsh is now dominated by the invasive species *Phragmites australis.* The Grand Canal Levee is an earthen berm structure that was built over a hundred years ago when the canal was excavated as part of the development of the W.K. Vanderbilt Estate. The excavation occurred through a large tidal wetland area and significantly altered the hydrology of the area. The levee runs in a north-south direction along the Grand Canal. The portion of the wetland located east of the levee was the area that was most affected by the structure, in which tidal exchange was almost completely cut-off and restricted to a few relatively small pipes and openings that were added later, possibly as part of a vector control project. These openings have deteriorated over time and have become blocked with silt and organic debris.

"The project will reestablish tidal exchange by inserting strategic openings within the levee located along the east side of the Grand Canal. The project would also provide limited public access such as wildlife viewing and hiking trails in environmentally compatible locations. The project is anticipated to provide public benefits for the community through storm surge protection, improvement of publicly owned wetlands and the addition of recreational and tourism benefits through the development of a hiking trail along the top of the levee. The installation of drainage pipes though the levee or excavated openings along with the construction of a hiking trail are both considered technically feasible.

'The proposed project includes funding for an engineering study to determine the most appropriate method to increase tidal flow. The proposed project specifically includes the installation of seven new pipes through the levee to hydraulically improve the tidal exchange between the Grand Canal and the wetlands.

Grand Canal, Oakdale, looking north—levee extends along the right side of the canal

Estimated Project Costs

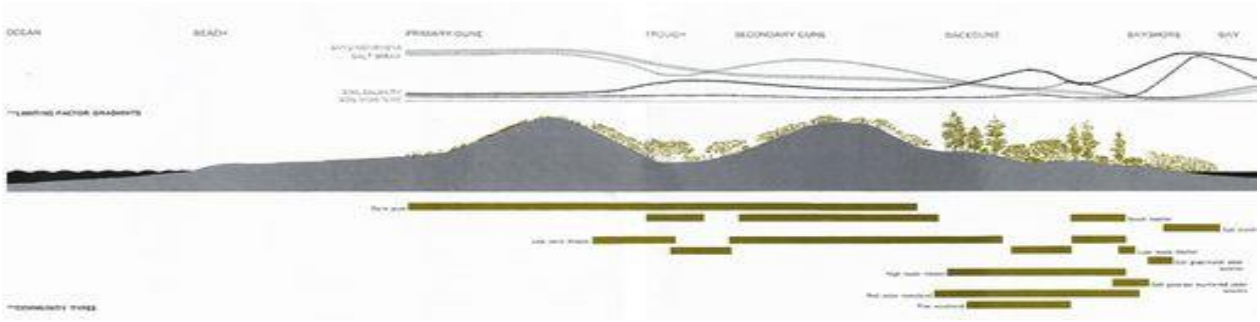
"The capital and soft costs of this project are estimated at $410,000. About half of this estimate is for construction of the seven culverts. The balance is for "soft" costs including an environmental engineering study, design, permitting, and contingency. Annual operating and maintenance costs are estimated at $4,500. With an expected useful life expectancy of 30 years, the conceptual life cycle cost is estimated to be $545,000. The trail will also help to stimulate tourism as the first phase of a proposed "South Shore Gold Coast Heritage Trail" system, which is proposed to extend from the Bayard Cutting Arboretum in Great River, through Oakdale to Green's Creek in West Sayville.

Environmental Benefits

"These wetlands are dependent on tidal flow (notably, salt/ brackish water) to maintain a diverse population of plant and animal species. Restricted tidal flow alters the natural balance of tidal wetlands resulting in a change of vegetation including the proliferation of invasive species. This is visible in the wetlands today with approximately 27 acres of the 87-acre Pickman—Remmer wetlands dominated by *Phragmites australis*, known as common reed, which can out-compete native salt marsh vegetation and reduce available food and shelter for saltmarsh dependent wildlife. The improvement of health of the wetlands is vital to the important role they serve of filtering out pollutants and excess nutrients, thereby improving surface and groundwater quality (Professional guidance of Jacob/Cameron Engineering was provided through NYRCR)."

7.4 Wetland Stewardship Strategy

"We're finding out these wetlands are not just for fishing and recreation and boating, but they are actually like our mangroves. They're our protection and they're failing." Jim Ruocco, Operation S.P.L.A.S.H. (Stop Polluting, Littering and Save Harbors). "Even if a narrow strip of marshland would have little impact on storm surge, it could reduce wave energy in a storm, writes Dr. Joannes J. Westerink, a civil engineer at the University of Notre Dame. "The scales of motion are much smaller" with waves, he said, and even if the wetland were overrun by storm surge, it would "attenuate waves very effectively," he added. "And waves can knock the socks off your infrastructure."



"Marshes were not made to be filled; they constitute a present value and a real danger to human habitation."
-Ian McHarg, ***Design with Nature***

Suffolk County's Wetland Stewardship Strategy (WSS) targets the 17,000 acres of salt marshes in the County in order to:

- Improve tidal regime and flux between estuary and marsh;
- Allow improved tidal exchange in the marsh interior;
- Enhance conditions for proper marsh accretion and resilience to sea level rise;
- Provide high quality habitat for salt marsh biota, and
- Enable biological control of larval salt marsh mosquitoes and of Phragmites.

Beneficial outcomes of the WSS include:

- Increased cover, health, and vigor of native vegetation;
- Improved nutrient fluxes buffering;
- Enhanced use of the marsh by wildlife including estuarine nekton; and
- Reduction in mosquito production.

With improved conditions for native vegetation and proper sediment capture, the marsh is expected to be resilient to sea level rise. The County's Vector Control and Wetlands Management Long Term Plan is available on-line:
http://apps.suffolkcountyny.gov/health/suffolkvectorplan/pdf/final/Revised%20Long-Term%20Plan.pdf

The eight years of post-restoration monitoring results for the Wertheim Restoration Project continue to indicate that the newly created tidal network has improved marsh and vegetation health in the previously degraded portions of the marsh by increasing the cover of native plant species and decreasing the cover of phragmites (Rochlin et al. 2012, Integrated Marsh Management): a new perspective on mosquito control and best management practices for salt marsh restoration). Recovery from areas impacted by construction has occurred. In addition significant reductions in mosquito production and consequent decrease of pesticide applications to the salt marshes have been also achieved at Wertheim. Most recent data may be found at: http://apps.suffolkcountyny.gov/health/suffolkvectorplan/index.html.

While the barrier islands form Suffolk County's first line of defense, hundreds of thousands of South Shore residents have historically been protected by coastal wetlands which make up the critical second line of defense. "Tidal wetlands can protect coastal communities from storm damage by reducing wave energy and amplitude, slowing water velocity, and stabilizing the shoreline through sediment deposition. More than half of normal wave energy is dissipated within the first three meters of marsh vegetation such as cord grass. In addition, given sufficient sediment deposition, wetlands are able to build elevation in response to sea-level rise, providing a buffer against climate change and coastal submergence." -**NYS 2100 Commission Report**, Governor Andrew Cuomo. **Figure 7-14** summarizes the processes that affect wetlands development.

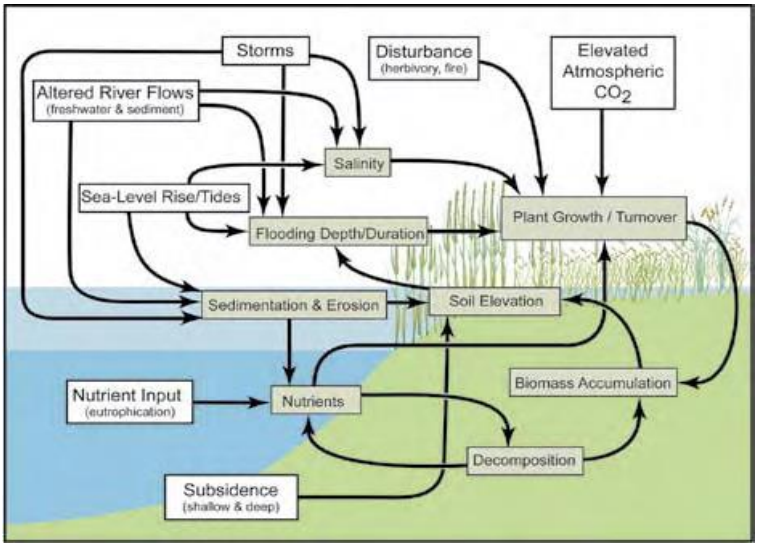


Figure 7-14 Drivers and Processes that Influence Vertical Wetlands Development
(Coastal Sensitivity to Sea-Level Rise: A Focus on the MidAtlantic Region, J Titus, 2009)

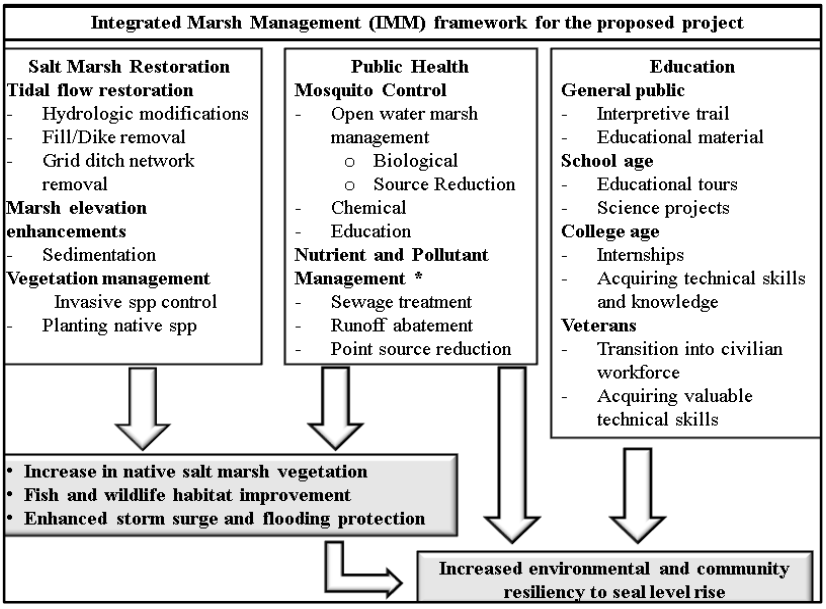
SECTION 7 COASTAL RESILIENCY

The resilience of large expanses of Long Island tidal marshes is threatened by tidal restrictions, waterlogging, extensive mudflat and panne formation, and invasive plants. The Nature Conservancy (TNC) collaborated with Columbia University to produce a trend analysis of tidal marsh in the Great South Bay between 1974 and 2008. On Captree Island, high marsh has receded by 20.4% (33 acres), intertidal marsh by 20.3% (35 acres), and total natural vegetated marsh by 20.4% (54 acres). Pannes, shallow depressions that contain very high concentrations of salt, constitute, as of 2008, 13% of the island.

Reducing, then reversing wetland loss, will improve fish and wildlife habitat, while buffering adjacent coastal communities to impacts of storms and sea-level rise. Rehabilitated wetlands also allay public health threats engendered by mosquito proliferation. In the bargain, recreational opportunities are showcased, underscoring the socioeconomic and ecosystem value of salt marshes. Restoring the entire wetlands ecosystem of the Great South Bay would recreate the kinds of conditions that once hosted a multi-billion dollar shellfish industry that is now moribund.

The primary management techniques proposed for Captree and Oak Island have been successfully applied by Suffolk County and include:

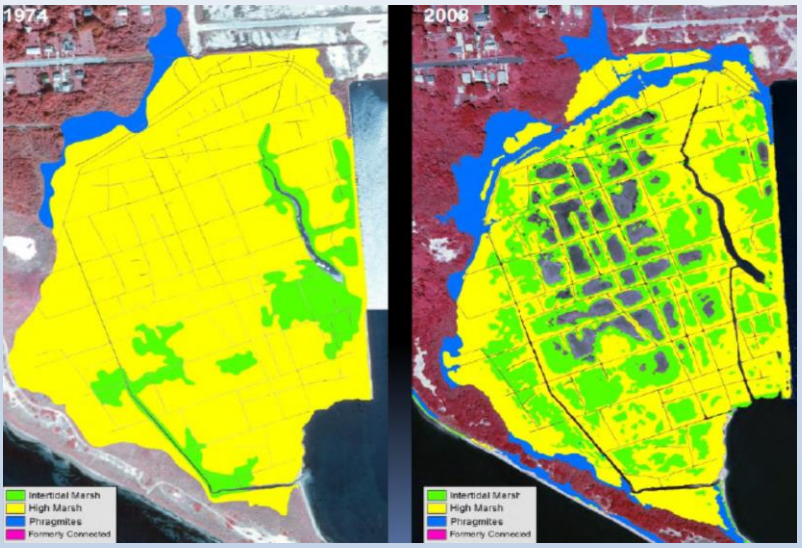
- Restoring tidal flow by creating channels, sometimes out of mosquito ditches, that will improve tidal regime and hydraulic exchange between the bay, estuary, and marsh interior;
- Creating shallow connecting channels and small ponds to prevent waterlogging of the marsh, allowing access for native killifish that will control mosquito larvae, reducing the need for chemical control;
- Spreading excavated material on the marsh and filling obsolete grid ditches will provide elevation for desirable vegetation and enhance marsh accretion and resilience to sea level rise and storm surges.



"Enhancing coastal resiliency through integrated salt marsh management along the south shore of Long Island, New York" Suffolk County was granted $1,310,000 by the National Fish & Wildlife Foundation/ Department of Interior to restore 400 acres of wetlands and enhance its capacity to rebuild 1,500 more acres.

Project Goals and Objectives

The primary goal of this project is to develop and implement sustainable salt marsh rehabilitation methodologies. Such on-going stewardship of the tidal wetlands will enhance resiliency of coastal ecosystems and communities in the face of rising sea levels and extreme storm events (Deegan et al 2012). Approximately 1,500 acres of tidal wetlands will be evaluated and 200 to 400 acres will be rehabilitated during the 2 years of the project. The diverse components of this project will coalesce under the conceptual umbrella of Integrated Marsh Management (IMM) (Rochlin et al. 2012b; Fig. 2). IMM has been field tested by the core team of Suffolk County applicants at Wertheim National Wildlife Refuge (NWR) and recently adopted by US Fish & Wildlife Service (FWS) as part of their approach for expanding salt marsh habitat restoration on the remainder of their refuges on Long Island (funded through DOI grant). The project's primary goal can be realized by extending the use of IMM techniques to wider swathes of County marshes in a sustainable manner.



Smith's Pont panne formation, 1974-2008 (Cameron Engineering)

IMM is an approach to tidal wetlands management that seeks to maximize multiple benefits and reconcile competing management goals. The IMM approach to project design involves convening strategic stakeholders into an interagency team that will plan the project based on the site-specific considerations and stakeholder goals and mandates. Marsh management techniques are then chosen and tailored to the needs of that site.

The primary management techniques already in use at Wertheim and proposed for this project include:

- Restoring tidal flow by creating tidal channels that closely resemble natural tidal creeks. Existing mosquito ditches are sometimes converted for this purpose;
- Creating small ponds that closely resemble natural salt marsh ponds to create habitat for fish and wildlife;
- Creating shallow connecting channels to prevent waterlogging of the marsh, allow access to ponds by estuarine fish and allow access to the marsh for native killifish that will control mosquito larvae;
- Using excavated material to fill obsolete grid ditches, and
- Spreading excavated material on the marsh surface to provide the proper elevation for desirable vegetation and eliminate habitats for mosquito larvae.

Results published by the core team on the pilot project at Wertheim NWR demonstrate that techniques deployed promoted growth of desirable vegetation while improving fish and wildlife habitat. In addition, production of mosquito larvae was reduced to levels where the need for pesticide application was dramatically reduced and could be eliminated with some minor additional work. The IMM framework can also include additional marsh management techniques, such as vegetation control or planting where indicated. The cooperative, interagency management approach effectively lends itself to partnerships while incorporating educational and training goals into the overall management scheme (IMM Figure 2).

The resilience of large areas of Long Island tidal marshes is threatened by tidal restrictions, waterlogging, extensive mudflat and panne formation and invasive plants. Moreover, many of these wetlands produce mosquitoes in large enough numbers to require regular pesticide application. The preponderance of these challenges can be redressed using the IMM approach. Rehabilitating these wetlands to a level of resilience engendered by healthy native vegetation is key to keeping pace with sea level rise. Additionally, reducing, then reversing wetland loss, will improve fish and wildlife habitat, while mitigating vulnerability by buffering adjacent coastal communities to impacts of storms and sea-level rise. Rehabilitated wetlands also allay public health concerns engendered by mosquito proliferation, even as they showcase recreational opportunities that underscore the socioeconomic and ecosystem value of salt marshes.

7.5 Drainage Strategies in Chronically Flooded Areas

"We elevate our houses, but we're still living in Venice." –*South Shore resident on chronic flooding*

Green infrastructure measures can reduce, capture, and treat stormwater at its source via green roofs, bioswales, permeable pavement and contain/retain/drain strategies. Communities across Suffolk County, such as the Villages of Babylon and Lindenhurst, have determined that there is a cost/benefit that can accrue from these measures. *The National Institute of Building Sciences has delineated examples of savings accruing from Low Impact Development which deploys natural and engineered infiltration and storage techniques to control storm water where it is generated (http://www.wbdg.org/resources/lidtech.php).*

Of particular utility to chronically flooded areas of the South Shore are porous surfaces. Permeable Interlocking Concrete Pavers (PICPs) higher initial installation cost compared to asphalt is counterbalanced by a lifespan three to five times longer and requires less maintenance so, in effect, permeable pavers will have a similar uniform annual cost as well-maintained asphalt over 65 years. Though useful for traffic calming, pavers may generate more noise, be more difficult to navigate for bicycles, and more challenging for utility companies to restore after repair. As 17 percent of Berkeley, CA is paved over by streets and sidewalks, they've opted to follow the examples of Portland, OR; Warrenville, IL; Oakland, CA; and Moline, IL. Moreover, as seen in the Port of Oakland, pavers are significantly more durable than flowed cement. The Port has a routine traffic flow of multiple containers—with up to 240 tons per load area and 200,000 lbs. containers stacked three to four high, far more than that carried by the most trafficked streets. (http://www.icpi.org/sites/default/files/03_Feb_Port_of_Oakland.pdf; http://www.ci.berkeley.ca.us/uploadedFiles/Public_Works/Level_3_-_Sidewalks,_Streets_-_Utility/Permeable%20Pavers%20and%20Climate%20Action%20Plan%2012-15-09.pdf)

Interboro's 'Green Corridor' component of its Rebuild by Design proposal addresses drainage via a stretch of Sunrise Highway from Valley Stream to Freeport. Presently underdeveloped, its post-Sandy feature is that it is high and dry, just beyond the reach of a category 2 surge, a 6-foot sea level rise, and the FEMA flood zone. The corridor is also highly impermeable: its roads and parking lots are a major source of both flooding and polluted stormwater runoff. In addition to transit-oriented, walkable, mixed-use downtowns and relief from river choke-points, the 'Green Corridor' proposes to reuse abandoned water infrastructure under Sunrise Highway for water storage and flow augmentation. This abandoned system, which includes a 72-

inch steel force main, a 48-inch cast iron main, a 36-inch cast iron main, and a network of pumping stations, once provided Brooklyn with its drinking water from Long Island's aquifers.

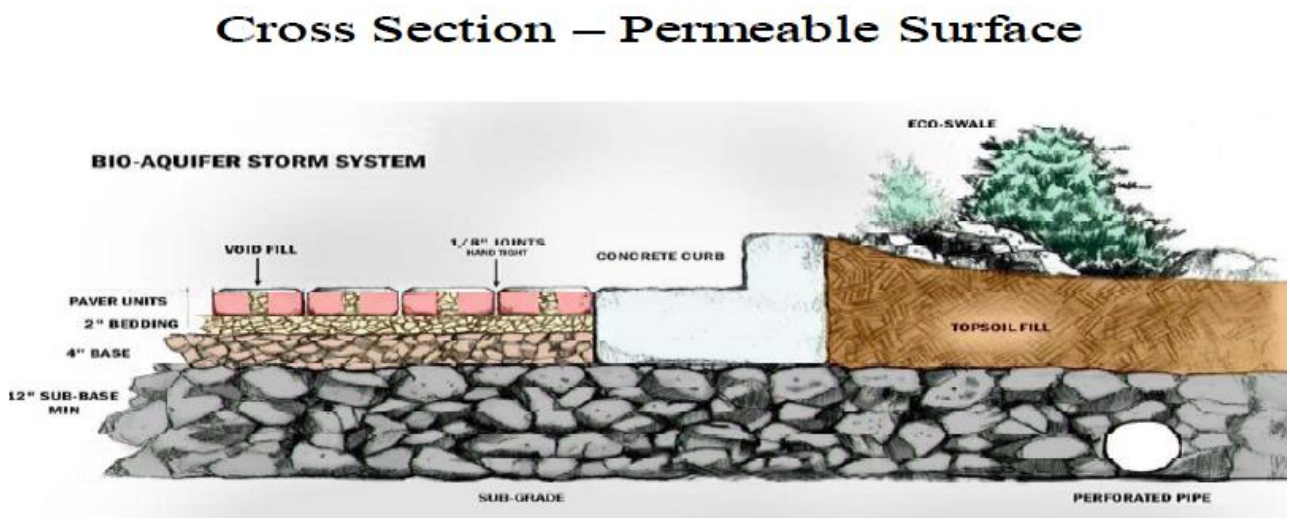


Figure 7-15 Portland Street with Pavers in Parking Lanes and Lindenhurst Library with Porous Parking Lot

7.6 Hard Defenses

Green infrastructure has gained increasing favor over the hard defenses of gray infrastructure.

"As sea level rises, shoreline armoring eventually eliminates ocean beaches (IPCC, 1990), estuarine beaches (Titus, 1998), wetlands (IPCC, 1990), mudflats (Galbraith *et al.,* 2002), and very shallow open water areas by blocking their landward migration. By redirecting wave energy, these structures can increase estuarine water depths and turbidity nearby and thereby decrease intertidal habitat and submerged aquatic vegetation (J. Titus *et al.,* "Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region," US Climate Change Science Program, 2009)."

Table 7-6 Permeable Interlocking Concrete Pavers (PICP)

Reason for Improvement	Root Cause	Mitigation Focus	Benefit to City
Improve long term durability of street paving materials	Clay soil seeps up into the stones and gravel base of older streets, causing instability. This leads to cracks, allowing storm water to create potholes	PICPs will allow for up to a 50-100 year life cycle for properly constructed street vs. less than 17 years for asphalt (shorter on major or collector streets).	PICP construction is **45% to 60% more expensive** on like-to-like construction (reconstructed street). However, **durability is nearly 3-5x longer (50 -100 year life cycle).**
Reduce storm water street flooding	Hardscaped streets force all water into storm drains in short time intervals	PICPs will slow the velocity of water into storm drains by absorbing water into gravel base and sub-base before reaching storm drains, thus reducing downstream flooding	Help reduce the need to build larger storm drains ($80M total cost from past estimates but with a near term $11m capital budget and annual $1.3M expense budget)
Reduce the speed of traffic on city streets	Increased traffic volumes and pace of urban life have led to injuries and traffic deaths on our hardscaped city streets	PICP implementations in Portland, OR; Warrenville, IL; and the Netherlands have seen the reduction of traffic speed and increased overall driver and pedestrian awareness	Help **reduce the average rate of speed from 30 MPH to 25 MPH** without police enforcement costs
Reduce greenhouse gases by 80% by the year 2030.	Oil based asphalt adds to the increase of greenhouse gases through production and the need for constant repair - **currently 783 metric tons of CO_2 are produced annually with current paving methods**	PICPs will incrementally reduce greenhouse gases by using "green cement" that sequesters CO_2 into cement and "smog eating" titanium dioxide paver coatings - allowing for increased use of electrical vehicles. PICPs reduce surface heat gain through the use of light colored pavers and absorb heat through open space between pavers	Help meet City's greenhouse goals by year 2030 and help reduce dependence on fossil fuels
Reduce sidewalk repair cost from tree roots heaving cement.	Hardscaping seals the surface. Tree roots which require water and air, must break through, entering sanitary and storm drains, lifting asphalt and cement	PIPCs enable roots to sink vertically down and still drink and breath	Help reduce $778K annual capital budget associated with sidewalk repair costs (mostly associated with tree root break-through)
Reduce impact of storm water runoff into San Francisco Bay	50% of heavy metals in Bay originates from hardscaped streets according SF Bay RWQCB	PICP implementation will help trap and filter heavy metals in base and sub base of PICP constructed streets	Reduce street sweeping frequency/costs (SF Bay RWQCB proposes an increase to weekly sweeping to mitigate heavy metal issue - clean cities budget is $3.5m annually)

Source: City of Berkeley, 12/15/09)

There remains, however, a distinct place for hard defenses. The massive Dutch Maeslantkering, the movable storm surge barrier whose gates are each the length of the Eiffel Tower, was built in 1997 at a cost over $0.5B and used only once - successfully. The Dutch engineering firm, Arcadis, helped design a $1.1 billion, two-mile-long barrier that protected New Orleans from a 13.6-foot storm surge from Hurricane Isaac in 2006. All the barriers closed, all the levees held, all pumps worked and the Lower Ninth Ward which had been devastated by Hurricane Katrina, was left unscathed.

Malcolm Bowman, a physical oceanographer at the State University of New York at Stony Brook, has been saying for years that New York City needs harbor-spanning storm-surge barriers, one at Throgs Neck, to keep surges from Long Island Sound out of the East River, and a second one spanning the harbor south of the city. Arcadis has prepared just such a conceptual design for a storm-surge barrier in the Verrazano Narrows. The proposed Outer Harbor Gateway, with fourteen gates out of stone and concrete, would

extend six miles across Lower New York Bay. "A giant barrier across the bay is not practical or affordable," concluded Mayor Bloomberg.

Table 7-7 Shoreline Armoring Alternatives *Source: U.S. Climate Change Science Program, January 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region)*

Response Measure	Method for Protection or Retreat	Key Environmental Effects
Shoreline armoring that interferes with waves and currents		
Breakwater	Reduces erosion	May attract marine life; downdrift erosion
Groin	Reduces erosion	May attract marine life; downdrift erosion
Shoreline armoring used to define a shoreline		
Seawall	Reduces erosion, protects against flood and wave overtopping	Elimination of beach; scour and deepening in front of wall; erosion exacerbated at terminus
Bulkhead	Reduces erosion, protects new landfill	Prevents inland migration of wetlands and beaches; wave reflection erodes bay bottom, preventing submerged aquatic vegetation; prevents amphibious movement from water to land
Revetment	Reduces erosion, protects land from storm waves, protects new landfill	Prevents inland migration of wetlands and beaches; traps horseshoe crabs and prevents amphibious movement; may create habitat for oysters and refuge for some species
Shoreline armoring used to protect against floods and/or permanent inundation		
Dike	Prevents flooding and permanent inundation (when combined with a drainage system)	Prevents wetlands from migrating inland; thwarts ecological benefits of floods (e.g., annual sedimentation, higher water tables, habitat during migrations, productivity transfers)
Tide gate	Reduces tidal range by draining water at low tide and closing at high tide	Restricts fish movement; reduced tidal range reduces intertidal habitat; may convert saline habitat to freshwater habitat
Storm surge barrier	Eliminates storm surge flooding; could protect against all floods if operated on a tidal schedule	Necessary storm surge flooding in salt marshes is eliminated

Adjusting to Venetian Living on the South Shore

With vast numbers of people living in coastal areas and waterways, the call for car and a watercraft to be combined was waiting to be made. The Gibbs **Aquada** (among other entries) is a high-speed amphibian which can top 100 mph on land and 30 mph on water, and takes a mere 6 seconds to morph from sportscar to jetboat. Conceived for a waterside living, the British-built Aquada is powered by a 175hp, V6 engine with an auto transmission linked to a fully-enclosed jet propulsion system. Getting into the water is simply a matter of driving down a boat ramp and pushing the button - the accelerator becomes the throttle and jet propulsion takes over. At $411,000, this is a concept car, obviously not ready for the mass market. (www.gizmag.com/four-new-amphibious-vehicles/2797/)

Around 4,000 Amphicars were produced in 1960s with President Lyndon Johson one of the car's many celebrity owners.

The Floating House will rest upon a 65-foot by 22-foot buoyant concrete hull, and can float atop the water like a non-movable houseboat. In addition, if located on a flood-plain, it can rest atop stilts or on a non-floating flood-resistant thick concrete base. The design has the two story home's living quarters contained within a 45-foot by 16-foot cross-laminated timber frame, with a thick layer of insulation and triple-glazed windows. The interior comprises two bedrooms, a study, a bathroom, living room, and a kitchen. A "crow's nest" observation area is situated on the rooftop/upper deck. Powered by solar, a rainwater-harvesting tank is situated on the roof to provide a renewable source for most of the home's non-drinkable water requirements, according to Carl Turner Architects (http://paperhouses.co./blog/entry/http-paperhouses.co-pages-turner).

Pointing to the waterfront reinforcement already in place in New Orleans and the Fox Point Hurricane Barrier in Providence, the managing partner of Long Island's Cameron Engineering proposes that, "movable steel barriers could be constructed across East Rockaway, Jones, Fire Island, Moriches, and Shinnecock inlets. Under normal conditions, the barriers would be open for tidal circulation, to maintain bay water quality, to permit recreational and commercial boat traffic, and to allow outflow from the bays during a nor'easter. The barriers would be closed only in advance of major storms.... Providence, R.I., has had a 3,000-foot-long barrier since 1966. The 17-foot-high barrier in Stamford, Conn., stopped Sandy's 11-foot surge from causing many millions of dollars in damage." (J. Cameron & D. Berg, "Movable barriers can protect Long Island's South Shore," Newsday, 9/15/13). Moreover, as a component of FIMP, the Corps has proposed elevating coastal roads that could double as storm-resistant berms.

The USACE's summary of the range of structural and non-structural measures to address storm-related flooding, wave attention and erosion is included here as **Table 7-8.**

Table 7-8 Summary of Structural and Non-Structural Measures to Reduce Storm-Related Risks

Table IV-4. Coastal Storm Risk Management and Resilience Attributes Associated with the Full Array of Measures

Aggregated Measure Type[1]	Category[2]	Coastal Storm Risk Management Function			Multi-Benefits[3]	Resilience
		Flooding	Wave Attenuation	Erosion		Adaptive Capacity[4]
Acquisition (building removal) and relocation[5]	Non-STR	High	High	High	High	High
Building retrofit (e.g., floodproofing, elevating structures, relocating structures, ringwalls)	Non-STR	High	Low	Low	Low	Low
Enhanced flood warning and evacuation planning (early warning systems, emergency response systems, emergency access routes)	Non-STR	Low	None	None	Low	High
Land use management/ conservation and preservation of undeveloped land, zoning, and flood insurance	Non-STR	Medium	None	None	High	Medium
Deployable floodwalls	STR	Medium	None	None	None	Low
Floodwalls and levees	STR	High	Low	None	Low	Low
Shoreline stabilization (seawalls, revetments, bulkheads)	STR	Low	High	High	Low	Low
Storm surge barriers	STR	High	Medium	None	Low	Low
Barrier island preservation and beach restoration (beach fill, dune creation)	STR/NNBF	High	High	Medium	High	High
Beach restoration and breakwaters	STR/NNBF	High	High	High	High	Medium
Beach restoration and groins	STR/NNBF	High	High	High	High	Medium
Drainage improvements (e.g., channel restoration, water storage/retention features)	STR/NNBF	Medium	Low	Medium	Medium	Low
Living shorelines	STR/NNBF	Low	Medium	Medium	High	High
Overwash fans (e.g., back bay tidal flats/fans)	NNBF	Low	Medium	High	Medium	High
Reefs	NNBF	Low	Medium	Medium	High	High
Submerged aquatic vegetation	NNBF	Low	Low	Low	High	Medium
Wetlands	NNBF	Low	Medium	Medium	High	High

1 An extensive list of management measures was compiled as part of the NACCS Measures Working Meeting in June 2013. The measures presented here represent an aggregated list of the categories of measures and corresponding conceptual parametric unit cost estimates.

2 STR = structural measure, Non-STR = nonstructural measure, and NNBF = Natural and Nature-Based Features measure. Multiple measures are listed if the aggregated measure type is made up of a combination of measures.

3 Multi-benefits focus on socioeconomic contributions to human health and welfare above and beyond the risk management benefits already highlighted in this table (i.e., flooding, wave attenuation, etc.). These benefits could include increased recreational opportunities, development of fish and wildlife habitat, provisioning of clean water, production of harvestable fish or other materials, etc.

4 Adaptive capacity is the assessment of a measure's ability to adjust with changing conditions and forces (including sea level change) through natural processes, operation and maintenance activities, or adaptive management, to preserve the measure's function.

5 Acquisition, relocation, and buyouts do not actually prevent flooding and erosion but remove the population and associated development from its effects.

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http://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf

SECTION 7 COASTAL RESILIENCY

Looming large over how we respond to the challenges of coastal living is how the costs will be borne. The Dutch have a national commitment to coastal resiliency because as the American economist working for the Dutch points out, "the entire nation is at risk if the western portion floods," and so they are all in it together. Not so in the United States where, increasingly, it is up to every individual to either sink or swim. The National Flood Insurance Program, in particular, has come under assault and premiums were set to go to so-called market rates as stipulated by the 2012 Biggert-Waters flood insurance bill. After some premiums in Louisiana reportedly jumped as high as $28,000, a bipartisan vote, in January of 2014, set up a congressional four year "timeout" for large premium increases.

Premiums will, at some point, increase markedly, especially for houses in flood zones that have not elevated and become FEMA-compliant. At that point, the high road/low road of an ad-hoc market place will drive the latter out of town. Simultaneously, municipalities will sink or swim based on their capacity and determination to take proactive measures that minimize lost revenues and eroding property values. The latest County initiative to extend sewering and institute an upgraded on-site wastewater treatment program will start to reverse the nitrogen loading that has been degrading wetland defenses. Furthermore, with FIMP slated to support 4,000 house elevations, elevated roadways and more robust barrier beaches and wetlands, municipalities must prepare road maintenance programs that deploy porous surfaces in conjunction with more pervious landscaping and bioretention to minimize the flooding that has rendered coastal habitation increasingly vexing. To that end, projects coming out of Rebuild by Design, NY Rising and various Sandy grants will provide templates and proof of concept for villages, town and the county to emulate.

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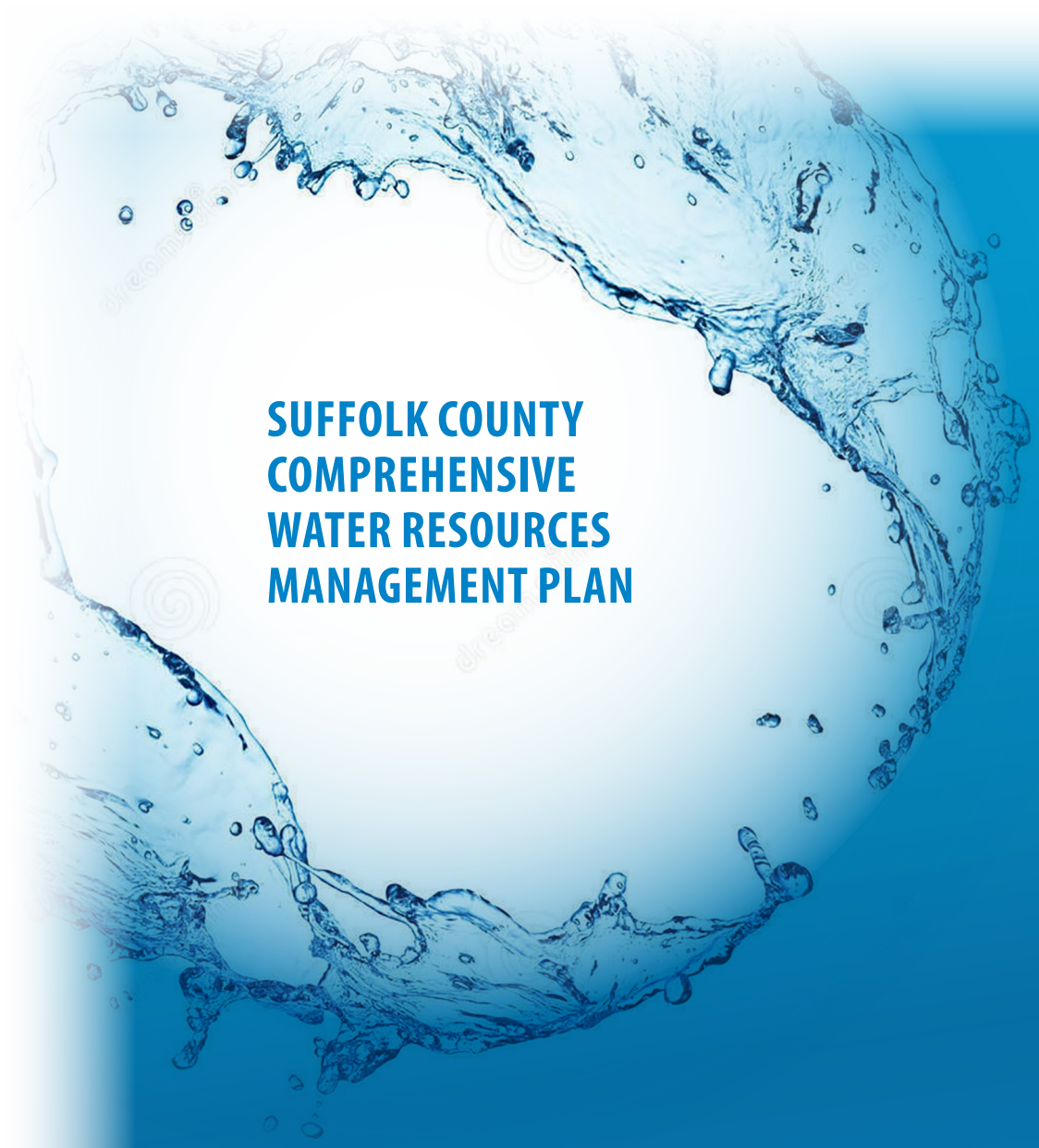


SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Section 8
WASTEWATER MANAGEMENT

Section 8
Wastewater Management

8.1 Problem Identification

In Suffolk County our economic prosperity, public health and safety, and quality of life rely upon a clean and sustainable supply of water. While all sources of water pollution are concerning, nitrogen pollution from septic systems has clearly emerged as the most widespread and least well addressed of the region's growing list of water pollutants.

Suffolk County New York is approximately 912 square miles and bounded by Nassau County to the west, the Atlantic Ocean to the east and south, and the Long Island Sound to the north. In 2013, the estimated population of Suffolk County was approximately 1.5 million (with 568,943 housing units), larger than the population of 11 states. The County's water resources are extremely valuable to residents, businesses, and visitors. The EPA designated sole source aquifer located directly underneath the County provides a source of fresh water to meet our potable drinking water, irrigation, and grey water needs. Surface waters resources provide recreational opportunities such as swimming and boating, a thriving tourist industry, fishing and shell fishing industry and coastal protection from storm surges.

The County's water resources are impacted by various pollutants contained in wastewater, storm water, fertilizers, and from atmospheric deposition. Portions of the Long Island Sound, Peconic Estuary, and South Shore Estuary have been listed on New York State's Draft Section 303(d) list of impaired water bodies.[1] One of the major water quality pollutants is nitrogen. Average nitrate concentrations in the same set of 175 upper glacial community supply wells that were sampled in 1987 and in 2013 have increased by approximately 1 mg/L, and average concentrations in the same set of 213 Magothy community supply wells increased by an of 0.76 mg/L from 1987 to 2013.

In Suffolk County, wastewater is one of the major contributors of nitrogen, which has significantly impacted ground and surface water quality. It is estimated that 69 percent (IBM Smarter Cities Challenge Report) of the nitrogen comes from onsite sewage disposal systems. Only 26 percent of Suffolk County is connected to a community sewage collection and treatment system capable of reducing nitrogen. The remaining 74 percent of the County utilizes onsite sewage disposal systems to meet their sewage disposal needs. These onsite sewage disposal systems are either systems consisting of cesspools (also known as leaching pools) or a combination of a septic tank and

leaching pool (conventional onsite sewage disposal system). These systems typically have little nitrogen reduction capabilities. The wastewater effluent from these onsite sewage disposal systems discharges into the ground eventually impacting ground and surface water resources. Increased levels of nitrogen in drinking water can cause methemoglobinemia also known as "Blue Baby Syndrome".[2] Increased nitrogen levels in surface waters result in eutrophication. The higher levels of nitrogen in surface waters can spur hypoxia, harmful algal blooms, reduce coastal resiliency, and create a decline of sea and shell fisheries. As an example, increased nitrogen levels in surface waters can stimulate algal blooms followed by an algal die-off when the nitrogen nutrient is depleted causing dead algae to settle, which increases the biological oxygen demand (BOD) when the microorganism population expands to consume the dead algae. Excessive amounts of algae leads to increased algal metabolism and turbidity of water, decreased dissolved oxygen in the water, and changes in community structure of the ecosystem.[3]

Suffolk County contains the highest density of onsite septic systems within the tri-state area with approximately 360,000 homes currently utilizing onsite sewage disposal systems. Of particular concern are the onsite septic systems located in the groundwater contributing areas of potable supply wells and estuarine surface waters. The Suffolk County Department of Economic Development and Planning has identified that approximately 209,000 of these homes with onsite sewage disposal systems are located in areas considered to be high priority areas. High priority areas are as follows (**Figure 8-1**):

- Areas in the 0-50 year contributing zone to public drinking water wells fields
- Areas in the 0-25 year contributing zone to surface waters
- Unsewered parcels with densities greater than what is permitted in Article 6 of the Suffolk County Sanitary Code
- Areas located in an area where groundwater is less than 10 feet below grade

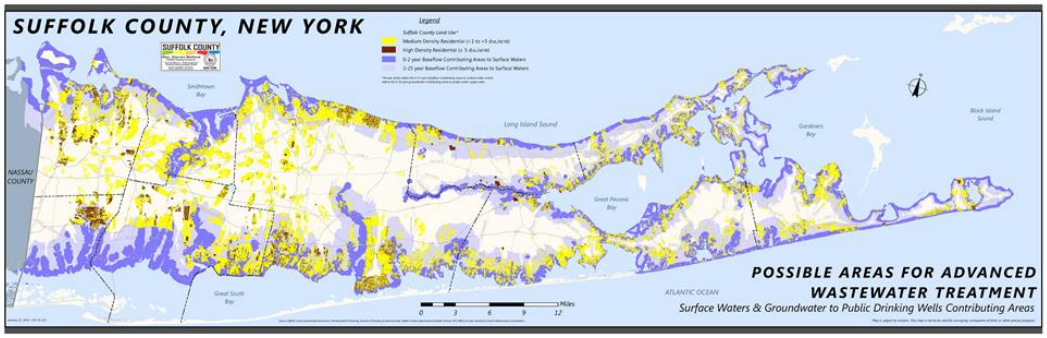


Figure 8-1 Map of Areas for Advanced Treatment

Suffolk County must maintain a balance between protecting the quality of water resources while maintaining the ability to dispose of wastewater to protect public health and stimulate development in order to promote economic growth and stability. This is accomplished by the implementation of a responsible wastewater management plan to limit the impacts of nitrogen from wastewater and other emerging wastewater constituents (personal care products, pharmaceuticals, etc.) on the County's water resources to preserve and protect these resources for future generations. The wastewater management plan should consist of connecting lots to community sewers by expanding existing sewer districts or creating new sewer districts where possible, upgrading cesspools to conventional onsite sewage disposal systems or innovative/alternative onsite sewage disposal systems, requiring new construction to install innovative/alternative sewage disposal systems in priority areas, developing/researching new technologies to better reduce nitrogen and other emerging wastewater constituents, and developing/providing funding sources to implement the wastewater management plan, etc.

8.1.1 The History of Wastewater Management in Suffolk County

8.1.1.1 Population Growth and Construction Trends

A review of population growth and construction trends becomes important when developing a responsible wastewater management plan to protect water resources. With population growth comes an increased need for potable water and wastewater infrastructure to serve the needs of the people. Suffolk County witnessed a population explosion between the 1950s and 1960s (See **Figure 8-2**) as the population increased from 276,129 in 1950 to 1,127,030 by 1970, according to U.S. census data. This was an increase of approximately 308 percent over a 20-year period. From the 1980s to 2010 the population of Suffolk County grew modestly with a population growth of 5.2 percent between 2000 and 2010.

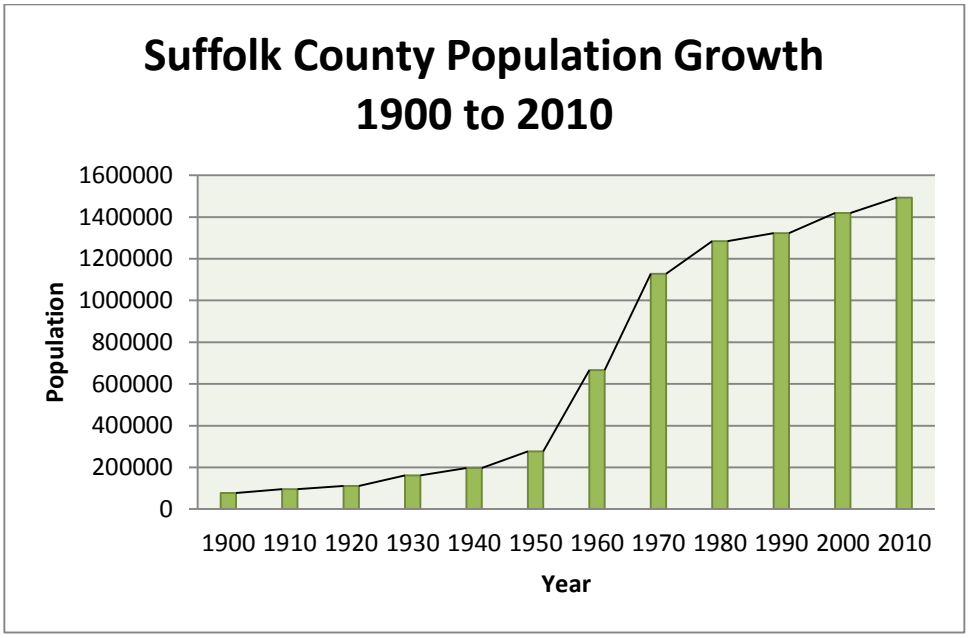


Figure 8-2 Suffolk County Population Growth

According to **The Suffolk County- Comprehensive Plan 2035**, the population of Suffolk County will continue to grow through 2035 reaching a population of 1.65 million.

Prior to 1950, much of Suffolk County was characterized by a network of small villages located along the Long Island Rail Road lines and supported by the fishing and agricultural industries. In the decade between 1950 and 1960, fueled by national housing and transportation policies that favored suburban tract development, the landscape of the County began to be transformed as the population of Suffolk County increased from 275,000 to 666,000 residents – an unprecedented growth of 140 percent. By 1970, after the population explosion during 1950s and 60s, the number of housing units within Suffolk County was 325,777 (See **Figure 8-3**). During the 43-year period after 1970 the number of housing units grew to 568,943.

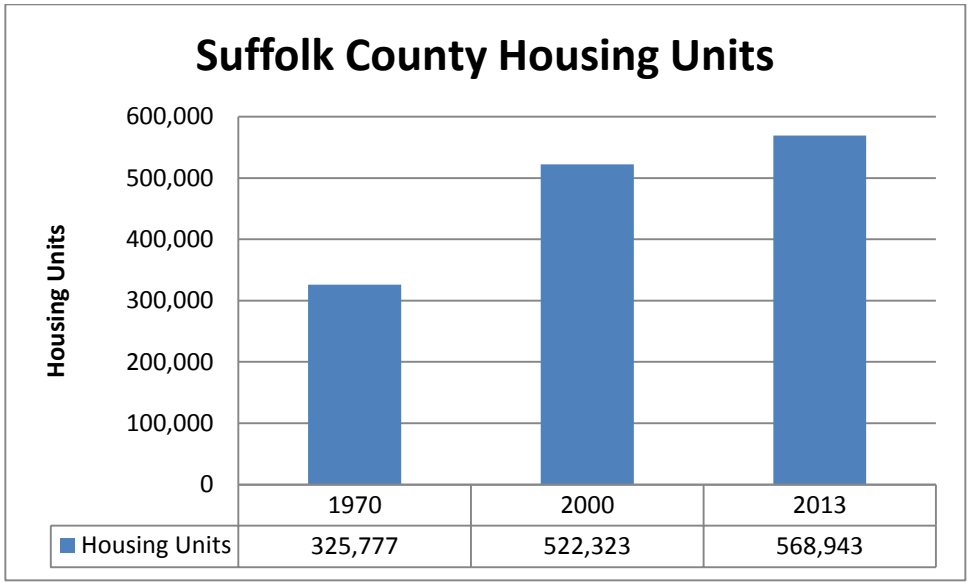


Figure 8-3 Suffolk County Housing Units

Currently, approximately 360,000 housing units use onsite sewage disposal systems that have limited nitrogen reducing capabilities as means of sewage disposal. The remaining units are connected to a community wastewater treatment system. In order to facilitate Suffolk County's continued population growth it is expected that development of remaining buildable undeveloped land will take place (other than the parcels sterilized for open space or development rights sold). In addition to the development of vacant parcels, previously developed parcels are being redeveloped. This includes infill development and redevelopment in and around train stations and transportation corridors and downtowns. One example of a blighted parcel is the redevelopment of the former United Artists Movie Theater previously located in Coram at the southwest corner of Middle Country Road and NYS Route 112. The vacant movie theater existed at the site for a number of years and was an eye sore to the community (See **Figure 8-4**).[4] In order to meet the growing housing needs of Suffolk County the site will be redeveloped with multiple workforce housing units and over 15,000 square feet of commercial space. Suffolk County played an active role assisting in the success of moving the workforce housing project forward and provided $1.5 million in funding for the construction of infrastructure components of the project.

Figure 8-4 Abandoned United Artist Movie Theater Located in Coram (Left) and Renderings of Proposed Residential-Commercial Buildings to be Constructed on the Site (Right)

8.1.1.2 Current Methods of Reducing/Limiting Wastewater Effluent Nitrogen Loading

8.1.1.2.1 Suffolk County Article 6 Density Standards and Groundwater Management Zones

Article 6 of the Suffolk County Sanitary Code outlines sewage disposal requirements for construction to help reduce the impacts of nitrogen loading to water resources. Per Article 6 of the Suffolk County Sanitary Code, property owners constructing a new building (including additions to existing buildings or changes of use of existing buildings with an onsite sewage disposal system) are required to obtain a permit from the Suffolk County Department of Health Services (SCDHS). The permit is usually for a proposed new onsite sewage disposal system conforming to current standards. In some cases where an addition or change of use is proposed, the permit may be to simply verify that the existing system meets current standards and is acceptable for the proposed addition or change of use.

A 208 Study was performed by SCDHS beginning in the early 1970s, to study the effects of building density on groundwater quality. The Long Island Comprehensive Waste Treatment Management Plan was based on the results of the 208-Study. Based on the study, eight Groundwater Management Zones, with differing recharge characteristics were identified. In addition the study showed that 1 acre zoning was needed to keep groundwater impacts acceptable and allow development to proceed. As a result, Article 6 was added to the Suffolk County Sanitary Code in 1981, which defined the means and methods for wastewater treatment in Suffolk County. Based on differences in regional hydrogeological and groundwater quality conditions, Article 6 delineated boundaries of the eight Groundwater Management Zones (GWMZ) for protection of groundwater quality (See **Figure 8-5**). The goal of creating the

GWMZ was to limit groundwater nitrogen to 4 mg/l in GWMZ III, V, and VI and to 6 mg/l in the remaining zones.

Figure 8-5 Suffolk County Sanitary Code Article 6 Groundwater Management Zone Map

Residential properties located within GWMZ III, V, and VI were required to have a minimum lot size of 40,000 square feet of land with the use of a conventional onsite sewage disposal system and public water or private wells. Residential properties located in the remaining zones are required to have a minimum 20,000 square feet of land when utilizing conventional onsite sewage disposal systems and public water (40,000 square feet with private wells).

Commercial/Industrial properties located in GWMZ III, V, and VI were limited to a total discharge of 300 gallons per day (gpd) per acre when using a conventional onsite sewage disposal system and public water or private well. The remaining zones were allowed 600 gpd/acre with public water (300gpd/acre with private well).

Since Article 6 was enacted in 1981 four (4) exemptions were permitted, as outlined below, for lots that existed prior to 1981. This permitted higher density development in certain areas when these exemptions where met.

1) Lots separately assessed on the Suffolk County Tax Maps as of January 1, 1981 and are buildable under current town or village zoning ordinances.
    a. (Applies to 4 or less lots owned by the same developer)

2) Subdivision previously approved by the New York State Health Department and have been filed in the Office of the Clerk of the County of Suffolk

3) Developments or other construction projects previously approved by the Department

4) Development or other construction projects, other than realty subdivisions, approved by a town or village planning or zoning board of appeals prior to January 1, 1981

Projects that exceed the density requirements as stated in Article 6 of the Suffolk County Sanitary Code and do not meet one of the exemptions are required to provide advanced treatment capable of reducing effluent nitrogen to 10 mg/l. This is accomplished by connecting the site to an existing or proposed community sewage treatment plant.

Many areas of Suffolk County were built before the Article 6 density restrictions or prior to conventional treatment system requirements. It is these many homes and businesses that are contributing to the pollution of groundwater in Suffolk County as well as the surface waters and ecosystems of the County. The Suffolk County Department of Economic Development and Planning estimated that over 60 percent of the residential parcels in Suffolk County are less than or equal to one half acre. There are approximately 372,018 residential parcels less than or equal to ½ acre (See **Table 8-1**). Of the 372,018 residential parcels, 257,626 (52.9 percent of the parcels) are not sewered. Out of the 487,082 residential parcels there are 214,903 residential parcels less than ¼ acre including 129,947 unsewered parcels (26.7 percent, as shown on **Table 8-2**). **Table 8-3** depicts the number of sewered parcels versus unsewered parcels by town, which equates to 75.3 percent unsewered (366,693 residential parcels) and 24.7 percent sewered (120,389 residential parcels).

8.1.1.2.2 Expansion of Sewers

Alternatively to meeting the density requirement of Article 6 of the Suffolk County Sanitary Code to protect water resources, connection to community wastewater treatment systems is an acceptable method of reducing nitrogen. A feasibility Study was conducted to explore the construction of public sewers within Suffolk County in 1961, and in 1965 Suffolk County established the County Sewer Agency, which was responsible for sewage collection, conveyance, treatment and disposal.

By 1970, the County acquired its first sewage treatment plant, the already constructed 1.5 million gallon per day (MGD) plant, located in Port Jefferson known as Suffolk County Sewer District #1. Eventually in the late 1970s and 1980s the Southwest Sewer District (SWSD), known as Sewer District #3, was created and the Bergen Point wastewater treatment plant (WWTP) was built and went online in October, 1981 through funding from the federal Government and New York State.[5] Sewer District # 3 is the largest sewer

district in Suffolk County consisting of an area of 57 square miles with of 950 miles of sewer lines and 14 remote pumping stations. The WWTP is currently designed for 30 MGD plus a scavenger waste flow of 0.5 MGD (**Figure 8-6**) serving an estimated population of 340,000 people.[6]

Table 8-1 Residential Parcels Less Than or Equal to ½ Acre

Residential Parcels Smaller Than or Equal to ½ Acre in Suffolk County Per Town					
Town	# of Parcels Less Than or Equal to ½ Acre	# of Unsewered Parcels Less Than or Equal to 1/2 Acre	# of Sewered Parcels Less Than or Equal to 1/2 Acre	Total Residential Parcels	Percent of Unsewered Parcels Less Than or Equal to ½ Acre
Babylon	58,377	15,291	43,086	59,485	25.71%
Brookhaven	119,535	92,253	27,282	151,672	60.82%
East Hampton	9,452	9,157	295	19,342	47.34%
Huntington	44,952	39,566	5,386	64,747	61.11%
Islip	78,796	47,143	31,653	88,138	53.49%
Riverhead	6,996	5,276	1,720	11,957	44.12%
Shelter Island	491	384	107	2,498	15.37%
Smithtown	28,181	24,985	3,196	37,643	66.37%
Southampton	17,776	17,114	662	37,365	45.80%
Southold	7,462	6,457	1,005	14,235	45.36%
Totals	**372,018**	**257,626**	**114,392**	**487,082**	52.89%

Table 8-2 Residential Parcels Less Than or Equal to ¼ Acre

Residential Parcels Smaller Than or Equal to 1/4 Acre in Suffolk County Per Town					
Town	# of Parcels Less Than or Equal to 1/4 Acre	# of Unsewered Parcels Less Than or Equal to 1/4 Acre	# of Sewered Parcels Less Than or Equal to 1/4 Acre	Total Residential Parcels	Percent of Unsewered Parcels Less Than or Equal to 1/4 Acre
Babylon	50,094	12,381	37,713	59,485	20.81%
Brookhaven	67,423	50,334	17,089	151,672	33.19%
East Hampton	3,479	3,186	293	19,342	16.47%
Huntington	27,373	22,608	4,765	64,747	34.92%
Islip	38,994	19,577	19,417	88,138	22.21%
Riverhead	4,064	2,926	1,138	11,957	24.47%
Shelter Island	128	53	75	2,498	2.12%
Smithtown	13,766	10,823	2,943	37,643	28.75%
Southampton	6,791	6,132	659	37,365	16.41%
Southold	2,791	1,927	864	14,235	13.54%
Totals	**214,903**	**129,947**	**84,956**	**487,082**	**26.68%**

Table 8-3 Sewered vs Unsewered Residential Lots

Sewered vs Unsewered Residential Parcels in Suffolk County Per Town					
Town	Total Unswered Residential Parcels	Total Sewered Residential Parcels	Total Residential Parcels	Percent of Unsewered Residential Parcels	Percent of Sewered Residential Parcels
Babylon	15,694	43,791	59,485	26.38%	73.62%
Brookhaven	122,984	28,688	151,672	81.09%	18.91%
East Hampton	19,046	296	19,342	98.47%	1.53%
Huntington	58,298	6,449	64,747	90.04%	9.96%
Islip	53,968	34,170	88,138	61.23%	38.77%
Riverhead	10,048	1,909	11,957	84.03%	15.97%
Shelter Island	2,348	150	2,498	94.00%	6.00%
Smithtown	34,411	3,232	37,643	91.41%	8.59%
Southampton	36,700	665	37,365	98.22%	1.78%
Southold	13,196	1,039	14,235	92.70%	7.30%
Totals	**366,693**	**120,389**	**487,082**	75.28%	24.72%

Figure 8-6 Aerial Photo of Bergen Point STP (Courtesy of Newsday)

Since the creation of the SWSD and extension of sewers to existing homes and commercial buildings located within the district there has not been a sewer project of its kind in Suffolk County in over 30 years. Evidence has shown that sewering can help reduce nitrogen loads to surface waters, for example the average nitrogen in the Carlls River in the 1970s was 3.2 mg/l and in the 2000s was reduced to 1.8 mg/l (See Section 5).

Suffolk County has recently started to evaluate the feasibility of sewering various areas throughout Suffolk County. In 2008, the Suffolk County Sewer District/Wastewater Treatment Task Force was established by the Suffolk County Legislature. The goals of the Task Force were to (suffolksewerstudy.cdmims.com):

1. Examine Suffolk's existing wastewater treatment facilities;
2. Educate the public as to the environmental and economic benefits of wastewater treatment facilities
3. Seek out public and private resources of funds to expand Suffolk County's wastewater treatment facilities to suitable areas in the County.

The unsewered areas to be studied were Bellport-North Bellport, Flanders Riverside Corridor, Lake Ronkonkoma Hub, Mastic-Shirley, NY 25 Corridor, Sayville, Southampton Village, and Yaphank.

In addition, the Task Force identified the following sewered areas for feasibility of potential expansion: Riverhead/Calverton, Patchogue, Port Jefferson and Sag Harbor.

Several additional feasibility study areas were later identified as separate projects: Deer Park-North Babylon-West Babylon-Wyandanch-West Islip, Center Moriches and Flanders-Riverside Corridor.

In 2014, Suffolk County was awarded $383 million from New York State to install sewers and connect approximately 10,000 properties to sewage collection and treatment systems. This will be the first major sewering based project within Suffolk County in more than 30 years. The goal of the project is to reduce nitrogen pollution to ground and surface waters to improve coastal resiliency against future storm events. The areas to be sewered, shown on **Figure 8-7,** the Suffolk County Coastal Resiliency Projects Fact Sheet, will be

(1) Mastic: Parcels in the Forge River area will be connected to a new sewer collection system that will flow to a new wastewater treatment plant located on municipal property near the Brookhaven Town Airport.

(2) North Babylon and West Babylon and Wyandanch: Parcels in the Carlls River area will be connected to the SWSD.

(3) Great River: Parcels in the Connetquot River and Nicolls Bay area will be connected to the SWSD.

(4) Patchogue: Parcels in the Patchogue River area will be connected to the Patchogue sewer system within the Patchogue Sewer District.

8.1.1.3 On-site Sewage Disposal Systems

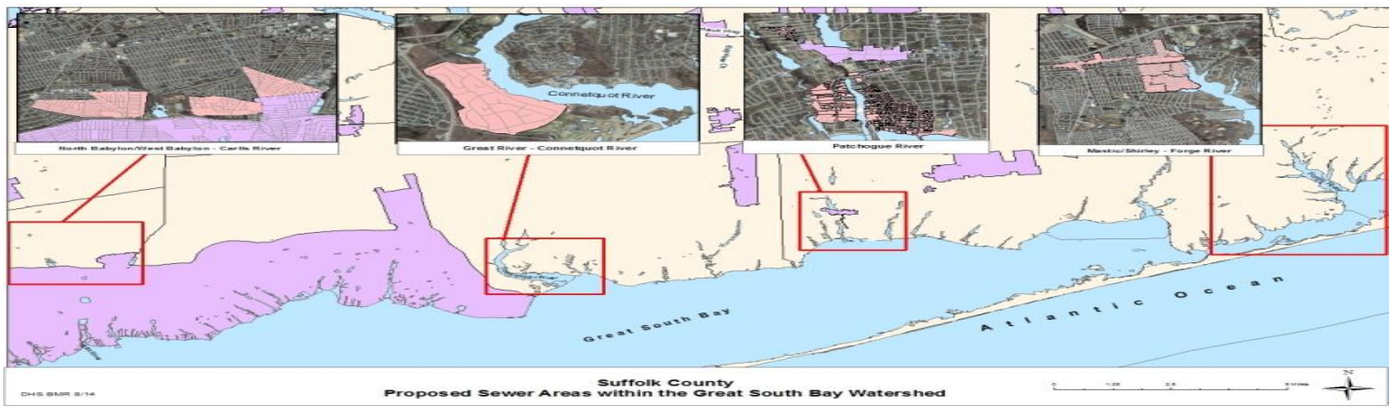
Seventy-four percent of Suffolk County residences use onsite sewage disposal systems as means of sewage disposal. The effluent from onsite sewage disposal systems are discharged into the ground. The sands, silts, gravels and clays that make up the unsaturated zone and the aquifer function as a large sand filter and help to limit the impact of contaminants contained in effluents to groundwater. In 1958 the first SCDHS Standards went into effect, requiring block cesspools for single-family homes. Up until 1972 these cesspools (AKA leaching pools) were permitted to be installed without a septic tank (**See Figure 8-8**). Leaching pools are defined as a covered pit with a perforated wall through which wastewater will infiltrate the surrounding soil. Today, leaching pools are reinforced precast concrete structures, but the original leaching

Great South Bay – Water Quality Initiative

10/21/14

Highest priorities: Sewer 4 sensitive sub-watershed areas of Great South Bay with small parcels, shallow groundwater, short travel time to groundwater and concentrated nutrient loads in sensitive stream corridors (Carlls River, Connetquot River, Patchogue River, and Forge River)

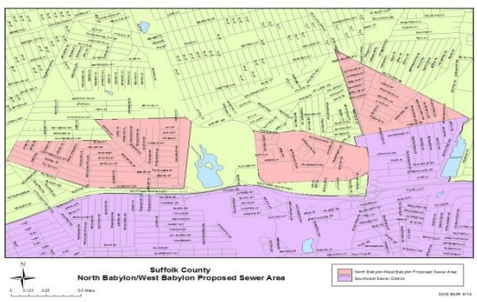
Sewer 10,647 Parcels** **Remove 860 lbs./day of Nitrogen** **Reduce Wasteater Nitrogen load by 15%



These four projects will address the following circumstances:

- **High Nitrogen/Poor Flushing**
  - Residence time~100 days
  - Unsewered wastewater is ~70% of nitrogen load
- **Harmful Algal Blooms**
  - Recurring Brown Tide that obliterate shellfish habitat
  - *Cochlodinium p. "rust tide"* in 2011
- **Depleted Coastal Resiliency**
- **Wetlands loss**
  - *NYSDEC estimates 18-36% loss in GSB between 1974-2001
- **Seagrass loss**
  - 90% loss of since 1930
- **Shellfish loss**
  - 93% loss of hard clam harvest in past 25 years
  - Loss of more than 6,000 jobs
- **Low Dissolved Oxygen**
  - "Impaired water body" declaration by NYSDEC in 2008

Total sewering cost: $383 million. Grant request: $325 million (85% of total cost)



Carlls River (including Area In-District Connections)

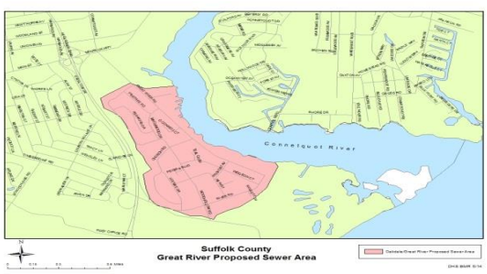
This project would:

- Sewer 6,606 parcels (2,106 w/in North and West Babylon & 4,500 w/in SD #3)
- Remove 543 lbs./day of nitrogen
- 25% reduction in existing Carlls River wastewater nitrogen load
- Remove ~100% of the remaining wastewater nitrogen load from unsewered parcels within Sewer District # 3

Key facts:

- Sewering SW district resulted in reducing nitrate from 4 mg/L → 2 mg/L
- Nitrate should be 0.5 mg/L or less in surface waters

Cost: $112 million



Connetquot River

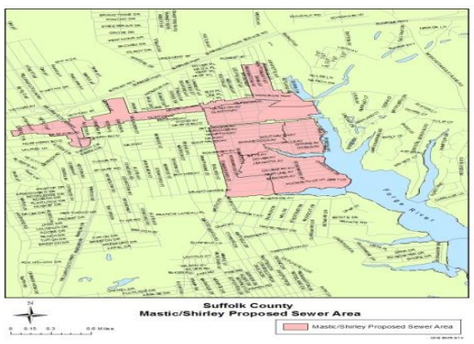
This project would:

- Sewer 500 parcels
- Remove 41 lbs./day of Nitrogen
- 8% reduction in Connetquot River wastewater nitrogen load

Key facts:

- Nitrates rose from 0.6 mg/L → >2 mg/L since 1960's unsewered development
- >233% increase in Nitrates

Cost: $27.2 million



Forge River

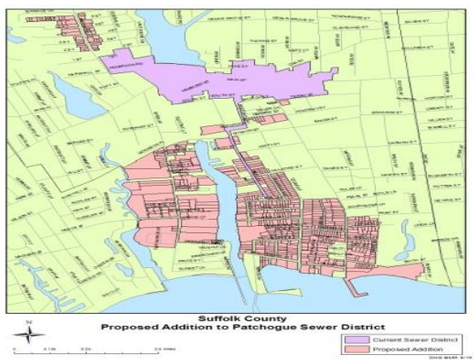
This project would:

- Construct a new Sewage Treatment Plant
- Sewer 2,893 parcels initially and allow for eventually sewering 10,500 parcels
- Remove 201 lbs./day of nitrogen
- 15% reduction of Forge River wastewater nitrogen load

Key Facts:

- Most eutrophic water body in Suffolk County
- Sustained severe anoxia during summer
- GW levels of nitrogen are already at 10 mg/L
- Nitrogen levels projected to go 14 mg/L if no action

Cost: $170.3 million



Patchogue River

This project would:

- Sewer 648 parcels (Patchogue S.D.)
- Remove 75 lbs./day of Nitrogen *
- Increase Patchogue River sewered nitrogen removal by >100%
- 25% reduction in Patchogue River/Patchogue Lake wastewater nitrogen load** (0-2 year contributing area sewer plan)

Key facts:

- Eastern GSB nitrates have risen significantly
- Eastern GSB flushing rates are poor (~100 days)
- Nitrates rose from 0.5 mg/L → >2.5 since 1960's ***

Cost: $15.5 million

pools known as cesspools were constructed from concrete blocks and are highly susceptible to collapse. There have been a number of news stories of individuals who have fallen into a cesspool which collapsed. Some individuals are lucky such as a farther, son and neighbor who fell into a cesspool that gave way in Huntington in 2006. They fell into a collapsed cesspool with sewage up to their necks but were rescued by police before they drowned. [7] Some are not so lucky; in September of 2001 a Huntington man who was practicing archery in his backyard died when his 18-foot deep cesspool caved in, taking him with it.[8]

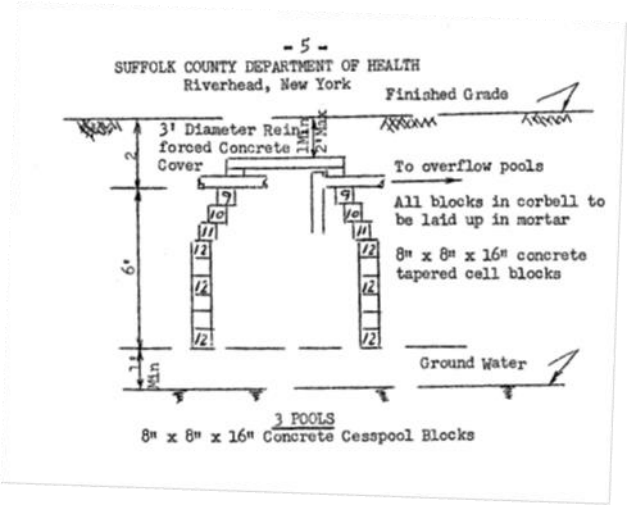


Figure 8-8 Block Leaching Pool Detail -SCDHS Residential Standards Prior to 1972

In 1972, the standards were revised to require basic treatment for single-family homes, consisting of a 900 gallon septic tank and precast leaching pools (also known as conventional onsite sewage disposal systems). **Figure 8-9** depicts the layout of a typical conventional onsite sewage disposal system and precast leaching pool rings respectively. Septic tanks are watertight chambers used for settling, stabilizing and anaerobic decomposition of sewage. Today all new construction including additions to existing buildings or changes of use of existing buildings are required to install a conventional onsite sewage disposal system when a community sewage disposal system is not available.

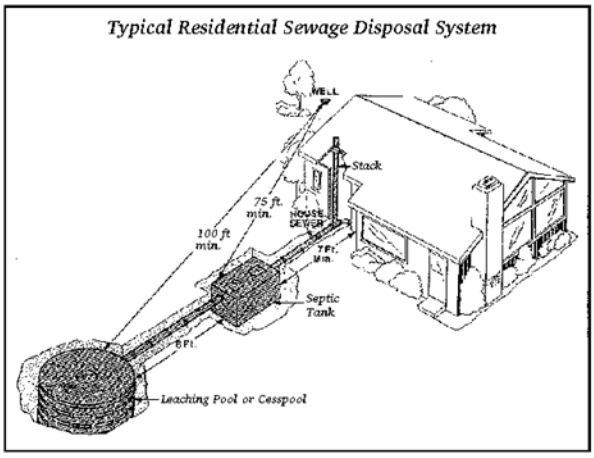


Figure 8-9 Precast Leaching Rings (Left) & Typical System layout (Right)

Currently, property owners with older onsite sewage disposal systems such as cesspools are not required to make an application to the SCDHS to upgrade their system to current standards. When either a cesspool fails or a conventional system fails the property owner has the right to re-install the system in kind without obtaining a permit from the SCDHS. However, as stated in the current residential construction standards, the SCDHS recommends property owners follow the standards as a guideline for re-construction of a failing system.

Based on 1970 census data there were 325,777 homes in Suffolk County that predate the Suffolk County Sanitary Code and construction standards requiring a precast septic tank and leaching pool to be installed at the time of construction. It is estimated that 252,530 homes out of the 325,777 homes in 1970 are not connected to sewers and do not have a sanitary system that conforms to current standards. **Table 8-4** shows the breakdown of number of houses per town that require sanitary upgrades assuming 80 percent of homes in Babylon and 33 percent of homes in Islip are on sewers. (**Suffolk County Decentralized Wastewater Needs Survey Final Report**, March 2012).

Most commercial buildings within Suffolk County are served by onsite sewage disposal systems. It has been estimated that there are approximately 39,318 active commercial properties within Suffolk County using onsite sewage disposal systems. Some of these sites have multiple onsite sewage disposal systems serving the building(s) located on the parcel. Similar to residential sewage disposal systems, commercial onsite sewage disposal systems that comply with current standards consist of a precast septic tank for primary treatment and precast leaching pool(s). Commercial buildings with any type of

Table 8-4 Estimated Sanitary Systems Pre-Dating Requirements for Septic Tanks

Estimated Number of Residential Parcels Pre-Dating Requirements for Septic Tanks		
Town	**Homes in 1970 (Census Data)**	**Homes Requiring Upgrade**
Babylon	58,359	11,672
Brookhaven	78,660	78,660
East Hampton	3,137	3,137
Huntington	56,996	56,996
Islip	79,680	53,120
Riverhead	5,402	5,402
Shelter Island	469	469
Smithtown	27,944	27,944
Southampton	10,329	10,329
Southold	4,801	4,801
Total	**325,777**	**252,530**

food service use also require the addition of a precast grease trap. The first commercial standards went into effect in 1961 and permitted the use of cesspools (block or precast) only or conventional sanitary systems. In 1984, commercial standards requiring precast septic tank and leaching pools went into effect known as "Standards for Approval of Plans and Construction for Sewage Disposal Systems for Other Than Single-Family Residences". In addition to addressing the requirement for precast and septic tanks, the standards reference allowable sanitary flow permitted to be discharged from a commercial/industrial parcel. Therefore there are many sites constructed prior to 1984 that may exceed the current density requirements of Article 6 and may have cesspools as means of sewage disposal.

After the commercial density requirements went into effect in 1984, the SCDHS approved passive denitrification systems as a form of treatment that allowed commercial properties to exceed Article 6 density as long as the total flow generated was less than 15,000 gallons per day (gpd). Originally, these systems were truly passive treatment systems. Later, in an effort to increase performance, pumps were added to the system to optimize the dosing of the treatment works. The system had five main components. The pretreatment unit consisted of a standard septic tank and grease trap. It was followed by a dosing siphon or pump station that distributed flow to the downstream treatment units.

The treatment process was accomplished by two separate treatment units. The first unit consisted of a buried aerobic sand filter where nitrification would

take place. The sewage was introduced to the top of the filter by a distribution manifold. As the sewage filtered down through the media, oxygen would be pulled down into the unit and mixed the sewage and the in-situ bacteria that attached to the sand. Both carbonaceous satisfaction and nitrification would occur in the filter before liquid was captured in an underdrain collection system.

The next treatment step consisted of an upflow denitrification filter that was charged with sulfur and limestone. The limestone acted to buffer the solution and the sulfur acted as the food source for the sulfur fixing bacteria that performed the denitrification process. The overflow from the denitrification filter was passed on to the final step which was effluent recharge via leaching pools.

Passive denitrification systems were installed between 1985 and 1994. There are approximately 450 of these systems installed throughout Suffolk County. This technology was thought to be advantageous because it provided developers the ability to exceed density with a much smaller footprint and significantly lower operating cost than a traditional decentralized onsite wastewater treatment plant. Unfortunately, permission to install these systems was ultimately suspended by the NYSDEC due to the fact the technology could not consistently meet the groundwater nitrogen discharge limit of 10 mg/l due to clogging of both the sand media and denitrification filter.

Over time, most of these systems failed hydraulically and were bypassed to conventional treatment systems. These systems originally operated under a State Pollution Discharge Elimination System (SPDES) permit requiring that they met the groundwater nitrogen discharge limit of 10 mg/l. When the systems were discontinued from use, the SPDES permits were modified to drop the effluent limitations and place the permittee on notice that additional treatment may be required in the future.

In 2009 Suffolk County began investigating innovative/alternative onsite wastewater treatment systems (I/A OWTS) capable of reducing effluent total nitrogen for residential use. A study by Holzmacher, McLendon & Murrell (H2M) on behalf of Suffolk County to evaluate "Alternative Onsite Wastewater Treatment Systems" was completed in 2012. The systems evaluated were required to produce a total effluent nitrogen of 10 mg/l or less consistently to meet NYSDEC requirements. The evaluation was broken into two categories as follows: (1) Systems between 300 gpd and 1000 gpd and (2) Systems between 1,000 gpd and 30,000gpd.

Based on the study, five new types of systems were found to be viable to meet NYSDEC total effluent nitrogen requirements for systems between 1,000 gpd

and 30,000 gpd. These systems are now permitted to be installed in Suffolk County provided they meet the requirements of the Suffolk County Sanitary Code and separation requirements as stated in the SCDHS commercial standards. Only one system between 300 gpd to 1000 gpd (residential systems) that consistently met effluent total nitrogen of 10 mg/l or less was identified. The drawback of the system was cost, which could run a homeowner approximately $41,500 as compared to a conventional onsite sewage disposal system at approximately $5,080

The County has revaluated the need to require I/A OWTS for residential lots to meet an effluent total nitrogen of 10 mg/l or less. The County is exploring I/A OWTS that can reduce effluent total nitrogen to 19 mg/l at a lower cost. Based on the Suffolk County "Advanced Wastewater & Transfer of Development Rights Tour Summary" (Prepared April 2014), there are a number of systems existing that can meet these requirements.

In 2014, Suffolk County began its first demonstration project for I/A OWTS. The demonstration project is intended to provide field-testing and technology verification to determine if a particular I/A OWTS can function effectively in Suffolk County. The technologies and manufactures that have been selected to participate in the demonstration project are outlined in **Table 8-5**.

8.1.1.4 Sewage Treatment Plants and Sewering

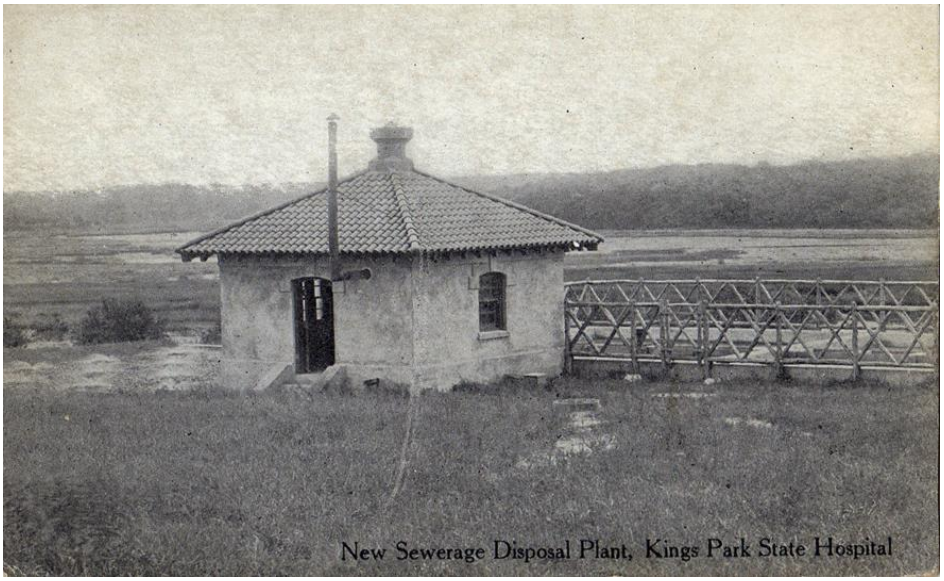
As of 2013, Suffolk County has 197 operational sewage treatment plants (STPs). 171 of the STPs are designed to remove nitrogen from the wastewater with typical effluent total nitrogen of 10 mg/l or less. These types of plants are considered "Tertiary Plants". The remaining 26 STPs are considered "Secondary Plants" capable of reducing biochemical oxygen demand (BOD_5) and suspended solids (SS). Of the 197 sewage treatment plants, 15 sewage treatment plants discharge directly to surface waters. The 2013 average effluent total nitrogen for the tertiary plants in Suffolk County was 8.7 mg/l, which is less than the maximum allowed of 10 mg/l per SPDES permits.

Table 8-5 Suffolk County Demonstration Project I/A OWTS

I/A OWTS MANUFACTURER	SYSTEM	PROCESS
Norweco	Singulair TNT	Extended Aeration
Norweco	Hydro-Kinetic 600 FEU	Extended Aeration
Busse	Busse MF 400	Membrane Bioreactor
Orenco Systems	AdvanTex AX-RT	Attached Growth Textile Packed Bed Filter
Orenco Systems	AdvanTex AX20	Attached Growth Textile Packed Bed Filter
Hydro-Action	Hydro-Action	Extended Aeration

The sewage treatment plants in Suffolk County can be broken down into centralized and decentralized STPs. Centralized sewage treatment systems involve advanced collection and treatment processes that collect, treat and discharge large quantities of wastewater.[9] Municipalities usually own the centralized STPs. There are approximately 23 centralized STPs located in Suffolk County. Some of the major centralized sewer districts in the County are Bergen Point (Sewer District #3), Selden (Sewer District # 11), Town of Riverhead, and Village of Patchogue, which serve multiple individually owned tax lots and are operated by municipalities. Bergen Point is the largest treatment plant in Suffolk County with an operating capacity of 30 MGD and currently under construction to expand the plant to 40 MGD. Bergen Point is a secondary plant that discharges treated effluent 2 miles off of Fire Island into the Atlantic Ocean.

Most of the STPs located within Suffolk County are considered decentralized.



Decentralized STPs are designed to operate on a smaller scale than centralized STPs and do not require multiple remote pump stations to convey sewage to the plant. The historical use of decentralized STPs in the County has been to serve single lots containing condominium complexes, apartment complexes, hotels, or industrial/commercial buildings.

The SCDHS has been actively requiring older plants that are underperforming and/or lack nitrogen removal capability, to undergo renovations or replacement. During the past 15 years 100 new STPs were constructed of which 20 were constructed to replace existing facilities whose physical conditions and/or treatment capability deteriorated over the years. For example, the

Kings Park Sewage Treatment Plant located on the grounds of the former Kings Park Psychiatric Center main structure was built in 1935, rehabilitated in 1960, and upgraded again in 2004 to a sequencing batch reactor (See **Figures 8-10** and **8-11**).

Figure 8-10 Kings Park State Hospital Sewage Disposal Facilities Circa 1935[10]

Figure 8-11 Aerial photo of Kings Park STP in 1978 (Left) and 2013 (Right)

Some of the types of sewage treatment plants utilized in Suffolk County are rotating biological contractor (RBC), sequence batch reactors (SBR), extended aeration systems with a denitrification filter, membrane bioreactor (MBR), and biologically engineered single sludge treatment (BESST) processes (See **Tables 8-6** and **8-7**).

.

Table 8-6 List of Suffolk County STPs (See Table 8-7 for Additional STPs)

Sewage Treatment Name	Sewage Treatment type	Tertiary or Secondary	Sewage Treatment Name	Sewage Treatment type	Tertiary or Secondary
Artist Lake	Extended aeration denite filter	Tertiary	Greens @ Half Hollow	SBR	Tertiary
Avery Village	SBR	Tertiary	Greenview Commons	SBR	Tertiary
Bellhaven Nursing Home	SBR	Tertiary	Greenview Court	Cromaglass	Tertiary
Birchwood @ Spring Lake	Extended aeration denite filter	Tertiary	Greenwood @ Oakdale	Extended aeration denite filter	Tertiary
Birchwood Glen	Extended aeration denite filter	Tertiary	Greenwood Village	Extended aeration denite filter	Tertiary
Birchwood Nursing Home	SBR	Tertiary	Gurwin Jewish Assisted Living	SBR	Tertiary
Birchwood On The Green	Extended aeration denite filter	Tertiary	Gurwin Jewish Geriatric Center	SBR	Tertiary
Blue Ridge	SBR	Tertiary	Hampton Rehab Center	SBR	Tertiary
Bretton Woods	SBR	Tertiary	Hawthorne (Concord) Village	MBR	Tertiary
Bristal East Northport	Cromaglass	Tertiary	Heatherwood @ Holbrook	BESST	Tertiary
Bristal @ Lake Grove	Cromaglass	Tertiary	Heatherwood @Lakeland	Extended aeration denite filter	Tertiary
Encore Atl Shores Bristal Est.	SBR	Tertiary	Heatherwood House @ Lake Ronk	Extended aeration	Secondary
Broadway Knolls	SBR	Tertiary	Heritage Gardens at Brentwood	BESST	Tertiary
Broadway West	Cromaglass	Tertiary	Hidden Ponds	Extended aeration denite filter	Tertiary
Brookhaven Hospital	SBR	Tertiary	Hilton Gardens	SBR	Tertiary
Brookhaven National Lab	Modular Aeration	Tertiary	Holiday Inn Express	Cromaglass	Tertiary
Brookhaven SD #2	BESST	Tertiary	Holiday Inn	Extended aeration denite filter	Tertiary
Brookhaven Town Hall	Extended areation denite filter	Secondary	Homestead Village	Extended aeration Susp. growth denite	Tertiary
Brookwood on the Lake	Bio disc denite filter	Tertiary	Huntington Town	SBR	Tertiary
Browning Hotel Marriott Courtyard	SBR	Tertiary	Inn @ East Winds	Cromaglass	Tertiary
Cabrini Gardens	Cromaglass	Tertiary	IRS	SBR	Tertiary
Calverton Enterprise Park	Extended aeration	Secondary	Island View	SBR	Tertiary
Calverton Hills	Extended aeration	Secondary	Islandia Center	Extended aeration denite filter	Tertiary
Cedar Lodge	Extended aeration	Secondary	Kensington Gardens st jamess NH	Extended aeration denite filter	Tertiary
Cenacle Manor	SBR	Tertiary	LA fitness	BESST	Tertiary
Chatham Holts RI Holt Hotel	SBR	Tertiary	La Quinta	Cromaglass	Tertiary
Chelmsford Weald Condo	Cromaglass	Tertiary	Lake Grove Apqartments	SBR	Tertiary
Country Pointe	SBR	Tertiary	Lake Pointe	Extended aeration denite filter	Tertiary
Country View Estates	SBR	Tertiary	Lakes @ Setauket	Biodisc denite filter	Tertiary
Country View @ Holtsville	BESST	Tertiary	Lakeview Woods Bayport	Cromaglass	Tertiary
Country View @ Smithtown	Cromaglass	Tertiary	Larkfield Gardens Atria	SBR	Tertiary
Courtyard at Southampton	Cromaglass	Tertiary	Lexington Village	Extended aeration	Secondary
Crescent Club	Extended Aeration	Secondary	DSW Plaza Loehmans Plaza	RBC denite filter	Tertiary
Dowling	RBC denite filter	Tertiary	Mac Arthur Plaza	Extended aeration denite filter	Tertiary
Eagles walk	Cromaglass	Tertiary	Medford multicare center for living	SBR	Tertiary
East Port Meadows	Cromaglass	Tertiary	Medford NH	SBR	Tertiary
Emanon Group	Cromaglass	Tertiary	Medford Ponds	BESST	Tertiary
Emerald Greens	SBR	Tertiary	Melville Mall	Biodisc denite filter	Tertiary
Exit 63 Development	SBR	Tertiary	Memorial Sloan Kettering	Cromaglass	Tertiary
Fairfield at Mastic	Cromaglass	Tertiary	Middle Island Co-op	Extended aeration	Secondary
Fairfield at Selden	SBR	Tertiary	Mill Pond Estates	BESST	Tertiary
Fairfield Inn by Marriott	Cromaglass	Tertiary	Montauk Manor	Oxidation ditch	Tertiary (Seasonal)
Fairfield Lk Ronk	Cromaglass	Tertiary	Nesconset NH	Extended aeration denite filter	Tertiary
Fairfield Village (Groton)	MBR	Tertiary	Newsday	Aerotor/MBR	Tertiary
Fairhaven Apts. @ Nesconset	Extended aeration	Secondary	North Isle Village	Extended aeration denite filter	Tertiary
Fairway Manor	Extended aeration denite filter	Tertiary	Northport VA	Extended Aeration w/ Suspended Growth D	Tertiary
Fox Meadows	Extended aeration denite filter	Tertiary	Northport Village	Extended aeration denite filter	Tertiary
Greenport Village	SBR	Tertiary	Oak Creek Commons	Cromaglass	Tertiary

Table 8-7 List of Suffolk County STPs (See Table 8-6 for Additional STPs)

Sewage Treatment Name	Sewage Treatment type	Tertiary or Secondary	Sewage Treatment Name	Sewage Treatment type	Tertiary or Secondary
Oak Creek Commons	Cromaglass	Tertiary	S-Hampton Commons	SBR	Tertiary
Oak HollowNH	Extended aeration upflowdenite filter	Tertiary	SHampton Hospital	Bio disc denite filter	Tertiary
Oak Ridge Hollow	Cromaglass	Tertiary	Shelter Island Heights	SBR	Secondary
Oakwood Care Center Affinity	SBR	Tertiary	Silver Ponds	RBC denite filter	Tertiary
Ocean Beach	Chemical Carbon Filter	Secondary	Smithaven Mall	SBR	Tertiary
Orchard @ Bulls Head Inn	Cromaglass	Tertiary	Smithtown Galleria	SBR	Tertiary
Patch NH	Extended aeration upflowdenite filter	Tertiary	Somerset Woods	Extended aeration	Secondary
Patch Senior Conifer 16128	SBR	Tertiary	Southern Meadows	SBR	Tertiary
Patchogue Village	Aerotor/mbr	Tertiary	Springhom	Cromaglass	Tertiary
Paumanok	SBR	Tertiary	Spruce Ponds	SBR	Tertiary
Petite Fleur	Extended aeration denite filter	Tertiary	St Annes	Cromaglass	Tertiary
Pine Hills S Mirror Ponds	SBR	Tertiary	Stone Ridge at Dix Hills	Cromaglass	Tertiary
Pinewood Gardens	Cromaglass	Tertiary	Stonehurst	SBR	Tertiary
Plum Island	Extended aeration	Secondary	Stonington	SBR	Tertiary
Preserves	Cromaglass	Tertiary	Stony Hollow	SBR	Tertiary
Quail Run	SBR	Tertiary	Stratford Green	MBR	Tertiary
Radisson HotelBest Western	Extended aeration denite filter	Tertiary	Stratmore on the Green	Extended aeration denite filt	Tertiary
Residence Inn	Cromaglass	Tertiary	Sunrise assited living Smithto	Cromaglass	Tertiary
Riverhead Town	SBR	Secondary	Sunrise Dix Hills	Cromaglass	Tertiary
Rocky Point Apts.	Extended aeration	Secondary	Sunrise E. Setauket	Cromaglass	Tertiary
Ross Health Care	BESST	Tertiary	Sunrise Garden Apts.	SBR	Tertiary
Rough Riders Landing	Oxidation ditch	Tertiary	Sunrise Holbrook	Cromaglass	Tertiary
Saddle Brook	Cromaglass	Tertiary	Sunrise Village	Cromaglass	Tertiary
Sag Harbor	SBR	Tertiary	Tall Oaks	Extended aeration	Tertiary
Sagamore Hills	SBR	Tertiary	The Inn @ East Winds	Cromaglass	Tertiary
Sayville Commons	SBR	Tertiary	The Greens	SBR	Tertiary
SCC Riverhead	SBR	Tertiary	Timber Ridge @ Westhamptor	Cromaglass	Tertiary
SCC Selden	Extended aeration denite filter	Tertiary	Towne House Village South	Extended aeration	Tertiary
SD # 1 Port Jefferson	SBR	Tertiary	Valley Forge	SBR	Tertiary
SD # 12 Birchwood	SBR	Tertiary	Victorian Gardens	SBR	Tertiary
SD # 13 wind Watch	SBR	Tertiary	Victorian Homes	SBR	Tertiary
SD # 14 Parkland	SBR	Tertiary	Village in the Woods 00130	Extended aeration denite filt	Tertiary
SD # 15 Nob Hill	Extended aeration Susp. Growth denite	Tertiary	Villages @ Lake Grove	SBR	Tertiary
SD # 18S Hauppauge Industrial Park	Extended aeration susp. growth denite	Tertiary	Fairfield Villas @ Medford	Cromaglass	Tertiary
SD # 2 Tallmadge	SBR	Tertiary	Villas @ Pine Hills	SBR	Tertiary
SD # 20W Leisure Village	SBR	Tertiary	Vinyards @ E. Morriches	Cromaglass	Tertiary
SD # 21 SUNY Stony Brook	Oxidation ditch	Tertiary	Walden Ponds	SBR	Tertiary
SD # 22 Hauppauge County Center	Cannabal	Tertiary	Waterways	Extended aeration denite filt	Tertiary
SD # 23 Coventry Manor	Bio disc denite filter	Tertiary	Waverly Park	SBR	Tertiary
SD # 28 Fairfield@St James	Extended aeration denite filter	Tertiary	West Hampton NH	Extended aeration denite filt	Tertiary
SD # 3 Bergen Point	Aeration	Secondary	Westhampton Pines	SBR	Tertiary
SD # 5 Strathmore Huntington	SBR	Tertiary	Whispering Pines	Extended aeration denite filt	Tertiary
SD # 6 Kings Park	SBR	Tertiary	Willow Ponds	SBR	Tertiary
SD # 7 Twelve Pines	Extended aeration susp. Growth denite	Tertiary	Windbrooke	SBR	Tertiary
SD # 7 Woodside	Extended aeration denite filter	Tertiary	Woodbridge	Cromaglass	Tertiary
SD # 9 College Park	Extended aeration susp. Growth denite	Tertiary	Woodcrest	SBR	Tertiary
SD #11 Selden	SBR	Tertiary	Woodhaven Manor	Extended aeration	Tertiary
SD 20E Ridgehaven	SBR	Tertiary	Woodhull	SBR	Tertiary
SD Gabreski Airport	SBR	Tertiary	Yaphank CC	Bio disc denite filter	Tertiary
SD Yaphank County Center	Bio disc denite filter	Tertiary	Yardarm	Bio disc denite filter	Tertiary
Setauket Meadows	SBR	Tertiary			

"Standards for Approval of Plans and Construction for Sewage Disposal Systems for Other Than Single-Family Residences" Appendix A and B outline the construction requirements for new sewage treatment plants. Appendix A is geared towards plants with flows less than or equal to 15,000 gallons per day while Appendix B is for plants with flows greater than 15,000 gallons per day. The major difference between the two appendixes is the setback requirements. **Table 8-8** outlines the differences in setbacks between Appendix A and B. Enclosed STPs with flows less than or equal to 15,000 gallons per day with the installation of an odor control system, usually carbon drum filters, have the least restrictive setback requirements. In certain cases, enclosed STPs with odor control with flows less than 15,000 gpd may qualify for reduced setbacks to property lines to a minimum of 25 feet when the property line boarders a major highway, railroad tracks, recharge basin, or areas designated as permanent open space.

Table 8-8 SCDHS STP Setback Requirements

Required Setback Distance of Sewage Treatment Plants (STP) of Suffolk County Department of Health Services Standards for Approval if Plans and Construction for Sewage Disposal Systems For Other Than Single-Family Residences Appendix A vs Appendix B			
	Distance to Habitable Structure	**Distance to Non-Habitable Structure**	**Distance to property Lines**
Enclosed STP w/ Odor Control (Less Than or Equal to 15,000 gpd – Appendix A)	75	50	75
Enclosed STP w/o Odor Control (Less Than or Equal to 15,000 gpd – Appendix A)	200	100	150
Enclose STP (Greater Than 15,00GPD - Appendix B)	200	200	150
STP Open to the Atmosphere (Greater Than 15,00GPD - Appendix B)	400	400	350

The types of systems installed meeting Appendix A requirements are normally considered to be package systems. Two systems, which have currently been installed in Suffolk County are the CromaFlow (formerly known as Cromoglass) treatment system and the biologically engineered single-sludge treatment processes (BESST) (See **Figure 8-12**). Both treatment systems are activated sludge processes. Other systems less than or equal to 15,000 gallon per day treatment capacity that are permitted to be installed in Suffolk County are sequence batch reactors, membrane bioreactors, Nitrex, AquaPoint, Inc. Bioclere and WesTech's STM-Aerotors.

Figure 8-12 CromaFlow (Left) and BESST (Right) Treatment Tanks

All of the tertiary treatment plants are designed specifically to remove nitrogen, but with the concern for emerging contaminants such as pharmaceuticals and personal care products some modifications may be required to some of the plants to remove these types of constituents in the future.

Sewer collection systems in Suffolk County consist mainly of gravity sewer lines with remote pump stations. In certain cases low pressure force mains have been utilized. The Village of Patchogue sewer district has been expanding in recent years through the use of low pressure force mains with Environmental One (E/One) pump systems such as the DH-152 model depicted in **Figure 8-13**. The advantage of installing low pressure force mains is the cost. They reduce the amount of major remote pump stations required, reduce the need for costly deep excavations to install gravity sewers, and lower dewatering costs. On the other hand, gravity sewers may be more expensive for developers/municipalities to install in certain cases but are less expensive for homeowners since the homeowner does not have to maintain and operate their own low pressure pump station located on their property.

Figure 8-13 E/One Low-Pressure Pump Station (Model DH-152)

8.1.2 Environmental Impacts due to Wastewater Effluent

Nitrogen in various forms can present a public health hazard in drinking water and impact surface waters. SCDHS samples for total nitrogen in wastewater effluent. Total nitrogen consists of organic nitrogen, ammonia (NH_4+), nitrate (NO_3-), and nitrite (NO_2-). Tertiary wastewater treatment plants discharging into the ground in Suffolk County are required to have an effluent total nitrogen of 10 mg/l of less. The sources of nitrogen to Suffolk County's water resources are wastewater, storm water, fertilizers, and atmospheric deposition. It has been estimated that wastewater nitrogen contributes approximately 69 percent[11] of the total nitrogen to ground and surface water resources. The main source of wastewater nitrogen in Suffolk County is from the approximately 360,000 onsite sewage disposal systems utilized by the residents of Suffolk County to meet their wastewater needs. Sections 8.1.3.1 and 8.1.3.2 discusses the current nitrogen trends in Suffolk County's groundwater and surface water resources.

8.1.2.1 Status and Trends of Nitrogen in Suffolk County Groundwater

Early in 2014 SCDHS prepared an evaluation report of nitrates trends in Suffolk County supply wells (Appendix F). The evaluation of nitrates in groundwater is essential because it is a component of total nitrogen and is the primary contaminant in drinking water. When ammonia has contact with oxygen, the

oxygen converts ammonia to nitrate via oxidation. After water containing nitrates is ingested, nitrate is converted to nitrite by bacteria conversion in the gastrointestinal tract. Nitrite then converts hemoglobin to methemoglobin, which reduces the bloods ability to transport oxygen causing methemoglobinemia (AKA "Blue Baby Syndrome"), which may cause death. Blue baby syndrome usually affects children less than 3-months old but may affect children up to six years of age.

The SCDHS evaluation report was an expansion of work previously completed by CDM in the Draft Comprehensive Water Resources Report which compared the 1987 and 2005 nitrate water quality data. SCDHS expanded CDM's work by including 2013 nitrate data. Suffolk County has approximately 1,000 public water supply wells and an estimated 45,000 private wells. Several public water supply wells in Suffolk County are approaching or exceeding the nitrate drinking water standard and must blend or treat to reduce nitrate concentrations. Public water suppliers on Long Island can spend an estimated $3.5 million in capital expenses for a nitrate removal system at a typical pump station and can spend an additional $125,000 per year in operating costs for electricity, disposal of waste streams, etc. [12]

Nitrate data was compared at public supply wells screened in the glacial and Magothy aquifers. The Lloyd aquifer was not evaluated since there are currently only a total of 5 public supply wells installed in the Lloyd aquifer and only one was sampled in 1987, 2005, and 2013.[12]

The nitrate results for the glacial aquifer wells were based on samples collected from the same 173 wells sampled in 1987, 2005, and 2013. Nitrate concentrations in the glacial aquifer wells rose over 41 percent from an average concentration of 2.54 mg/l in 1987 to 3.58 mg/l in 2013. This was an annual increase of 0.04 mg/l per year (see **Figure 8-14**).[12]

As with the glacial aquifer, the nitrate levels in the Magothy aquifer were based on samples collected from the same 190 public supply wells sampled in 1987, 2005, and 2013. Nitrate concentrations in the Magothy aquifer wells rose over 93.2 percent from an average concentration of 0.91 mg/l in 1987 to 1.76 mg/l in 2013. This was an annual increase of 0.03 mg/l per year from 1987 to 2005 and 0.04 mg/l from 2005 to 2013 (see **Figure 8-14**). [12]

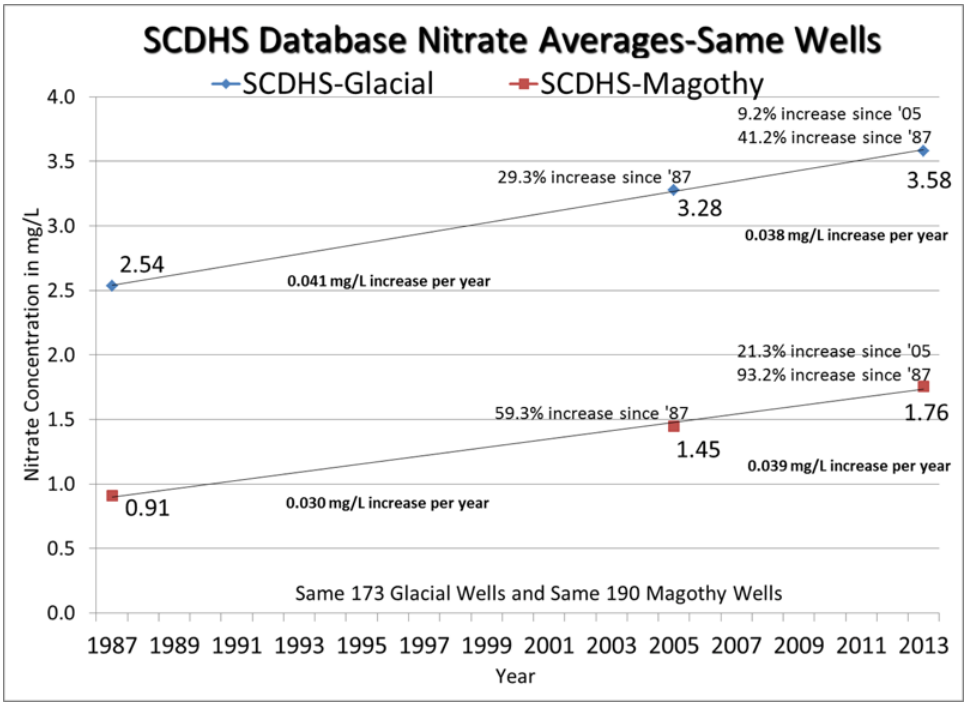


Figure 8-14 Average Nitrate Concentration of Same Wells Tested In 1987, 2005, and 2013

In addition, SCDHS compared the average nitrate concentration of all wells in the glacial and Magothy aquifers (**Figure 8-15**). From **Figure 8-15** the average nitrate concentration in the glacial aquifer increased from 3.01 mg/l to 3.34 mg/l or 11.0 percent from 1987 to 2013. During the same time period, the average nitrate concentration in public supply wells screened in the Magothy aquifer increased from 0.98 mg/l to 1.54 mg/l or 57.3 percent. It should be noted that the number of wells in the glacial aquifer decreased from 732 wells to 498 wells, which could be due to non-community water suppliers connecting to community water supplies and older supply wells being retired. In addition the number of Magothy wells increased from 260 to 390 which could be due to increased demand and/or Magothy well installed to replace a glacial well.[12]

To monitor the success of a wastewater management plan nitrate results should continue to be compared as part of the plan evaluation process. As stated in the nitrate evaluation report,

> *"Comparison of nitrate levels measured at the same set of wells over time provides the most reliable assessment of how nitrate levels in the aquifer are changing. As public supply wells continue to be abandoned or replaced, the pool of available data*

from the same subset of wells will continue to decrease resulting in a very limited assessment of overall quality in the aquifers. Public water supply wells are also generally installed in areas with better water quality, which may be biasing the data in an overall assessment of the aquifer. Alternative methods for compiling a database of consistent and reliable sampling points should be considered (e.g. monitoring well network).”

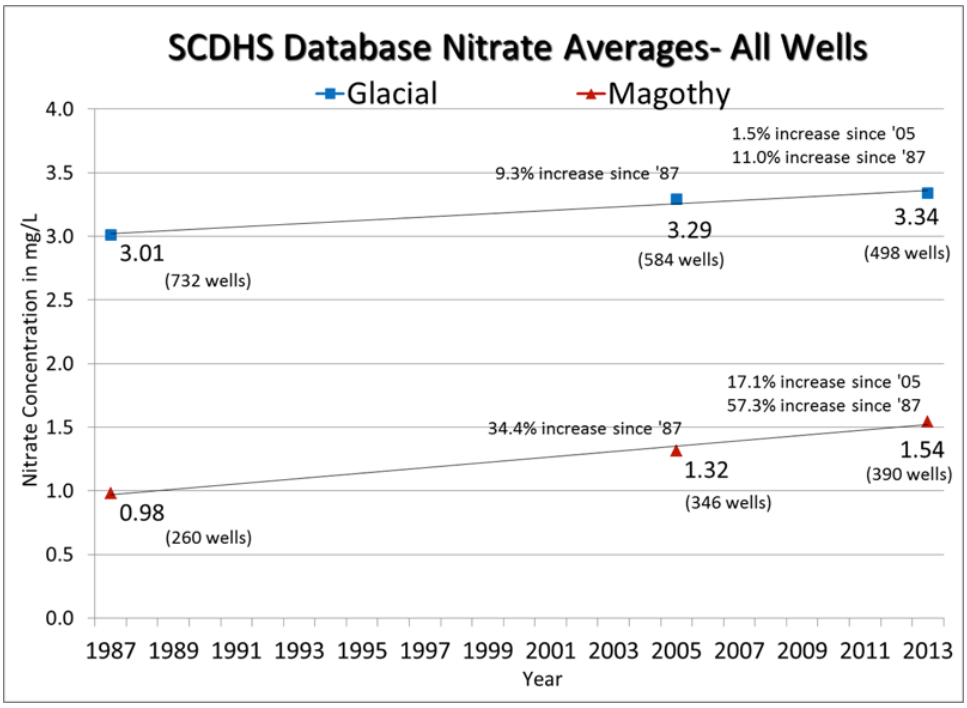


Figure 8-15 Average Nitrate Concentration of All Wells Tested In 1987, 2005, and 2013

8.1.2.2 Status and Trends of Wastewater Impacts to Suffolk County Surface Waters

Suffolk County has approximately 360,000 homes with septic tanks or cesspools contributing to surface waters with many systems in low lying areas that have less than 10 feet separating their systems from the water table. When flooded or submerged in groundwater, septic systems do not function as designed and they fail to adequately treat pathogens. In addition, the excess nutrient load from this wastewater via groundwater flow to our estuaries is impacting our valuable natural resources, natural coastal defenses and threatens our human health. In fact, recent studies by researchers Kinney and Valiela demonstrate that 69 percent of the total nitrogen load for the Great South Bay is from septic systems and cesspools.

All 3 major estuaries in Suffolk County are experiencing environmental and health impairments due to wastewater and nutrient over-enrichment. These impacts include impairments to fish and wildlife populations, oxygen depletion, beach closures, marsh and seagrass loss, shellfish harvest restrictions and recurrence of Harmful Algal Blooms, some of which are toxic to humans.

When algal blooms occur they can alter marine habitats by blocking light or killing marine life. When the algae eventually die off and decay, they deplete the dissolved oxygen in the water which results in uninhabitable dead zones (hypoxia). Since 1985, five distinct groups of harmful algal bloom have emerged in Suffolk County's coastal waters:

- Brown tide (Aureococcus anophagefferens) -a marine microalgae that when in bloom, turns waters coffee-brown and has been responsible for the decline in eelgrass beds in various locations, as well as the mortality of shellfish, particularly bay scallops.

- Red tide (Alexandrium fundyense) – causes paralytic shellfish poisoning (PSP) by the ingestion of shellfish that have been filter feeding on certain strains of algae which produce saxitoxin. Shellfish accumulate this toxin and can, when these contaminated shellfish are consumed by humans or another predator, cause sickness or even death.

- Dinophysis- causes Diaretic Shellfish Poisoning (DSP) by the ingestion of shellfish that have been filter feeding on certain strains of algae which produce the bio-toxin Okadaic acid. Shellfish accumulate this toxin and can cause sickness, when these contaminated shellfish are consumed by humans. In 2011, Dinophysis caused the first DSP event in Suffolk County waters (Northport Bay).

- Cochlodinium polykrikoides - Studies have demonstrated that this organism can have a serious impact on marine resources, as it causes the mortality of juvenile fish and shellfish.

- Toxic cyanobacteria (blue-green algae)-can produce powerful toxins that affect the brain and liver of animals and humans. Blooms of the organism have caused beach closures at various lakes in Suffolk County.

These algal blooms are not only unsightly and in some cases toxic, they block out valuable sunlight that seagrass needs to survive. Seagrasses stabilize bottom sediments, improve estuarine water quality, and provide critical

habitat for a large number of varied species. However, thousands of acres have died off in Long Island's eastern and south shore estuaries. According to the NYS Seagrass Task Force, historic photography and records indicate that there may have been as much as 200,000 acres of seagrass in 1930 in Long Island Bays and harbors; only about 22,000 acres remain.

Salt marshes, or tidal marshes, are highly productive coastal wetlands that provide a wide array of important ecosystem services, including storm surge protection for coastal communities, nutrient removal, carbon sequestration, and habitat for numerous fish and wildlife species (Mitsch and Gosselink, 1993). Unfortunately, recent scientific studies have focused on excess nutrient nitrogen loadings from septic/cesspool systems, waste water treatment plants that do not treat for nitrogen, as a significant driver of marsh loss. What was once vegetated intertidal marsh is being converted to non-vegetated underwater lands/mud flats. In addition, high marsh vegetation is being converted to low marsh vegetation. This process is reducing our coastal resiliency as wetlands have been scientifically proven to reduce vulnerability from storm surge. They can greatly reduce wave height and energy over short distances as waves travel through vegetation1. Losses of healthy marshes have accelerated in recent decades. NYSDEC estimates that there was an 18-36 percent loss in tidal wetlands in the Great South Bay between 1974 and 2001.

The impacts of wastewater and nutrient over-enrichment to shellfisheries and fisheries have been negative and severe. In the past 25 years, the hard clam harvest in Great South Bay has fallen by more than 93 percent. In the 1970s, bay-scallop fishery on Eastern Long Island and hard clam fishery in the South Shore bays were the two largest in the U.S. However, due to recurring algal blooms, and to some extent over-harvesting, they have failed to recover. More recently, the NYSDEC has placed shellfish harvest restrictions due to marine bio-toxins caused by red tides of Alexandrium fundyense (PSP) at various locations within all three major estuaries in Suffolk County

8.1.2.3 Impacts and Trends of Other Wastewater Effluent Constituents

8.1.2.3.1 PPCPs

Since the 1987 Comp Plan was published, more advanced and sensitive analytical techniques have been developed that allow the detection of increasingly lower concentrations of contaminants in the environment. In recent years, very low levels of pharmaceuticals and personal care products (PPCPs), also sometimes referred to as pharmaceutically-active compounds (PhACs) or organic wastewater contaminants (OWC), have been detected in the environment. PPCPs include a broad range of products such as prescription and over the counter drugs, including antibiotics, veterinary and

illicit drugs, fragrances, sun-screen products, cosmetics, some detergents, some food and drink additives, trace plasticizers that contaminate the consumer products and all of their respective metabolites and transformation products. Many are used and released to the environment in large enough quantities such that low levels are detected in wastewaters and receiving waters.

As most pharmaceuticals are designed to be water soluble, and to be persistent long enough to serve their designated therapeutic purposes, they can be present in dissolved form in receiving ground and surface waters. PPCPs are continuously introduced into the environment by sewage treatment plants and by on-site wastewater disposal systems (e.g., septic tanks and leach fields) in unsewered areas. Based upon estimated release rates to the environment and field surveys, the presence of PPCPs is expected to be at about the nanograms per liter (ng/l) or part per trillion (ppt) level in the environment and it is documented that many of these contaminants (e.g., nonylphenol, which mimics estrogen and is found in detergents, paints and cosmetics) are stable and persistent in the environment. SCDHS currently analyzes for thirty PPCPs; contaminants that have been detected in community, non-community, private or monitoring wells are summarized in **Table 8-9**.

Suffolk County has also participated in a study with USEPA; PPCPs in effluent from WWTPs with hospitals in their tributary area were studied. **Table 8-10** identifies the twenty contaminants that were detected during that study.

8.1.2.3.2 Pathogens

Pathogens are of potential concern for wastewater discharges to ground or surface waters, including onsite wastewater treatment systems (OWTSs). The highest risk is associated with ingestion when pathogens, including bacteria, viruses and protozoans, reach groundwater or surface waters where they can cause human disease through direct consumption, recreational contact, or ingestion of contaminated shellfish. Pathogen removal in OWTSs primarily occurs by die-off when microorganisms are detained by sorption to soil media. Thus, pathogen removal is most efficient when effluent from OWTSs is discharged into granular (sand) media than when non-porous media is present, for example, bedrock (e.g. basalt). Concerns over pathogens resulted in the implementation of travel time requirements for environmental buffers in systems where the disposal system may be hydraulically connected to drinking water supplies. Travel times are average values and some groundwater takes a faster path and arrives sooner than the average. Travel times are most accurately calculated for porous media aquifers. In non-porous media aquifers, travel times are best determined using site specific field tracer tests. For indirect potable reuse (IPR) systems in California, travel time requirements range from 6 to 12 months, depending on the percentage of

Table 8-9 PPCPs currently Analyzed by the Suffolk County PEHL and Maximum Concentrations Detected

Contaminant	Use	Detected by PEHL
Pharmaceuticals		
Acetaminophen	Pain Reliever	X
4-Androstene-3,17-dione	hormone	
Carbamazepine	anticonvulsant	X @ 17.8 µg/L
Carisoprodol	skeletal muscle relaxant	X @ 13.0 µg/L
Diethylstilbestrol	hormone	X
Dilantin (Phenytoin)	antiepileptic	X
4-Hydroxyphenytoin	metabolite of dilantin	X
Estrone	hormone	X
17 b Estradiol	hormone	
17 a Ethynylestradiol	hormone	
Gemfibrozil	lipid regulator	X @ 4.6 µg/L
Ibuprofen	anti-inflammatory	X @ 7.6 µg/L
Personal Care Products		
Benzophenone	fragrance	X
Chloroxylenol	antimicrobial	X
Dibutyl phthalate	plasticizer in nail polish	X
1,4-Dichlorobenzene	disinfectant	X
Diethyl phthalate	binds cosmetics & fragrances	X @ 59.8 µg/L
Dimethyl phthalate	used in insecticide repellents	X
Dimethyltoluamide (DEET)	insecticide repellent	X @ 69 µg/L
D-Limonene	deodorant	X
Picaridin	insect repellent	
Triclosan	antimicrobial	X
Other		
Benzyl butyl phthalate	plasticizer	X
bis-(2-ethylhexyl) adipate	plasticizer	X
bis-(2-ethylhexyl) phthalate	plasticizer	X
Bisphenol A	plasticizer	X
Bisphenol B	plasticizer	
Butylated Hydroxyanisole (BHA)	antioxidant; food additive	X @ 2.2 ppb
Butylated Hydroxytoluene (BHT)	antioxidant; food additive	X
Caffeine	stimulant	X

Table 8-10 Summary of PPCPs Found in Suffolk County WWTP Effluent

PPCP	Use	Detected
Acetaminophen	Pain reliever	X
Caffeine	Stimulant	X
Carbamzaepine	Anti-convulsant	X
Codeine	Pain killer	X
Cotinine	Pain killer	X
Cis-Diltiazem	Treats hypertension/angina	X
DEET	Insect repellant	X
Erythromycin	Antibiotic	X
Fluorosemide	Diuretic	X
Gemfibrozil	Lipid regulator	X
Hydrochlorothiazide	Diuretic	X
Ibuprofen	Anti-inflammatory	X
Meprobamate	Anti-anxiety agent	X
Metroprolol	Antihypertensive	X
Naproxen	Anti-inflammatory	X
Paraxanthine	Stimulant	X
Ranitidine	Inhibits stomach acid	X
Sufamethoxazole	Antibiotic	X
Tramadol	Analgesic	X
Triclosan	Anti-microbial	X

reclaimed water in the planned IPR system. In 2009, Massachusetts adopted a 6-month travel time requirement for environmental buffers in IPR systems. Although New York State does not currently have guidelines for water reuse, Subpart 5-1 'Public Water Systems' of the State Sanitary Code (November 2011) requires that all new and existing sewer discharges to groundwater systems must have a 60-day travel time or more from the point of discharge to the point of intake (NYCRR Title 10, 2011). The retention times required for environmental buffers ranges from 50 days to 12 months, which can have a major impact on design and implementation of OWTSs.

Bacteria

Extensive laboratory and field studies have been conducted on the survival of the bacteria, *Escherichia coli* (*E. coli*), which is generally a nonpathogenic indicator, although there are pathogenic strains that occur. A summary of studies on *E. coli* decay rates revealed that most researchers found decay rates of 0.1/day or greater when studying the decay of *E. coli* in sub-surface environments (Roslev et al., 2004). Many of these studies were conducted

under controlled conditions in groundwater without the effects of straining and sorption (filtration). Therefore, decay alone may result in 5-log removal of *E. coli* in less than 20 days during sub-surface transport. Research conducted at the University of South Florida (John and Rose) found that the mean inactivation rate for coliform bacteria was 0.127 log/day, based upon eight studies, and that enterococci have a slighter longer survival time than do coliforms.

Viruses

Concern over viruses has prompted continued research on virus transport and survival in environmental buffers (AwwaRF, 2001a.). Soil saturation and aquifer flow type (porous or non-porous media), media composition, ground water pH, and virus strain all interact to affect the sorptive capacity and virus die-off rate in soils and aquifers. Because viral subsurface inactivation rates are estimates, a second barrier with reliable, effective disinfection is recommended if drinking water is potentially influenced by these discharges. Further, virus removal by sorption is an active research area and remains difficult to predict in field studies. Other parameters affecting efficacy of the soil-aquifer treatment (SAT) process include travel time, vadose zone depth, and wet/dry cycles (Drewes, 2011).

Because of their smaller size, viruses are less easily filtered than other pathogens; the most significant removal mechanism is adsorption onto soil particles. Finer soils with pH below 7.40 are more effective at adsorbing viruses. Higher silt and clay content, and lower ionic strength have also been reported to increase adsorption and removal. During groundwater transport, both irreversible and reversible attachment to particles, and increasing inactivation at increasing temperature has been documented (Harris, 1995, Yates and Gerba, 1985). Inactivation rates for viruses in New York groundwater at 12 degrees C, expressed in terms of $\log_{10}$ decline in the culturable organisms per day, ranged from 0.026 to 0.054 $\log_{10}$ per day, or about 90 percent inactivation in one month (Yates, et al, 1985; Yates, et al., 1990).

A recent study by Betancourt et al. (2014) focused on removal of enteric viruses from three managed aquifer recharge (MAR) projects in Arizona, Colorado, and California. Source water receiving treated wastewater and reclaimed water, and groundwater samples, were tested for the presence of select enteric viruses with polymerase chain reaction (PCR) methods to gauge the efficacy of soil-aquifer treatment. Results show that enteric viruses were only detected in one groundwater sample with a residence time of 5 days. A subsurface residence time of 14 days resulted in virus concentrations below the detection limit (1 to 5-log removal) (Betancourt et al. 2014). This study noted that virus removal is a function of both travel distance and residence time.

In 2014, Abel published 'Soil Aquifer Treatment: Assessment and Applicability of Primary Effluent Reuse in Developing Countries', and reported that travel distances for virus removal ranged from 0 to 5 meters. A tool for 'Soil Aquifer Treatment pre-screening' developed in this study revealed that the efficiency of soil aquifer treatment to remove viruses was a function of the type of wastewater effluent, the pretreatment processes provided, and travel distance (Abel, 2014). Abel et al. (2010) modeled a primary wastewater effluent (influent to soil aquifer treatment) virus concentration of 1.2 x 10^4 CFU/100mL and found that in 4.6 days, the travel distance was 0.8 meters and 4 percent removal of enteric viruses had occurred (Abel et al. 2014). Similarly, Rice and Bouwer (1984) measured 0.4 – 4 percent removal of enteric viruses in tertiary effluent from a WWTP that had traveled 0.1-4.6 days, a distance of 1.0 - 5 meters (Abel et al. 2014).

Protozoans

Similar concerns over protozoa have been raised because *Cryptosporidium* oocysts and *Giardia* cysts have been found in groundwater (Bridgman et al. 1995; Hancock et al. 1998) and in reclaimed water (Gennancaro et al., 2003; Huffman et al., 2006) including infectious *Giardia*. There have been *Cryptosporidium* and *Giardia* outbreaks, some associated with heavy rainfall (Bridgman et al. 1995; Curriero et al. 2001), with research revealing that *Cryptosporidium* oocysts and *Giardia* cysts can be transported in the subsurface soil under normal conditions, especially when preferential porous media flow paths exist (Darnault et al. 2003 and Park et al., 2012). Protozoa have been reported to be able to persist for months in groundwater. Although transport has not been extensively investigated, because they are relatively larger than other micro-organisms, and they have a higher propensity for grain surfaces, it has been hypothesized that their movement may be retarded in sand aquifers relative to bacteria (CDM Smith, 2003). Additional research into the transport of protozoan pathogens is needed (EPA, 2012).

The Long Island Source Water Assessment Program (SWAP) developed by New York State Department of Health (NYSDOH) in cooperation with Nassau County Department of Health (NCDH), Nassau County Department of Public Works (NCDPW) and SCDHS concluded that the relative persistence of bacteria, viruses and protozoa in Long Island groundwater is low, and that the relative mobility of bacteria and protozoa in Long Island groundwater is low, and the relative mobility of viruses in Long Island groundwater is moderate.

Based on this assessment, the SWAP identified supply wells with potential microbial sources located within a two year travel time as highly sensitive to microbial contamination and supply wells with potential microbial sources located within a two to five year travel time as having medium sensitivity to microbial contamination.

8.1.2.3.3 Other

Chromium is a naturally occurring metal that can occur as trivalent chromium (Cr-3) and hexavalent chromium (Cr-6). The presence of low levels of Cr-6 in groundwater can be naturally occurring, or can result from industrial processes. While there is no MCL for Cr-6, USEPA has established an MCL of 100 ppb for total Chromium. In 2013, the results of SCWA monitoring for Cr-6 ranged from non-detect to 6.06 µg/L. Cr-6 has a high mobility in groundwater due to its anionic nature.

1,4-Dioxane ($C_4H_8O_2$) is an organic solvent with numerous industrial and synthetic uses. It is highly water soluble and environmentally stable, but it is oxidizable by free radical chemical processes and slowly by Ultraviolet (UV) radiation. When found in water, it is at µg/L levels. It is not efficiently removed by most treatment processes due to its low molecular weight and chemical properties. Pretreatment and discharge controls are the best ways to prevent its presence in wastewater. It does not occur with sufficient frequency and concentrations to be useful in evaluating treatment trains. If present in a particular water source at concentrations well above the detection limit, it could be useful. The U.S. EPA current 10^{-6} lifetime risk value for 1,4-dioxane is 0.35 µg/L and the non-cancer lifetime Health Advisory (HA) is 200 µg/L based upon non-cancer effects (U.S. EPA, 2012). As a point of reference, California Department of Public Health has posted a notification level of 1 µg/L based upon an evaluation of new evidence of its carcinogenic activity in animals, and the limits of the current standard analytical detection.

8.1.3 Contaminants of Emerging Concern (CEC) Treatability Considerations

There are literally thousands of references on the environmental occurrence, fate and transport of various constituents of concern (CECs) that originate from wastewater (Wells et al., 2008, 2009, 2010; Bell, et al., 2011, da Silva et al., 2012, 2013, 2014). These CECs include groups of compounds such as pharmaceutically active compounds, personal care and consumer product additives, etc. and have been the subject of thousands of studies on their removal in various wastewater treatment processes (Wells et al., 2008, 2009, 2010; Bell, et al., 2011, 2012, 2013; Keen et al. 2014). **Table 8-11** illustrates the types of compounds that have been reported in treated wastewater effluents in many of these previous studies.

Research findings point to three major themes that should be considered when evaluating the treatability of these compounds. First, the compounds that are being detected reflect polar, poorly degradable compounds that occur frequently in wastewater effluents (Reemtsma, 2006). The occurrence of many of the CECs can be attributed to the fact that they are difficult to remove

because they are very hydrophilic (tendency to mix with or dissolve in water) at the pH at which most treatment occurs, i.e. between pH 7 and pH 8; therefore, developing an understanding of appropriate measures of hydrophobicity/hydrophilicity of CECs is critical in understanding their removals by various treatment processes (Wells, 2006; 2007).

Secondly, there are significant differences in CEC removal among treatment processes, depending upon the mechanism of treatment. It is of note that the addition of advanced nutrient reduction and tertiary filtration to biological treatment systems is correlated with additional PPCP removal.

Finally, research reports on CECs only provide information about the parameters measured. As analytical technologies continue to advance and more chemicals enter commerce, it is a certainty that new chemicals will be discovered in water, and at even lower concentrations. According to Chemical Abstracts Services, more than 88 million organic and inorganic chemicals have been registered, more than 65 million chemical products are available commercially, and approximately 15,000 new chemicals are added per day (www.cas.org).

8.1.3.1 On-site Wastewater Treatment Systems

On-site wastewater treatment systems (OWTS) include a wide range of individual and cluster treatment systems that process household sewage. These systems are used by approximately 20 percent of all homes in the United States and by 74 percent of the homes in Suffolk County.

It has long been recognized that OWTSs are sources of contaminants, including nutrients and pathogens that can eventually enter both groundwater and surface waters. The EPA has published extensive guidance in *Onsite Wastewater Treatment Systems* (EPA, 2002) that provides detailed information on the background and use of onsite wastewater treatment systems, management of OWTSs, treatment performance requirements, and treatment processes and systems, including those that are aimed at achieving enhanced nutrient removal.

There are a wide variety of OWTSs that can be implemented; conventional (soil-based or subsurface wastewater infiltration) systems can include both gravity-driven and mechanized treatment processes. Sand filters (including other media) can be added onto conventional processes to improve treatment where soil conditions do not support adequate treatment. There are additionally, alternative treatment systems (e.g., fixed-film and suspended growth systems, evapotranspiration systems) that can also be used to provide enhanced treatment performance. But, in general there are three key components to OWTSs that are important in providing treatment. The three

Table 8-11 CEC Classes and Examples of Compounds in These Categories

Category	Compound(s)
Pharmaceuticals	Trimethoprim, Fluoxetine, **Carbamazepine,** Diltiazem, Cotinine, Caffeine, **Acetaminophen**, **Gemfibrozil, Ibuprofen**, Naproxen, Sulfamethoxazole, Primidone, Atenolol, Furosemide, Metoprolol, Meprobamate, Ofloxacin, Valsartan, Hydrochlorothiazide, Oxycodone, Sertraline, Verapamil
Sterols and Hormones	Coprostanol, cholesterol, β-sitosterol, β-stigmastanol, androstenedione, **estrone,** 17-α-ethynyl estradiol, 17-β estradiol
Flame retardants	Tris[2-chloroethyl]phosphate (TCEP), Hexabromocyclododecane (HBCD)
Perfluorinated compounds	Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA), Perfluorononanoic acid (PFNA), Perfluorohexanesulfonic acid (PFHxS), Perfluoroheptanoic acid (PFHpA), Perfluorobutanesulfonic acid (PFBS)
Nonylphenols	Nonylphenol Diethoxylate, Nonylphenol Monoethoxylate, para-tert-Octylphenol, p-Nonylphenol
Disinfection byproducts (DBPs)	Trihalomethanes (THMs), Haloacetic acids (HAAs), Chloride, Bromate, Bromide, Chlorate, *n*-Nitrosodimethylamine (NDMA)
Volatile organic compounds (VOCs)	Methyl tert-butyl ether (MTBE), m- & p-Xylene, o-Xylene, 1,2,4-Trimethylbenzene, Naphthalene, Isopropylbenzene, Benzene, Ethylbenzene, Carbon tetrachloride, Toluene, 1,4-Dioxane, tert-Butyl alcohol, Acetone (2-propanone), and Tetrachloroethene (perc), 1,1,1,2-Tetrachloroethane and 1,1,2,2-Tetrachloroethane
Pesticides, herbicides, fungicides	Atrazine, Benzo(a)pyrene, Metolachlor, Simazine, Bentazon, 2,4-D, MCPA, Pentachlorophenol (PCP), Carbaryl, N,N-Diethyl-meta-toluamide (DEET), Chlordane
Consumer products and manufacturing additives	Bisphenol A (BPA), Triclosan, Triphenyl phosphate, Salicylic acid, Camphor, Anthraquinone, p-Cresol, 1, 4-dioxane
Contrast media	Iopromide
Wastewater tracer	Sucralose

Cape Cod: An Illustrative Example of the Occurrence of CECs in OWTSs Linked to Groundwater Contamination

Standley et al. (2008) conducted a study that explored the connection between on-site septic system discharges and groundwater contamination leading to surface water quality impacts in Cape Cod, Massachusetts. The study investigated steroidal hormones, pharmaceuticals, and organic wastewater compounds from six aquifer-fed ponds in varying residential density areas with OWTSs. The study concluded that occurrence of these compounds in surface water ecosystems within unconfined aquifer settings results from OWTSs discharges. Additionally, increased concentrations of these organic wastewater compounds were found in the higher density residential areas of Cape Cod. The most commonly detected compounds were steroidal hormones such as androstenedione, estrone, progesterone, and pharmaceuticals such as carbamazepine, pentoxifylline, sulfamethoxazole, and trimethoprim (Standley et al. 2008). The highest concentration of any analyte measured was 19 ng/L (Ibuprofen); additionally, some estrogenic compounds reached concentrations that are known to trigger physiological impacts in fish species.

In 2009, Schaider et al. and Silent Spring Institute analyzed 20 public drinking water wells in 9 Cape Cod districts for 92 CECs. 75% of the drinking water wells sampled tested positive for the presence of CECs. Again in 2011, Silent Spring Institute measured CEC concentrations in 20 private drinking water wells in 7 towns across Cape Cod for 121 CECs; 85% of wells tested positive. Concentrations ranged from tens of nanograms per liter up to tens of micrograms per liter. Researchers concluded that Cape Cod wells impacted by septic systems are equally as contaminated as the 'most contaminated drinking water supplies so far reported in the United States' (Schaider et al. 2013).

Schaider et al. 2013 also modeled the loading of CECs into Barnstable County groundwater and found, similar to Standley et al. (2008) that the highest level of CEC discharges originated from densely populated residential areas with septic systems. This study concluded from loading estimates that effluent from septic systems and effluent from centralized WWTPs have similar concentrations of CECs.

primary components of a conventional system are the septic tank, the subsurface wastewater infiltration system (also called a leaching field or infiltration trench), and the soil in the unsaturated zone, which is a critical factor in providing aerobic conditions for treatment. The subsurface infiltration system is the interface between the engineered system components and the receiving ground water environment. It is important to note that the performance of conventional systems relies primarily on treatment of the wastewater effluent in the soil horizon(s) below the dispersal and infiltration components of the system.

Results from numerous studies have shown that well-operated, conventional systems can achieve high removal rates for most wastewater pollutants of concern, with the notable exception of nitrogen. Costa et al. 2002 estimated that 25 percent removal of total nitrogen could be assumed in cesspool systems and closer to 35 percent is removed when a conventional system including both the tank and the soil absorption or leaching field is considered. It is important to note that soil-aquifer treatment systems require unconfined aquifers, vadose zones free of restricting layers, and soils that are coarse enough to allow for sufficient infiltration rates but fine enough to provide adequate filtration (WRRF, 2012).Following pretreatment, biochemical oxygen demand (BOD), suspended solids (TSS), fecal indicators, and surfactants in septic tank effluent are effectively removed within 2 to 5 feet of unsaturated, aerobic soil.

Phosphorus and metals are removed through adsorption, ion exchange, and precipitation depending upon the retention capacity of the soil, which can vary substantially. While large microbial particles are effectively retained in soil treatment systems, the fate of viruses and trace organic compounds, however, has not been well documented. Field and laboratory studies do suggest that the soil is quite effective in removing viruses, but there are some types of viruses that are able to leach to groundwater. Additional information on recent research on pathogen removal via transport through soils systems is provided in **Section 8.1.2.3.2, Pathogens**.

8.1.3.1.1 Occurrence of Constituents of Emerging Concern in OWTSs

The impact of constituents of emerging concern (CEC) that originate from OWTSs has gained recent attention due to impacts on aquatic ecosystems and health risks to animals and potentially humans (Subedi et al. 2014; Schaider et al. 2010 & 2013; Swartz et al. 2006; Wilcox et al. 2009; Standley et al. 2008; Singh et al. 2010; Benotti et al. 2006; Rosen and Kropf 2009; Carrara et al. 2008; Godfrey et al. 2007; Katz et al. 2010; Zimmerman, 2005; Sima et al. 2014).

In 2012, Heufelder published a report titled 'White Paper: Contaminants of Emerging Concern from Onsite Septic Systems' to assist in the investigation into the connection between OWTSs and CEC concentrations and CEC removal in Barnstable County (Cape Cod) Massachusetts, a sole-source aquifer reliant community. Approximately 350 studies were reviewed and summarized, lending way to an aggregate compilation of knowledge on the subject per the date of publication, and the proposal of three priority aspects relating CECs and OWTS treatment and disposal to animal/human health. The three priority concerns discussed were: endocrine disruption, antibiotic pharmaceuticals, and direct toxic effects of select CECs. Heufelder (2012) also reviewed literature pertaining to OWTS treatment technologies, including advanced treatment. This paper, along with one published in 2013 regarding a Cape Cod study by Schaider et al. (2011) and the Silent Springs Institute, assemble the majority of research that was performed through 2013 regarding CEC contamination in groundwater and surface waters as a result of OWTSs.

Suffolk County Approach to CECs

The Suffolk County Department of Health Services (SCDHS) has responded to reports of CECs in the groundwater by implementing a programmatic approach to understanding the potential impact of these compounds on local water resources. The plan (SCDHS, 2011)) dates back to 2001, and includes:

4. Implementation of a monitoring program incorporating analytical methodology development by the Suffolk County Public and Environmental Health Laboratory (PEHL);

5. A continuing literature review; and,

6. Discussions with other environmental and public health agencies.

8.1.3.1.2 CEC Treatment Performance in OWTSs

Many CECs are components of a broader group of organic compounds that are removed during sub-surface transport by a combination of filtration, sorption, oxidation/reduction, and biodegradation. Biodegradation is the key sustainable removal mechanism for organic compounds during sub-surface transport (Fox et al., 2005; AWWARF, 2001b.). Considering bulk organic matter components such as natural organic matter (NOM) and soluble microbial products (SMPs), these are reduced during sub-surface transport as high molecular weight compounds are hydrolyzed into lower molecular weight compounds and the lower molecular weight compounds then can serve as substrate for microorganisms (Drewes et al., 2006). Synthetic organic compounds that are present at concentrations too low to directly support microbial growth may be co-metabolized, as NOM and SMPs serve as the primary substrate for growth (Rausch-Williams et al, 2010, Nalinakumari et al,

2010). During sub-surface transport, the transformation of organic compounds may be divided into two regimes, one short-term regime where transformations are relatively fast and a long-term regime where transformations of recalcitrant compounds continue to occur at slower rates over time (Fox and Drewes, 2001). Easily biodegradable carbon is transformed within a time-scale of days and when transport paths are sufficiently long; providing longer retention times in the subsurface allows organic compounds to continue to be transformed.

The removal of constituents of concern in general tends to parallel the removal of organic carbon. Easily biodegradable CECs, such as caffeine and 17β-estradiol, tend to degrade on a time-scale of days while more refractory compounds, such as NDMA and sulfamethoxazole, tend to degrade over a time-scale of weeks to months (Dickerson et al., 2008). Persistent compounds, such as carbamezapine and primodone, can persist for months or years in the subsurface (Clara et al., 2004, Heberer, 2002). Schaider et al. (2013) confirmed, through the studies on Cape Cod septic systems, that CECs with high biodegradability such as acetaminophen, caffeine, and triclosan, tend to have the highest degree of removal (>99%) in OWTS leaching fields, while the lowest degrees of removal (<50%) tended to be correlated with persistent CECs such as sulfamethoxazole, carbamazepine, and TCEP (Schaider et al. 2013).The transformation of organic constituents of concern can also depend on the presence of biodegradable dissolved organic carbon (BDOC) because the concentrations of constituents of concern are very low and may not support growth (Rausch-Williams et al., 2010; Nalinakumari et al., 2010).

In general, concentrations of CECs in conventional OWTSs have been reported to be comparable to those measured in previous studies of municipal wastewater treatment plant (WWTP) influent, and concentrations in systems after "advanced" treatment were comparable to previously measured concentrations in WWTP effluent (Wilcox, 2009; Garcia et al. 2013; Du et al. 2013; Schaider et al. 2013).

Advanced treatment, as used herein, is a reference to on-site wastewater treatment systems that differ from conventional systems in several ways. Advanced treatment systems incorporate multiple treatment steps to facilitate a consistent and high degree of treatment prior to effluent discharge to the leach field. Many advanced treatment systems control flow through the system using pumps and timers to avoid overloading the treatment and final dispersal components during periods of high water usage, or "peak flow" conditions, which could occur during a morning rush of activity or when many guests are in the home. The treatment provided by advanced treatment systems that serves to reduce the "strength" of the wastewater may also contribute to reductions in pathogens, nutrients and CECs, depending on the design and

configuration of the system. Systems that function to remove nitrogen prior to discharging effluent utilize alternating anoxic (or anaerobic) and aerobic treatment steps. These systems generally recirculate the effluent back to the septic tank or through a separate recirculation step, where raw effluent and treated effluent are mixed, creating conditions that facilitate denitrification, or actual removal of nitrogen by bacteria.

Advanced treatment systems that are designed as "treatment trains" or logical sequences of treatment components to achieve a certain level of treatment, may be specified by local, state, or regional governing agencies. In Rhode Island, the Department of Environmental Management (DEM), Coastal Resources Management Council (CRMC), and town governments may all have jurisdiction over a given area of land, and may impose differing regulations regarding wastewater treatment.

Technologies are initially chosen based on the level of treatment that is required; it is important to note that not all technologies will effectively achieve nutrient and/or pathogen reduction. Treatment technologies achieve the best results when receiving wastewater characteristics are evaluated and paired with the appropriate technologies. Site constraints may also dictate potential use of some technologies. For instance on small lots with existing homes and failed septic systems, advanced treatment technologies with the smallest footprints are most commonly used as replacement systems. Advanced treatment systems generally require annual or semi-annual maintenance activities in order to function properly; these maintenance activities should be performed by a trained and qualified service provider.

Available information indicates that advanced OSWTs that incorporate aerobic treatment (addition to oxygen to the wastewater to promote and support the growth of aerobic bacteria) can reduce CECs in treated effluent to similar concentrations as those observed in effluent from municipal WWTPs. This aerobic treatment process can be implemented by supplying air to the septic tank or through the use of an aerobic filter, such as a recirculating sand filter (Heufelder, 2012).

Further, Schaider et al. (2013) gathered from literature reviews and also from the Cape Cod study that median CEC concentrations in effluent from leaching fields, were comparable to those measured in WWTP effluent following conventional activated sludge processes (discussed in Section 7.1.3.2.1). The project was a synthesis of studies on various sites and sample depths ranged from 2 feet to 2-3 meters. In most cases, samples were collected from lysimeters that sampled vadose zone soils beneath leach fields. The cumulative information from these studies showed that seven of the nine CECs studied had median concentrations in leach fields within the same order of magnitude

as their respective concentrations in WWTP effluent, indicating that the leaching fields provide additional treatment.

There were, however, discrepancies between median concentrations of caffeine, where a median concentration in WWTP effluent was 10 times higher than the median concentration in the leaching field. Prior to this study, Swartz et al. (2006) also concluded that caffeine was readily removed through soil infiltration following septic tank in Cape Cod sites. Conversely, nonylphenol, an endocrine disrupting compound, was found at 20 times the concentration in leaching field effluent than in WWTP effluent, and had the highest predicted total loading into the Cape aquifer of all CECs by an order of magnitude (Schaider et al. 2013). These results also demonstrate that some CEC compounds are readily degradable whereas some are more persistent.

In a recent publication, Subedi et al. (2014) discussed a pilot project in central New York focusing on the occurrence of organic chemicals such as PPCPs, perfluoroalkyl surfactants (PFASs) and polybrominated diphenyl ethers (PBDEs) in effluent from four enhanced aerobic OWTSs consisting of synthetic media and innovative dispersal units such as bottomless sand filters and drip irrigation, adjacent surface waters, and tap water samples of the four houses near Skaneateles Lake. Residents typically use lake water for drinking water purposes; one residence disinfected the lake water with UV disinfection, and one residence obtained drinking water from a well near the lake shore. Each of the ten PPCPs studied, including two antibiotics, two antimicrobials, an antihypertensive, an anti-seizure, an analgesic, a plasticizer, a UV filter, and a stimulant, were found both in OWTS effluent and in surface (lake) water samples. There was no significant difference between measured PPCP concentrations in lake water samples and drinking water (tap) samples. This study did not measure removal efficiencies, but rather confirmed the presence of PPCPs, amongst other organic contaminants, in wastewater plumes traveling from septic tank effluent to receiving surface waters and eventually into tap water.

Though there have been a considerable number of studies validating the presence of CECs in groundwater, less than 20 studies have investigated the level of treatment that septic systems provide with respect to CECs (CEC removal efficiency) (Schaider et al. 2013). An important note when discussing the treatment provided by OWTSs is the high variability of CEC concentrations (can differ by orders of magnitude) from sample to sample and from site to site, likely due to inconsistent and sporadic timing and frequency of the use of personal care products, pharmaceuticals, and other organic wastewater contaminants (Heufelder 2012; Carrara et al. 2008; Conn et al. 2010). While the concentrations of CECs in the influent to centralized wastewater treatment plants reflect a homogenized stream of wastewater from

multiple sources, OWTSs can capture concentrations indicating a single discharge event has occurred (Heufelder 2012). The variability of influent water quality, complicated further by the vast range of site-specific conditions and soil characteristics, makes field studies and resulting recommendations for OWTS design difficult to generalize; therefore it should be noted that research and knowledge gaps on this topic are still prevalent and in need of further exploration. This literature review provides a summary of available information on the performance of various OWTSs with respect to CEC removal efficiency and transformation. **Table 8-12** summarizes broad conclusions with respect to OWTSs and CEC removal. **Table 8-13** summarizes removal efficiencies for select CECs compiled from relevant literature studies; the selection of CECs used in **Table 8-13** was governed by the literature. CECs included in the table were chosen for review because removal efficiencies had been calculated in more than one study providing data for comparison purposes. Additionally, CEC treatment removal mechanisms are discussed as well as recommendations for design parameters as gathered by researchers.

As noted previously, typical centralized WWTP influent wastewater quality is generally comparable to the wastewater quality in septic tanks. However, a study by Garcia et al. (2013) exemplified the need to distinguish treatment capabilities as they vary between municipal WWTPs, aerobic OWTS, and on-site septic treatment systems (STS). Although not entirely or specifically geared towards CECs, the study included endocrine disrupting compounds (EDCs) as a target contaminant in the Tier III group of an evaluation of effluent water quality from the three treatment types (municipal WWTP, aerobic OWTS and on-site septic treatment). Tier I and Tier II evaluations investigated select conventional water quality parameters (CBOD and TSS) and whole effluent toxicity, respectively. The results of the portion of the study pertaining to EACs illustrate the variability of concentrations of estrone (E1), 17β-estradiol (E2), 17α-ethinylestradoil (EE2), and testosterone (T), among municipal WWTPs, on-site aerobic wastewater treatment systems, and on-site septic wastewater treatment systems, with concentrations of the studied compounds ranging from 0.97 to 117 ng/L (Garcia et al. 2013). The most significant results show that concentrations of estrone, 17β-estradiol, and testosterone were significantly higher in advanced OWTS that incorporated aerobic treatment or municipal WWTPs. The study also concluded that the same general trends were observed regarding Tier I (CBOD and TSS) and Tier II (whole effluent toxicity) evaluation results, indicating that increased oxygen levels facilitate increased EDC removal (Garcia et al. 2013).

Table 8-12 General Conclusions from Literature Regarding CEC Removal and Treatment in OWTSs

Citation	Study Conclusions with respect to CEC Removal & Treatment in OWTSs
Wilcox et al. (2009); Stanford and Weinberg (2010)	Minimal CEC removal in anaerobic conditions of the septic tank
Swartz et al. (2006)	Minimal CEC removal in anaerobic groundwater, suggests significant aerobic biodegradation
Conn and Siegrist (2009), Heufelder (2012)	Significant CEC removal through sorption and aerobic biodegradation processes
Hinkle et al. (2005), Stanford and Weinberg (2010)	Significant CEC removal with advanced onsite treatment septic systems (trickling/packed bed filter, sequencing batch reactor, rotating biological reactor, aeration, forced aeration/attached growth media, aeration with carbon source, packed bed filter with carbon source, packed bed filter, trench with packed bed filter and carbon, attached growth media)
Heufelder (2012)	Significant CEC removal when leach fields were modified by hydraulic loading rates, vertical separation to groundwater, and horizontal setback distances from receiving water bodies.
Drewes et al. (2011)	Findings suggest that removal of DEET, diclofenac, ibuprofen, and meprobamate required at least one week of travel time to achieve 90% removal rates. Chlorinated flame retardants such as TCEP, TCPP, TDCPP were not well removed after 6 days, and antiepileptic compounds such as primidone, Dilantin, carbamazepine, sulfamethoxazole, and atrazine were not well removed after 5 days in either oxic or anoxic conditions.
Schaider et al. (2013)	High variability across removal efficiencies for various leach fields. Sulfamethoxazole had higher leach field effluent concentration than septic tank effluent concentration. Triclosan is well removed in septic treatment processes, but degradation products are persistent in the environment.
Berto et al. (2008)	Antimicrobials in hospital wastewater treated with an aerobic septic system could be degraded.
Garcia et al. (2013)	Aerobic on-site septic effluent was not statistically different than WWTP effluent. Anaerobic on-site septic effluent was of poorer quality than both ATS and WWTP effluent.
Teerlink et al. (2012)	Hydraulic loading was inversely related to CEC attenuation. Longer residence time may allow the microbial community to evolve to better transform CECs. Aerobic conditions facilitated better removal of acetaminophen and cimetidine than anaerobic conditions.
Roberts et al. (2014)	Direct relationship between organic carbon fraction and soil-water partitioning coefficient may exist, making estimation of CEC sorption to soil more accurate and useful.
Rosario et al. (2014)	Current horizontal setback distances from septic tanks to receiving surface waters are not enough to provide complete CEC attenuation.
Du et al. (2013)	Removal of CECs by aerobic on-site treatment systems was comparable to WWTP removal.

Table 8-13 Literature Reported Removal Efficiencies of Select CECs from OWTS Discharge

Citation		Du et al. (2013)		Schaider et al. (2013)	Teerlink et al. 2012	
CEC of Interest	Use	Aerobic OWTS Leach Field Removal Efficiency	Septic (Anaerobic) OWTS Leach Field Removal Efficiency	Leach Field Removal Efficiency	Loading Rate in Packed Columns Representing Leach Field Removal Efficiency	
					1 cm/ day	12 cm/ day
Caffeine	Pharmaceutical	89-99%	40-52%	50-99.9%	>99%	99%
Acetaminophen	Pharmaceutical	100%	28-65%	98-99.9%	>99%	99%
TCEP	Flame Retardant	-	-	0-80%	0%	0%
DEET	Pesticide	-	-	0 to >99%	48%	4%
Trimethoprim	Pharmaceutical	46-86%	12-20%	33->99.9%	87%	64%
Carbamazepine	Pharmaceutical	6-7.8%	5.9-7.4%	10-60%	6%	0%
Sulfamethoxazole	Pharmaceutical	17-31%	7.7-11%	0->95%	43%	45%

The studies referenced in **Table 8-12** provide valuable information regarding the treatment of CECs in OWTSs and the mechanisms by which treatment can likely be enhanced to better protect the integrity of the surrounding environment and human health. Upon review of available literature, conclusions have been compiled regarding attenuation of CECs with respect to removal mechanisms. Specifically, there are a suite of design parameters that ideally should be optimized to facilitate increased removal. Removal mechanisms and design parameters in OWTSs are discussed below.

8.1.3.1.3 Removal Mechanisms

Biodegradation and Oxidation-Reduction Conditions

Biodegradation is the key sustainable removal mechanism for organic compounds during sub-surface transport (Fox et al., 2005; AWWARF, 2001b). Aerobic microbial reactions that occur underground preferentially use oxygen,

due to energy requirements, as the terminal electron acceptor. Higher levels of oxygen result in the growth of microbial communities that can then attenuate chemical contaminants (Teerlink et al. 2012). Anaerobic biodegradation can also occur, however, aerobic conditions have been shown to enhance CEC removal in past studies (Conn et al. 2010, Swartz et al. 2006, Carrara et al. 2008; Schaider et al. 2013; Teerlink et al. 2012). The ratio of BOD_5 to COD indicates the level of biodegradability of the wastewater; ratios exceeding 0.4 typically indicate a high biodegradability (Metcalf and Eddy, 1991). Berto et al. (2008) found that BOD_5 to COD ratios in hospital wastewater increased from 0.39 to 0.48 within 30 and 120 minutes of Fenton reaction treatment, respectively. The Fenton reaction utilizes iron and hydrogen peroxide at low pH values to generate hydroxyl radicals that serve as powerful oxidants. The BOD_5 to COD ratio increasing with time dynamic lends positively to the belief that parent pharmaceutical compounds present in raw wastewater are more hazardous than oxidized intermediate pharmaceuticals that have undergone Fenton treatment, or a comparable disinfection process (Berto et al., 2008).

Additionally, a significant theme in 'White Paper: Contaminants of Emerging Concern from Onsite Septic Systems' is that aerobic conditions enhance CEC removal, especially with respect to endocrine disrupting compounds of hormone and phenolic surfactants (Heufelder, 2012). Hydraulic loading rate variations (delivery of septic tank effluent to the leaching field or infiltration trench) can impact the diffusion of oxygen and hence the growth of microbial communities and respective treatment of CECs in OWTSs. Hydraulic loading rates and residence time are discussed as design parameters, below.

Sorption

Sorption is another key mechanism governing the attenuation of CECs by OWTSs. Septic tank effluent is typically discharged to a soil treatment unit (STU) where sorption occurs. Contaminants present in the septic tank effluent can be removed by sorption to soil particles (Teerlink et al., 2012). Roberts et al. (2014) completed a study concerning the sorption of CECs and OWCs to four different types of soils (sand, sandy loam, loamy sand, and loam) in order to deduce a relationship between the fraction of organic carbon in the soil and the soil-water partitioning coefficients of select OWCs. The OWCs studied included triclosan, 4-nonylphenol, bisphenol-A, estrone, 17β-estradiol, and 17α-ethynylestradiol. Research results show that accurately estimating the soil-water partition coefficient of a group of similar CECs could help in the modelling and estimation of how much sorption will occur in particular types of soil, thereby reducing the uncertainty associated with the level of treatment provided by soil treatment units.

Generally, sorption tends to increase with increasing fraction of organic carbon levels (Roberts et al., 2014). For example, soil-water partition coefficients were

calculated for organic carbon fractions between 0.021 and 0.054. Triclosan was found to have soil-water partition coefficients of 75 and 260 at organic carbon fractions of 0.021 and 0.054, respectively; 17β-estradiol was found to have soil-water partition coefficients of 3 and 255 at organic carbon fractions of 0.021 and 0.054, respectively. (Roberts et al. 2014). Schaider et al. (2013) indicated that many factors affect the sorption of organic compounds to soil surfaces and therefore govern the attenuation of CEC concentrations from OTWSs. Factors noted include the importance of hydrophobicity of the CEC, the organic matter present in the soil, the acid dissociation constant (pKa), and the soil pH. The dynamics of these characteristics with respect to the soil and the CEC can provide valuable conclusions for the removal of CECs in OWTS leach fields. Among these conclusions include the confirmation that hydrophobic compounds undergo a higher degree of sorption.

Ion Exchange

Ion exchange is the soil's capacity to hold exchangeable ions at a given pH value. Ion exchange, in addition to biodegradation and sorption, is a mechanism of CEC removal from OWTS effluent. The acid dissociation constant and soil pH determine the ionization state of a given chemical which affects sorption levels. If a chemical has a net negative charge in soil, it is more likely to remain in solution because certain soil constituents (e.g. clay particles) also have a net negative charge (Schaider et al. 2013). Roberts et al. (2014) found that electrostatic repulsion between CEC anions and negatively charged soil constituents likely impact removal by resulting in less sorption. Siegrist et al. (2005) found that soils with a higher clay content exhibited slightly higher cation exchange capacity – or the ability to hold more positive ions at a given pH.

Temporal Variations

Hinkle et al. (2005) noted that variability of influent CEC concentrations to OWTSs could be temporally or seasonally dependent. The hypothesis when considering temporal variations and CEC removal is that increased biodegradation will occur with warmer temperatures.

One aspect of a recent study by Du et al. (2013) explored temporal seasonal variations in relation to CEC removal from advanced aerobic OWTS and septic tank OWTS. Although there was no observable correlation between the removal of total concentrations of all detected compounds between the fall and winter (October and January) seasons, there were select CEC compounds that experienced greater removal in October than in January. These compounds were caffeine, erythromycin, gemfibrozil, and sucralose. Standley et al. (2008) did not find any correlation between OWC concentrations in surface water bodies and temporal variations; however observed increased

levels of steroidal hormones in surface waters during warmer months (Standley et al., 2008).

Stempvoort et al. (2011) studied the transport of artificial sweetener in OWTS discharge to groundwater and found that the degradation of saccharin in the soil was slower during the winter season, when temperatures were lower.

8.1.3.2 Conventional Wastewater Treatment Plants

8.1.3.2.1 Description of Activated Sludge Process (CAS) and Disinfection

The CECs listed in **Table 8-13** are present in wastewater from municipal sewer systems, just as they are present in OWTS effluent. The following section discusses the mechanisms by which CECs can be attenuated in centralized wastewater treatment plants employing conventional treatment processes. It is important to note that the treatability and removal of CECs in OWTS differs from centralized systems partly because centralized WWTPs receive a homogenized stream of wastewater from multiple sources. Flow equalization and the conveyance time within the collection system result in WWTP influent concentrations that are not as susceptible to concentration spikes (single-event impacts) as OWTSs. It is also important to note that unit processes which are already part of conventional WWTPs provide a certain level of CEC removal, even though the plants themselves were not initially designed to treat for these constituents (Rojas et al. 2013).

Conventional Activated Sludge

Conventional primary wastewater treatment consists of settling tanks where solids settle to the bottom of the sedimentation tank and lighter wastewater constituents float to the top. Typically a skimming process is used to remove floating materials before the wastewater flows to secondary treatment processes. The secondary treatment process is referred to as biological treatment or activated sludge. The activated sludge process, most simply defined, uses living microorganisms to degrade organic contaminants present in the wastewater stream (NSFC, 2003). Aeration tanks are used to provide beneficial bacteria with the oxygen they need to grow and consume the organic contaminants, thereby producing heavier particles (floc) that settle to the bottom of the clarifier tank. The settled layer at the bottom of the tank is known as activated sludge, and is utilized as a "seed" sludge for subsequent incoming wastewater to the plant. The activated sludge process produces a supernatant that is typically sent to a downstream disinfection process.

Disinfection

Disinfection is an important part of conventional wastewater treatment because it deactivates pathogens such as bacteria, protozoa, and viruses that can be a threat to human health. Chlorine is a common disinfectant used in

conventional wastewater treatment; however, there are other chemical oxidants that are also capable of providing disinfection. Secondary benefits of using chemical oxidants such as chlorine, ozone or peracetic acid for disinfection include the oxidation of CECs. The degree of CEC oxidation depends on a number of factors, but is related to the reduction-oxidation (redox) potential for the chemical disinfectant. UV irradiation is also widely applied for disinfection.

Chlorine

Chlorine is the most widely used disinfectant in wastewater treatment today and although the exact mechanism of disinfection is yet unclear, it is believed that chlorine diffuses through cell walls and attacks enzyme groups, destroying the microorganism. Chlorine disinfection can be accomplished using various chemicals including gas, liquid sodium hypochlorite or solid calcium hypochlorite. However, when these are dissolved in water, disinfection occurs by common chlorine chemistry which is the combination OCl- and HOCl. The HOCl form is a more powerful oxidant than OCl- and the fraction of each is a function of pH (pKa for HOCl/OCl- is 7.5); which is reflected in higher pharmaceutical removals after hypochlorite addition at pH 5.5 (Westerhoff et al., 2005). It has been reported that ionized functional groups in CECs have a significant impact on chlorine reactivity (Gallard et al., 2002); generally deprotonated groups of compounds have second-order rate constants several orders of magnitude greater than those of protonated groups. For pharmaceuticals evaluated in these studies, most experiments were run at pH 5.5 to 8.2; therefore only weak acids would become protonated.

A research project by Lei and Snyder (2007) developed a quantitative structure-property relationship model for a wide range of CECs with respect to chlorine treatment and showed that degradation of compounds was, in fact, strongly inversely correlated with the ionization potential. As a result, the functional groups on a molecule strongly influence the compound's reactivity with chlorine which in these cases is predominantly by electrophilic substitution and addition (Lei and Snyder, 2007). A second mode of degradation is by oxidation, in which chlorine can promote ring cleavage, which usually has much slower reaction kinetics. A summary of recently reported removal rates of the selected pharmaceuticals by chlorine in various water matrices is shown in Table 8-14 along with the reference of the study.

While it has been demonstrated that chlorine addition to water can result in degradation of pharmaceutical compounds, Boyd (2005) found that the degradation products of some pharmaceuticals, in this work naproxen, produces degradation by-products that may be more toxic that the solutions of the original parent compound.

Table 8-14 Removal of Pharmaceutical Compounds with Chlorination

Compound	pKa	Chlorine Dose (mg/L)	Removal (% range)	Reference
Acetaminophen	9.7	3.5	> 70	Snyder, et al. (2008)
		1.2	98	Stackleberg, et al. (2008)
		2.8 - 6.75	96 - 98	Westerhoff, et al. (2005)
Caffeine	6.1	0.95 - 11.5	99 - >99	Huber, et al. (2005)
		1.2	88	Stackleberg, et al. (2008)
Carbamazepine	< 2	0.95 - 11.5	95 - >99	Huber, et al. (2005)
		3.5	< 30	Snyder, et al. (2008)
		1.2	85	Stackleberg, et al. (2008)
		2.8 - 6.75	93 - 98	Westerhoff, et al. (2005)
Clofibric acid		0.95 - 11.5	>99	Huber, et al. (2005)
Diazepam	2.4, 1.5, (3.3)	3.5	< 30	Snyder, et al. (2008)
		0.95 - 11.5	98 - > 99	Huber, et al. (2005)
		2.8 - 6.75	75 - 77	Westerhoff, et al. (2005)
Diclofenac	4.2	0.1 - 1	45	Huber, et al. (2005)
		3.5	> 70	Snyder, et al. (2008)
		2.8 - 6.75	93 - 96	Westerhoff, et al. (2005)
Dilantin	8.3	3.5	< 30	Snyder, et al. (2008)
		2.8 - 6.75	20 - 53	Westerhoff, et al. (2005)
Erythromycin	8.8	1	> 90	Snyder, et al. (2003)
		2.8 - 6.75	95 - 96	Westerhoff, et al. (2005)
		3.5	> 70	Snyder, et al. (2008)
		1.2	> 99	Stackleberg, et al. (2008)
Fluoxetine	[9.5]	3.5	< 30	Snyder, et al. (2008)
		2.8 - 6.75	15 - 50	Westerhoff, et al. (2005)
Gemfibrozil	4.7	0.95 - 11.5	59 - 93	Huber, et al. (2005)
		3.5	30 - 70	Snyder, et al. (2008)
		2.8 - 6.75	> 99	Westerhoff, et al. (2005)
Hydrocodone	[8.9]	3.5	> 70	Snyder, et al. (2008)
		2.8 - 6.75	95	Westerhoff, et al. (2005)
Ibuprofen	4.5 (4.9)	0.95 - 11.5	97 - > 99	Huber, et al. (2005)
		3.5	30 - 70	Snyder, et al. (2008)

Compound	pKa	Chlorine Dose (mg/L)	Removal (% range)	Reference
		2.8 - 6.75	30 - 75	Westerhoff, et al. (2005)
Iopromide	< 2 & > 13	0.1 - 1	97 - > 99	Huber, et al. (2005)
		3.5	< 30	Snyder, et al. (2008)
		2.8 - 6.75	3 - 32	Westerhoff, et al. (2005)
Meprobamate	< 2	3.5	< 30	Snyder, et al. (2008)
		2.8 - 6.75	12 - 26	Westerhoff, et al. (2005)
Naproxen*	4.5 (4.2)	1 - 10	61.5 - > 99	Boyd, et al. (2004)*
		0.95 - 11.5	53	Huber, et al. (2005)
		3.5	> 70	Snyder, et al. (2008)
		2.8 - 6.75	92 - 93	Westerhoff, et al. (2005)
Pentoxifylline	6 & < 2	0.95 - 11.5	98 - > 99	Huber, et al. (2005)
		3.5	< 30	Snyder, et al. (2008)
		2.8 - 6.75	73 - 81	Westerhoff, et al. (2005)
Sulfamethoxazole	2.1 & < 2 (5.7)	0.1 - 1	10 - 65	Huber, et al. (2005)
Trimethoprim	6.3, 4.0, < 2 (7.1)	1	> 90	Snyder, et al. (2003)
		3.5	> 70	Snyder, et al. (2008)
		2.8 - 6.75	97 – 98	Westerhoff, et al. (2005)

Ozone

Inactivation of bacteria by ozone is attributed to oxidation of cell membrane components; for virus inactivation, ozone appears to modify and break the protein capsid sites that the virus uses to fix on cell surfaces; for cysts, ozone is hypothesized to damage the cyst exterior, enabling inactivation. Analogous to chlorine, ozone disinfection efficacy likely depends on residual and reaction time. A number of parameters are used to monitor ozone disinfection: applied ozone dosage, transferred ozone dosage, and ozone residual. The oxidative power associated with ozone, also makes it a good candidate for removal of pharmaceutical compounds. Because of the potential applicability in wastewater treatment to provide disinfection, and potentially degrade emerging constituents such as pharmaceuticals, a number of studies have been conducted to evaluate the effectiveness of ozone disinfection on a wide range of compounds in wastewater. A summary of selected removal efficiencies in wastewater by compound for various ozone doses is shown in **Table 8-15**.

Table 8-15 Summary of Ozone Dose and Treatment Efficiencies for Select Pharmaceuticals

Compound	Wastewater		Reference
	Ozone Dose (mg/L)	Removal (% range)	
Caffeine	4.9 - 8.7	> 80	Lei, et al. (2007)
	32 – 34	19	Menapace, et al. (2008)
	2.1 - 8.7	34 - > 80	Snyder, Wert, et al. (2006)
Carbamazepine	4.75 - 53.8	80 - > 99	Andreozzi, et al. (2004)
	2 – 14	> 95	Bahr, et al (2007)
	1.5 – 4	89 - 99	Buffle, et al. (2006)
	4.9 - 8.7	> 99	Lei, et al. (2007)
	2.1 - 8.7	> 99	Snyder, Wert, et al. (2006)
Clofibric Acid	4.75 - 53.8	50 - > 99	Andreozzi, et al. (2004)
	2 – 14	> 95	Bahr, et al (2007)
	21.7 - 65	88 - 90	Gebhardt, et al. (2007)
	1	0.08	Ikehata, et al. (2006)
	10 - 15	34 - 51	Petrovic, et al. (2003)
Diazepam	1.5 – 4	< 1	Buffle, et al. (2006)
	21.7 - 65	53 - 95	Gebhardt, et al. (2007)
	41 – 46	28	Menapace, et al. (2008)
Dilantin	4.9 - 8.7	89 - > 99	Lei, et al. (2007)
	2.1 - 8.7	43 - > 99	Snyder, Wert, et al. (2006)
Diclofenac	4.75 - 53.8	72 - > 99	Andreozzi, et al. (2004)
	2 – 14	> 95	Bahr, et al (2007)
	1.5 – 4	> 95 - > 99	Buffle, et al. (2006)
	10 – 15	69 - 75	Petrovic, et al. (2003)
	2.1 - 8.7	> 98	Snyder, Wert, et al. (2006)
Erythromycin	4.9 - 8.7	> 98	Lei, et al. (2007)
	0.5 – 5	31 - 99	Huber, et al. (2005)
	47.5 - 48	56	Menapace, et al. (2008)
Fluoxetine	4.9 - 8.7	> 94	Lei, et al. (2007)
	2.1 - 7.1	> 93 - > 99	Snyder, Wert, et al. (2006)
Gemfibrozil	10 – 15	46 - 69	Petrovic, et al. (2003)
	2.1 - 7.1	> 94 - > 99	Snyder, Wert, et al. (2006)
Hydrocodone	4.9 - 8.7	> 99	Lei, et al. (2007)
	2.1 - 8.7	> 93 - > 99	Snyder, Wert, et al. (2006)
	1.5 – 4	< 1	Buffle, et al. (2006)
	4.9 - 8.7	94 - > 95	Lei, et al. (2007)
	10 – 15	65 - 90	Petrovic, et al. (2003)
	2.1 - 8.7	< 1 - > 94	Snyder, Wert, et al. (2006)
Iopromide	1.5 – 4	< 1	Buffle, et al. (2006)

Compound	Wastewater		Reference
	Ozone Dose (mg/L)	Removal (% range)	
	0.5 – 5	10 - 60	Huber, et al. (2005)
	4.9 - 8.7	72 - > 96	Lei, et al. (2007)
	2.1 - 8.7	14 - > 95	Snyder, Wert, et al. (2006)
Meprobamate	4.9 - 8.7	58 - 87	Lei, et al. (2007)
	2.1 - 8.7	31 - > 98	Snyder, Wert, et al. (2006)
Naproxen	2 – 14	> 95	Bahr, et al (2007)
	5	> 99	Ikehata, et al. (2006)
	10 – 15	45 - 66	Petrovic, et al. (2003)
	2.1 - 8.7	> 92 - > 96	Snyder, Wert, et al. (2006)
Sulfamethoxazole	4.75 - 53.8	90 - > 99	Andreozzi, et al. (2004)
	1.5 – 4	> 99	Buffle, et al. (2006)
	0.5 – 5	21 - > 99	Huber, et al. (2005)
	5	> 99	Ikehata, et al. (2006)
	2.1 - 8.7	97 - > 99	Snyder, Wert, et al. (2006)

The mechanisms of ozonation on various pharmaceuticals were also evaluated in the Lei and Snyder (2007) project that developed a model for explaining the mechanism of removal of CECs. This work showed that ozone was highly effective for removal of a wide range of compounds. Previous research has shown that ozone is a highly reactive, but selective electrophile that reacts with amines, phenols, and double bonds in aliphatic compounds (Snyder et al., 2006; Barron et al., 2006). Ozone also electrophilically attacks the sulfide, aniline, neutral tertiary amine, trimethoxytolyl and other electron-rich moieties that are commonly contained in antibacterial compounds (Dodd et al., 2006). As such, the model results that weakly polar surface area of a molecule is a good indicator of its ability to be oxidized by ozone is consistent with previous work.

Recent improvements in ozone technology, increased implementation of ozone disinfection systems, demonstrated effectiveness for addressing pharmaceuticals, and research indicating that the degradation products are less toxic than the parent solution (Andreozzi, et al., 2004) suggest that ozonation, at doses that are typical for meeting disinfection requirements, may be an effective treatment strategy for pharmaceuticals.

UV Based Disinfection Processes

Recent interest in addressing emerging contaminants, which include pharmaceuticals, has engineers looking toward potential treatment alternatives and one of these methods is UV disinfection. In addition to its

disinfection effectiveness, UV can also degrade organic compounds by direct photolysis of photolabile compounds as a consequence of light absorption, or by indirect photolysis using hydrogen peroxide (H_2O_2), an advanced oxidation process (AOP), which will lead to the formation of highly reactive, unselective, and short-lived hydroxyl radicals (•OH).

There are however, issues with respect to UV disinfection systems traditionally employed for microbial inactivation in the treatment of pharmaceuticals. For any compound to be degraded by UV disinfection, it must have the capacity to absorb photons of the incident light and the probability that a given compound will absorb light at a particular wavelength can be determined by measuring its absorbance. In most wastewater treatment plants, UV systems typically used for wastewater disinfection are based on low pressure high output lamps that have output centered on 254nm. Because the output of these lamps overlaps with the wavelength that is absorbed by DNA, this results in inactivation of the organism by dimerization of adjacent thymine nucleotides in the molecule, preventing reproduction of the organism (Rauth, 1965; Linden et al., 2001).

Pereira et al., 2007 produced a plot of UV absorption of pharmaceuticals over a range of wavelengths showing that various pharmaceuticals, including carbamazepine, clofibric acid, and naproxen absorb at peaks that do not overlap the wavelength output generated by low pressure UV lamps as shown in **Figure 8-16.** Rather, the peak absorbances of these pharmaceutical compounds are in the range of 230 for clofibric acid and naproxen, with carbamazepine having a bimodal absorbance with peaks near 210 and 290 nm.

These other wavelengths can be obtained using medium pressure lamps which have a wider range of output; medium pressure lamps produce radiation at several wavelengths (polychromatic) and the output ranges from 200 nm to 700 nm. However, if the primary reason for use of UV is for disinfection, then a drawback to use of medium pressure lamps is that the UV output of a medium-pressure lamp is 50 to 80 times higher than the output of a low-pressure lamp but is not as efficient in the conversion of electricity to germicidal UV radiation.

While there are certainly drawbacks to use of medium-pressure UV systems, they do tend to have a lower capital cost; although they are usually associated with higher operation and maintenance costs. The use of a medium pressure/high intensity UV system can result in a significant reduction in the number of lamps required for the same UV dose. The major advantages of a medium pressure system are the ability to handle large swings in flow, abrupt changes in water quality and the potential for addressing emerging contaminants such as pharmaceutical compounds.

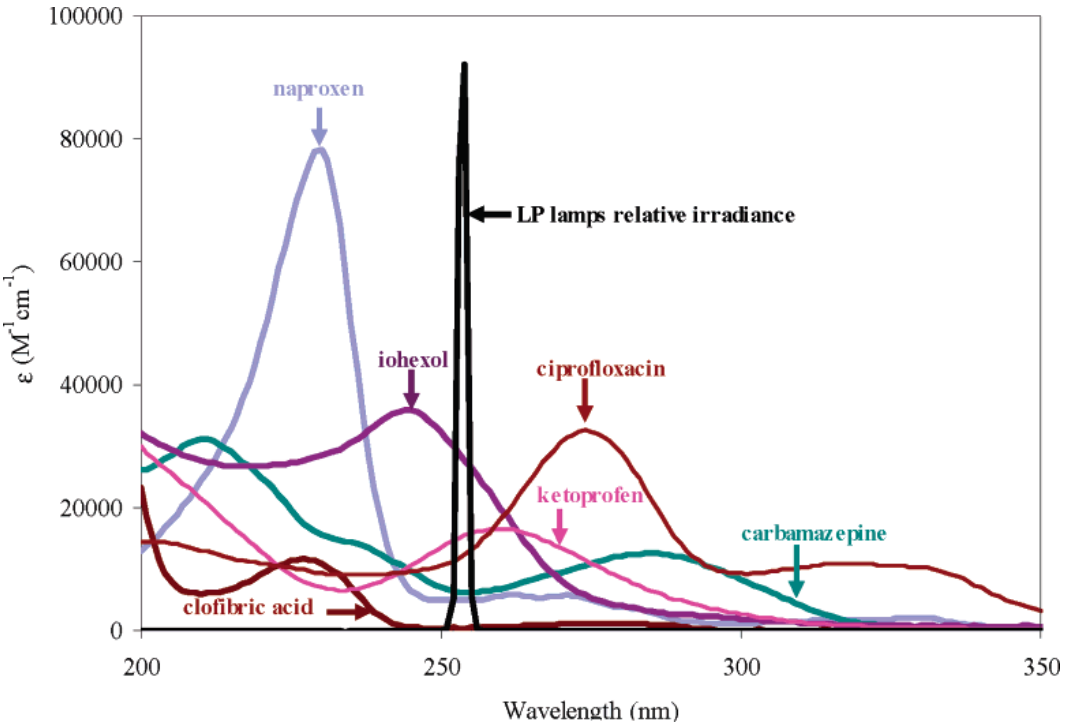


Figure 8-16 Plot of Absorption Coefficients of Pharmaceuticals over a Range of Wavelengths (reproduced from Pereira et al., 2007)

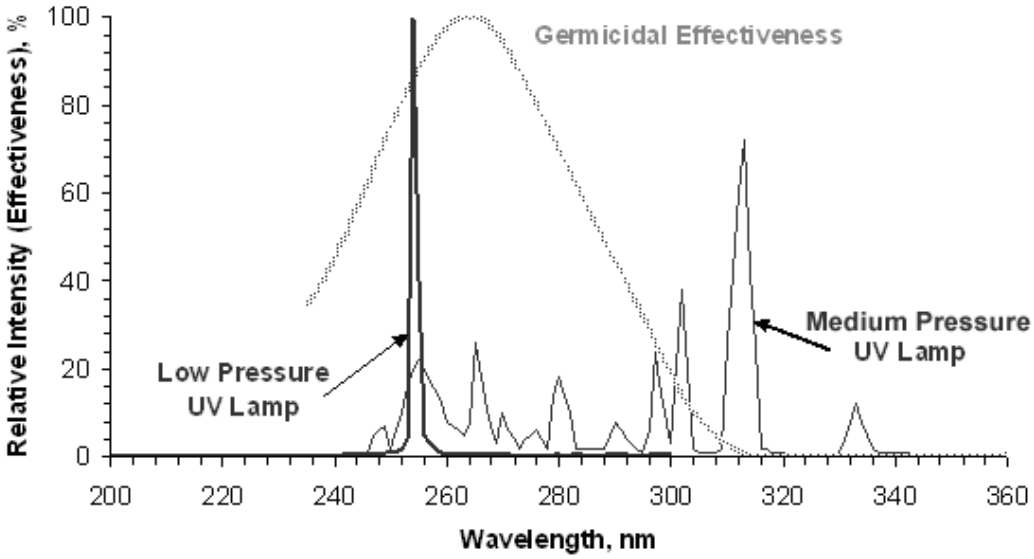


Figure 8-17 Output Wavelengths for UV lamps Shown with the Effective Germicidal Region for UV Disinfection; from http://www.americanairandwater.com/images/uv-lamp-output.gif

8.1.3.2.2 Mechanisms of Degradation of CECs and PPCPs in Conventional Activated Sludge Systems

The removal of CECs at municipal WWTPs is dependent upon a variety of factors, including the type of treatment employed, the solids retention times, levels of organic matter, and the properties of the chemical compounds (Schaider et al., 2013). During primary and secondary treatment, the attenuation of contaminants can be attributed to three removal mechanisms: **Biodegradation, sorption, and volatilization** (Khan and Ongerth, 2002). Biodegradation is believed to be the major elimination mechanism (Blair et al. 2013). Activated sludge processes have been shown to remove CECs, however the most persistent CECs display resistance to many types of treatment. Specifically, organophosphate flame retardants, fragrance compounds, pharmaceuticals, and perfluorinated chemicals tend to be the most persistent CECs and do not easily biodegrade during primary and secondary treatment (Schaider et al., 2013; Joss et al., 2006).

The mechanism for degradation of CECs and PPCPs in CAS systems can be summarized as "physical partitioning among liquid, gas, and solid phases with regards to biochemical transformation" (Rojas et al., 2013). Rojas et al. (2013) completed a study and literature review regarding CEC removal during conventional wastewater treatment processes for the 42 most common CECs discussed in literature and encountered in field studies, pilot studies, and laboratory experiments. The extensive literature review completed by Rojas et al. (2013) was a continuation of an assessment on CEC removal efficiency during wastewater treatment conducted by the EPA in 2010 (USEPA, 2010). In the EPA assessment, 246 compounds were surveyed using publications from 2003-2008. This study utilized two models, BIOWIN 2 and 6 and EPI Suites 4, to predict the biodegradability of each functional group present in the wastewater stream (USEPA, 2010). These models predict the removal of organic chemicals during secondary biological treatment (activated sludge) account for three mechanisms of removal: evaporation, biochemical degradation, and sludge sorption. The parameters utilized in the models to predict biodegradability include physical properties such as Henry's law (H) and the octanol-water partitioning coefficient, however the actual biodegradation rate was hard to determine due to its dependence on a variety of treatment parameters and operating conditions (Rojas et al. 2013). Dickenson et al. (2010) also noted that biological degradation rate constants are not available for many PPCPs and need to be determined based on *in situ* testing rather than assuming them from typical chemical characteristics.

The octanol-water partitioning coefficient quantifies the concentration of a compound in the aqueous-phase in relation to the concentration of a compound in organic material that is part of the solid phase. Rojas et al. (2013)

studied the correlation between log octanol-water partitioning coefficients and the probability of a plant removing >75% of select CECs, and found that trends between the two were not apparent unless the readily biodegradable compounds (caffeine, acetaminophen, etc.) were excluded. When the readily biodegradable compounds were excluded from the evaluation, the relationship between the log octanol-water partition coefficient and probability of > 75% removal was more positively correlated, indicating that sorption to sludge is the main elimination mechanism of hydrophobic compounds (Rojas et al. 2013). Thompson et al. (2011) found that log octanol-water partitioning coefficients greater than 4 resulted in substantial hydrophobic interactions and sorption to solids.

The operating conditions of activated sludge processes where biodegradation, sorption to sludge, and volatilization may occur are also important when studying mechanisms of CEC removal in wastewater treatment. Gerrity et al. 2013 studied the solids retention time (SRT) and its impact on the removal of 33 trace organic constituents in conventional wastewater treatment after 5.5, 6, and 15 days. Gerrity et al. (2013) concluded that the optimal SRT for trace organic constituent removal is between 10-15 days and SRTs exceeding 15 days may be unjustifiable. Gerrity et al. (2013) observed >90% removal on an aggregate level with respect to all 33 compounds – and attributed removal to sorption and biotransformation. Additionally, Stephenson and Oppenheimer, 2007, studied the impact of SRT on the removal of 30 PPCPs from six different WWTPs. SRT values in the study varied from 0.5 days to 30 days amongst the six WWTPs and showed that the minimum SRT that should be implemented was dependent upon the compound, but overall ranged from 5 to 15 days. Strenn et al. found that both ibuprofen and bezafibrate removal efficiencies were clearly dependent upon the SRT and in yet another study, Cirja et al. 2008 found that SRT in WWTPs should be at least 8 days to facilitate enhance organic compound removal. In a comprehensive WERF study on *Trace Organic Indicator Removal during Conventional Wastewater Treatment* (WERF, 2012), laboratory studies were conducted to provide information on the threshold solids retention times (under aeration) that were required to achieve removal of 80% of several target compounds.

Table 8-16 Threshold (aerobic) SRTs Required to Achieve > 80% Removal of Targeted CECs

CEC	Days Required for > 80 Percent Removal
Acetaminophen	2
Caffeine	2
Ibuprofen	5
Naproxen	5
Bisphenol A	10
Triclosan	10
DEET	15
Gemfibrizol	15
Atenolol	15
BHA	15
Iopromide	15
Cimetidine	15
Diphenhydramine	20
Benzophenone	20
Trimethoprim	30

The previous study provides evidence supporting Drewes et al. (2006) previous conclusions that secondary treatment encompassing nitrification and denitrification processes was more efficient than conventional secondary treatment alone with respect to removal of estrogenic compounds. Miege et al. (2009) also concluded that nitrifying activated sludge and membrane bioreactors may be favorable regarding the removal of PPCPs (Miege et al. 2009).

8.1.3.2.3 Removal Efficiencies for Groups of Compounds

The removal efficiency of CECs and PPCPs in conventional wastewater treatment schemes is not completely understood with respect to the impact of different configurations of unit processes (Blair et al., 2013). However, there are a number of studies that have begun to compile the growing body of information on this topic. In a report by Miege et al. (2009), results from 117 publications on CEC presence in influent and effluent wastewater were gathered. Amongst the publication results, 70-99% of hormone compounds studied were removed during conventional wastewater treatment. Carbamazepine and diclofenac had removal efficiencies of <10%, and <25%, respectively.

The review by Rojas et al. (2013) calculated removal efficiencies for compounds based on influent and effluent concentrations that were measured in the cited studies to develop a database of on removal rates. Rojas et al. (2013) found that conventional secondary treatment removed less than 20 percent of carbamazepine and less than 50 percent of diclofenac, almost all of the caffeine and acetaminophen were removed in half of the WWTPs studied. The Rojas et al. (2013) review was very comprehensive, incorporating 657 references of previous work to calculate mean removal efficiencies of compounds. A summary of findings from that study, separated by group of CEC compound, follows.

Antibiotics

The efficiency of antibiotic removal by secondary treatment varied. Tetracycline displayed an average removal efficiency of 70%. Sulfamethoxazole, roxythromycin, nor-floxacin and ciprofloxacin had average removal efficiencies between 50 and 70%, and sulfamerazine and trimethoprim had removal efficiencies below 50%.

Estrogen and Estrogen Mimics

Removal efficiencies for hormonal compounds, specifically, estrogen and estrogen mimics, were uniformly greater than 75%.

Musks

Musks, though classified as nonbiodegradable, have removal efficiencies above 65%. One nito-musk, musk ketone, had removal efficiencies greater than 90%. A noteworthy comment with respect to musk removal was the hydrophobic nature of these compounds and the associated possibility that their removal could be attributed to sludge adsorption.

Plastics Additives

Benzophenone and DEHP displayed high removal efficiencies. Bisphenol A (BPA) and epoxy resins such as alkylphenols and alkylphenol ethoxylates had average removal efficiencies of 80-85%.

Perfluorinated Compounds

Compounds such as PFOS and PFOA showed removal efficiencies close to zero. This result was anticipated because perfluorinated compounds are both hydrophilic and nonbiodegradable.

8.1.3.3 Sequencing Batch Reactors & Membrane Bioreactors

8.1.3.3.1 Membrane Bioreactors

Unlike conventional activated sludge processes, membrane bioreactors (MBRs) do not include mechanical pretreatment or primary sedimentation. Instead, a microfiltration or nanofiltration membrane is used to separate liquid from the

activated sludge that remains in the aeration basin. MBRs operate at much higher (typically five to eight times) mixed liquor suspended solids (MLSS) concentrations than CAS systems. Because of this, MBR systems produce high quality effluent with respect to nutrients, COD, microbial community growth, in a substantially smaller footprint for the physical system.

Treatment conditions such as SRT, temperature, pH, biomass concentration, and the class of CEC present in the wastewater determine the removal efficiencies of both CAS systems and MBR systems. SRT for MBRs is typically 25 to 80 days whereas SRT in CAS systems in considerably less, from 8 to 25 days (Cirja et al. 2008; Joss et al. 2006). Rojas et al. (2013) found that CEC removal efficiencies in membrane bioreactors were similar to those found in conventional wastewater treatment, however, compounds such as clofibric acid and naproxen were removed to a higher degree. Acetaminophen, diclofenac, ibuprofen, and ketoprofen seemed to exhibit more resistance during MBR treatment and had lower removal efficiencies than by conventional processes. BPA and p-nonylphenol were removed to similar extents between MBR and conventional activated sludge processes (Rojas et al. 2013).

Sipma et al. (2009) hypothesized that MBRs provide additional removal of refractory organic contaminants when compared to traditional activated sludge systems. The average removal efficiencies for 30 PPCPs that have been documented for MBR and CAS were compiled for this review. The authors found that due to sludge age and the formation of unique microorganism communities, MBRs outperform traditional activated sludge processes when removing poorly degradable PPCPs. However, easily degradable compounds such as acetaminophen, ibuprofen, and paroxetine were readily removed in both MBR and CAS systems. Compounds that were either barely or reasonably removed in CAS were more efficiently removed in MBRs. One example is sulfamethoxazole which exhibited removal efficiency of 33% in CAS systems, and removal efficiency of 73% in MBR systems (Sipma et al. 2009).

Cirja et al. (2008) found, in contrast to conclusions gathered by Sipma et al. (2009), that no real removal efficiency differences could be found between the MBR and CAS systems. Even though there were no conclusive overall differences, the paper noted that various operating conditions resulted in inconsistent performance from CAS to MBR. For example, CAS systems generally had consistent treatment performance even during temporal variations from 10-25 degrees Celsius. This can likely be attributed to the larger surface area in CAS as opposed to MBR; larger surface areas may protect microbial communities from temperature shock. MBRs were strongly influenced by changes in temperature and season (Cirja et al 2008). Higher temperatures in the MBR systems resulted in an 80-100% increase in removal

rates. High temperature operating conditions in MBR systems likely enhance removal of persistent organic compounds. Cirja et al. 2008 concluded overall that conventional wastewater treatment plants in locations with average temperatures between 15 and 20 degrees Celsius may be more effective at removing micropollutants when compared to locations with an average temperature less than 10 degrees Celsius (Cirja et al. 2008).

8.1.3.3.2 Sequencing Batch Reactors

A sequencing batch reactor is an activated sludge process that operates under non-steady state conditions. Both aeration and sedimentation occur in the same basin in a time sequence and therefore the system operates as a batch reactor. Because the reactions, sedimentation process, and decanting process occur in the same tank, there are no secondary clarifiers needed and there is no recycled sludge process employed.

Studies regarding CEC removal in SBRs focus on the microorganism community within the reactor, and its ability to degrade pollutants (Keen et al. 2014). Toyama et al. 2013 studied the removal efficiency of endocrine disrupting compounds in SBRs and found that two particular rhizobacteria of *Phragmites australis* effectively degraded EDCs to below detection limits within 12 hours (Toyama et al. 2013). Mohan et al. (2004) found that suspended growth SBR systems may facilitate increased removal of complex chemical constituents, when compared to traditional CAS systems, because short term non-steady state conditions can be enforced in combination with fluctuating "feast and famine" periods. Essentially, it was observed that microbial communities may be able to store substrate during "feast" periods and reuse the substrate for growth during "famine" (withdrawal) periods. This dynamic is believed to enhance removal (i.e. substrate uptake) and allow better settling of the biomass (Mohan et al. 2014). Performance of the suspended growth SBR system was measured by percentage of BOD and COD removal. When operating at an organic loading rate of less than 1.7 kg COD/m^3/day, COD removal was approximately 66% and BOD removal was 92%; when operating at or above 1.7 kg COD/m^3/day, COD removal dropped to 47% and BOD removal reduced to 72%. When the organic loading rate was increased to 3.5 kg COD/m^3/day, COD removal was 57% and BOD removal was 35%. Therefore, Mohan et al. 2014 concluded that ideal organic loading rates are less than 1.7 kg COD/m^3/day whereas performance inhibiting conditions begin when the organic loading rate is increased past 3.5 kg COD/m^3/day. Additionally, Mohan et al. 2014 found that the SBR was stabilized within 2-5 days of initial start-up which is typically shorter than a conventional activated sludge reactor needs (Mohan et al. 2014).

Gonzalez et al. (2009) studied the combination of aggressive pretreatment by chemical oxidization followed by SBR treatment for the removal of antibiotic

sulfamethoxazole and found that 76% removal of TOC concentrations occurred over an 8-hour period. Gonzalez et al. concluded that powerful oxidation processes, can be applied successfully as pretreatment steps to SBR systems for the removal of recalcitrant PPCPs (Gonzalez et al. 2009).

8.1.3.4 Advanced Treatment Options

Subedi et al. (2014) studied advanced on-site wastewater systems in the vicinity of Skaneateles Lake in central New York for the removal of PPCPs and PFASs. Originally, advanced systems were installed in homes to limit nutrients entering receiving surface water bodies. In this instance, advanced systems incorporated synthetic media such as textile filter, peat fiber, and textile/peat along with innovative dispersal technologies such as drip irrigation and bottomless sand filters (Subedi et al., 2014).The designs chosen for installation were shown to be effective at reducing total nitrogen load to the subsurface which was the initial goal. Results from numerous past studies have shown that well-operated, conventional systems can achieve high removal rates for most wastewater pollutants of concern, with the notable exception of nitrogen. Costa et al. 2002 estimated that 25 percent removal of total nitrogen could be assimilated in conventional soil absorption systems. Commercially available advanced OWTSs evaluated in the Subedi et al. (2014) study included aerobic systems utilizing synthetic media (textile filter, peat fiber, and textile/peat) and dispersal units such as a sand filters with no bottom (Subedi et al. 2014). Subedi et al. (2014) found significant concentrations of sulfamethoxazole subsequent to textile/peat treatment in comparison with effluent concentrations from the other systems. Additionally, concentrations of atenolol were found to be tenfold lower when treated with the biofilter treatment unit. Overall, exact removal efficiencies between the four systems were not within the scope of study, however the textile/peat filter was found to be the most effective advanced OWTS in terms of removing total coliform, E. coli, enterococci, and all of the measured PPCPs. It is of note, however, that effluent from the textile/peat filter had PFOS concentrations 2 to 4 times higher than the other advanced OWTSs.

Stanford and Weinberg (2010) conducted a study on the use of advanced OWTS processes for removal of steroid estrogens and nonylphenols; five different systems were tested and all systems were in locations where >25 people reside. The systems utilized a variety of pretreatment methods such as aerobic wetlands, anaerobic wetlands, sand filters, vegetated sand filters, greenhouse irrigation beds, and UV disinfection or chlorination prior to release (Stanford and Weinberg, 2010). Stanford and Weinberg concluded that advanced pretreatment methods such as aerobic sand filtration or aerobic wetlands are likely needed to ensure removal of EDCs before effluent reaches groundwater. When these particular pretreatment methods were utilized,

TOC, NH_3-N, BOD, steroid estrogens and nonylphenols, and total estrogenic activity were substantially reduced. On the other hand, when aerobic pretreatment methods were not utilized, high estrogenic activity, TOC levels, and high levels of endocrine active substances were observed. Where aerobic processes are not used prior to discharge to leaching fields, it is important to be aware of the possibility of increased levels of these constituents in groundwater, especially when the soil is particularly sandy and the groundwater table is shallow (Stanford and Weinberg, 2010).

Du et al. (2014) found that a septic tank system coupled with subsurface flow constructed wetlands performed far better than a septic tank alone; however, the coupled system did not outperform aerobic OWTS or municipal WWTP treatment. The septic tank system studied did not include soil treatment (traditional septic systems utilize a leaching field) and was used to represent a septic system that does not properly function; 10 to 20 percent of septic systems in the United States malfunction every year (USEPA, 2002).The study conclusions highlighted the potential of constructed wetlands for enhanced CEC removal when soil absorption leaching fields are not possible (space restrictions, etc.). In a constructed wetland, mechanisms for removal of CECs are primarily biodegradation, sorption, sedimentation, and vegetation uptake. In this study, constructed wetlands performed similar to municipal wastewater treatment plants with respect to CEC removal with the exception of diclofenac, gemfibrozil, and benzoylecgonine (Du et al. 2014). For example, in this study caffeine had a removal efficiency of 100% in the WWTP, 99% in the aerobic OWTS, 100% in the septic tank system paired with the constructed wetland, and 52% in the septic tank alone (Du et al. 2014).

Mechanisms of treatment that are employed in advanced on-site wastewater treatment systems are discussed below, though the list is not intended to be exhaustive. These types of processes could be added to conventional OWTSs to enhance CEC removal. If CEC removal is enhanced, it is also likely that the overall water quality of the effluent will be enhanced with respect to nutrients and the suite of conventional water treatment parameters. It is important to emphasize that metabolites or disinfection by-products can be the result of some treatment processes, and further attention needs to be placed on the linkage between unit processes, class of CEC, and the potential formation of unwanted, harmful, products or intermediate compounds.

8.1.3.4.1 Sorption

There are two types of activated carbon: powdered activated carbon (PAC) and granular activated carbon (GAC) (NRC, 2012). Activated carbon can be used to enhance adsorption of contaminants, such as organic wastewater chemicals, on a solid phase material and therefore remove them from the water. PAC is most commonly utilized in the activated sludge process to increase solids

contact, whereas GAC is a common component in pressure and gravity filters (NRC, 2012).

8.1.3.4.2 Biofiltration

Biofiltration is a process that relies upon the growth of microbial communities on filter media in order to facilitate microbial degradation of organic matter (Kandasamy et al. 2002). A biofilter can be any type of filter that has developed a biological film on the filter media; examples include trickling filters, GAC filters, and sand filters (Kandasamy et al. 2002). The microbial community transforms organic material into both energy and cell mass. Operating parameters such as the pH, temperature, and hydraulic loading rates can impact the performance of the microbial community (Kandasamy et al. 2002).

8.1.3.4.3 Ion Exchange

Ion exchange incorporates a solid phase material to substitute ions in the aqueous phase for an ion in the solid phase (Asano et al. 2007). The most common application of this process is in water softening, where the hardness of the water is reduced by removing magnesium and calcium ions from the water and replacing them with sodium ions from the solid phase exchange material such as polymeric resin, kaolinite, or montmorillonite (Asano et al. 2007). Essentially, the exchange materials have fixed charge functional groups attached to the material itself; oppositely charged ions, known as counter ions, uphold the electroneutrality of the exchange material and the aqueous solution, allowing removal of select ions from the water by replacement (Asano et al. 2007). Ion exchange can be used to remove a variety of constituents such as barium, radium, arsenic, perchlorate, chromate, Na+, Cl^-, SO_4^{2-}, NH_4^+ and importantly for systems that discharge to groundwater for the purposes of indirect potable reuse, NO_3^- (Asano et al. 2007).

8.1.4 Recommendations for Suffolk County: Planning for the Future

In Suffolk County, CECs are not the only concern when planning for future OWTSs. About 70 percent of the nitrogen load in Suffolk County is estimated to originate from OWTSs; this is a very high percentage when compared to other regions. Effluent nitrogen levels from traditional OWTS are an estimated 38 mg/L. Barnstable County, MA requires effluent nitrogen concentrations to be between 19 and 25 mg/L whereas the State of Maryland requires effluent nitrogen concentrations to be 30 mg/L. Of the 19 pilot advanced OWTS systems investigated on the 'Suffolk County Septic Road Show', only one is permitted in all four studied jurisdictions for the adequate reduction of nitrogen. The system, known as Bio Microbics FAST, is an Integrated Fixed Film Activated Sludge (IFAS) process. Busse GT and Bio Microbics Bio Barrier

are OWTSs that likely enhance removal of both nitrogen and CECs (Bellone, 2014).

As discussed in previous sections, enhanced aerobic conditions (i.e. extended aeration), MBRs, and biofiltration are methods that have been shown to slightly or modestly increase removal of CECs from wastewater – but research gaps inevitably exist, particularly with respect to how each specific system performs. Further investigation is, without doubt, a crucial component of making educated decisions about the long-term selection and implementation of processes to provide treatment for these compounds.

Thus, both practical recommendations for design and implementation of OWTSs as well as further investigation are provided. These recommendations are provided based on the cumulative information that is available, but specifically leverages information that is documented for centralized systems that have similar treatment processes and removal mechanisms as the proposed advanced OWTSs. Finally, it is worth considering how monitoring information can be used to inform risk assessment and risk management from CEC contamination of groundwater supplies; a brief discussion of how CEC data currently being collected can be used to inform this process.

8.1.4.1 Design Parameters for OWTSs

Recommendations for design of OWTSs have been extracted from literature with respect to optimizing treatment performance, which also includes the treatment that occurs in the aerobic vadose zone into which effluent is discharged.

8.1.4.1.1 Separation Distances

Carrara et al. (2008) reported that removal of pathogens is typically the governing factor when setting criteria for separation distances between a water supply well and the tile bed (or leaching field) of OWTSs, and these criteria do not account for the transport or effective removal distances for CECs (Carrara et al. 2008). Moving forward, separation distances should be adequate to ensure both pathogen removal and CEC removal. While there is not clear guidance in the literature on ideal or minimum separation distances that are necessary to achieve CEC removal, it is known that researchers have reported higher observed concentrations of PPCPs at sample locations that are closer to the OSWTs discharge. Rosario et al. (2014) theorized that the limited separation distance in some OTWSs result in higher concentrations of PPCPs in down-gradient samples, such as groundwater or stream samples. Additionally, Heufelder (2012) recommended maximizing vertical separation of OWTSs from groundwater in efforts to increase residence time within the soil aquifer system to provide better CEC removal, however the authors noted that this needs to be studied further.

Current SCDHS requirements for septic systems require a minimum of three feet below the bottom of the leaching pool and the highest recorded groundwater elevation for conventional OWTS. In addition, the County requires a minimum of 100 to 150 foot distance between a leaching pool and the nearest private well (depending upon the well depth) and a minimum of 200 feet to a public supply well (SCDHS, 1995). SCDHS guidance for siting new or expanded WWTPs advises that WWTPs should not be located within the zero to two year contributing area to public supply wells as identified by the 2007 source water assessments, based on the NYSDOH's assessment of the sensitivity of microbial contaminants. In addition, the County advises that the siting of WWTP discharges within the two to 50 year groundwater travel time should be minimized to the extent feasible; if a WWTP is located within this zone, an advanced treatment process shall be provided (SCDHS, 2014). The separation distances proposed by SCDHS are consistent with providing some level of CEC removal, particularly when the OWTS is an advanced treatment system that includes aerobic treatment.

8.1.4.1.2 Horizontal Setback Distances from OWTS to Receiving Surface Waters

The Rosario et al. (2014) study proposed increased horizontal setback distances between OTWS and surface waters in order to increase treatment of CECs and PPCPs. In soils predominantly characterized by sandy clay loam, PPCPs migrated up to 15 to 18 m from the drain field to the nearby stream. Current SCDHS guidance for siting new or expanded STPs advises that siting of STPs within the zero to twenty-five year contributing area to sensitive surface waters should be minimized to the extent feasible; if an STP is located within this zone, an advanced treatment process shall be provided (SCDHS, 2014).

8.1.4.1.3 Hydraulic Loading Rates and Residence Time

Drewes et al. (2011) made conclusions regarding soil-aquifer treatment operations from findings of field monitoring efforts at five field sites. The main findings suggest that removal of DEET, diclofenac, ibuprofen, and meprobamate required at least one week of travel time to achieve 90% removal rates. Chlorinated flame retardants such as TCEP, TCPP, TDCPP were not well removed after 6 days, and antiepileptic compounds such as primidone, Dilantin, carbamazepine, sulfamethoxazole, and atrazine were not well removed after 5 days in either oxic or anoxic conditions.

In the laboratory column study published by Teerlink et al. (2012), CEC attenuation was explored as a function of hydraulic loading rates. The majority of CECs did not show a significant difference in removal as a function of loading rates however readily biodegradable CECs seemed to exhibit better removal at lower loading rates (Teerlink et al. 2012). One study suggested an increase of residence time by decreasing the hydraulic load. Recommendations

include a loading rate of 0.74 gallons per square foot per day (Heufelder et al. 2012).

8.1.4.1.4 Vents

Heufelder (2012) recommended that in order to promote increased air exchange and enhance the resulting treatment benefits of sufficient levels of oxygen with respect to aerobic organisms, at least one vent should be required in all SAS systems. Heufelder (2012) also noted that ideal design of soil-absorption systems would incorporate minimal coverage because less coverage promotes air exchange.

8.1.4.1.5 Distribution of OWTS Effluent

Heufelder (2012) has been testing OWTS in Massachusetts for 20 years – in his work, he makes recommendations for design features for OWTS that are thought to optimize CEC removal. One of the key recommendations is pressurizing the treated effluent to optimize oxygen transfer and produce consistent unsaturated flow conditions. In gravity fed systems the majority of the soil aquifer system soil interface area is not used and effluent percolates over time under saturated flow conditions through less soil volume. Low-pressure distribution of septic tank effluent results in higher levels of oxygen transfer due to the effluent being exposed to increased surface area of soil particles. This design modification is recommended so that OWTS effluent is distributed to the soil treatment unit via low pressure distribution in order to utilize the most surface area within the soil absorption system (Heufelder 2012).

8.1.4.2 Monitoring Indicators for CECs Treatment Performance

The core purpose of wastewater treatment is focused on reducing the organic and nutrient load in wastewater. Biological treatment processes are the predominant type of treatment in the U.S. and other parts of the world. These processes have been designed in many different configurations depending on the level of treatment required. Although not originally designed for this purpose, conventional treatment processes (both centralized and OWTSs) can remove a variety of CECs. There are a number of factors which have been identified in previous works to affect the attenuation of CECs in various treatment systems (both centralized and OWTSs), among them solid retention time (SRT), pH, and temperature. Quantitative relationships between these factors and CEC removal have not yet been systematically established for centralized systems; less is known about CECs in OWTSs. Therefore, our ability to predict CEC removal during treatment is currently limited.

However, with the thousands of chemicals contained in wastewater, comprised of pharmaceuticals, personal care products, food additives, and other high production volume chemicals with a wide range of physical and chemical

properties, many CECs have been detected in groundwater supplies. As we can only monitor a very small fraction of all CECs that are present in environmental samples, strategies are needed to describe and predict removal efficiencies for representative CECs. Therefore, a strategy based on performance indicators selected by considering key removal mechanisms and compound properties could be used to inform the process of evaluating OWTSs.

Considering that the major removal mechanisms in OWTSs include sorption and biotransformation, researchers have identified a key group of indicator compounds that can be grouped into nine bin categories that represent a larger group of CECs with similar sorption and biotransformation characteristics (WERF, 2012). Each bin category can be described in terms of anticipated range of removal efficiency and the accuracy and reliability of predicting fate during activated sludge treatment using current fate models. As previously noted, solid retention time (SRT) was found to drive the biotransformation of indicator compounds that are moderately biotransformed and threshold SRTs were defined for each indicator that exhibited more than 80% removal as previously described while characteristics such as hydrophobicity drive removals by sorption onto solids.

Based on research published by WERF (2012), the parameters identified in **Table 8-17** can be used as indicators with respect to evaluating biological treatment performance in conventional systems, and these may also be useful in assessing the performance of OWTSs being piloted in Suffolk County.

Table 8-17 Indicators Recommended for Assessing Biological Treatment Performance

		Biotransformation (k_b, L/g-d)		
		Slow <0.1	**Moderate 0.1 - 10**	**Rapid > 10**
Sorption (log K_d)	**Low <2.5**	Carbamazepine Meprobamate Primidone TCEP Sucralose	DEET Sulfamethoxazole Gemfibrozil Iopromide Trimethoprim	Acetaminophen Caffeine Naproxen Ibuprofen Atenolol
	Moderate 2.5 – 3	TCPP	Cimetidine	Benzophenone Diphenhydramine Bisphenol A
	High > 3	Tricolcarban		Triclosan Fluoxetine

Twenty-two compounds that could be used as performance indicators were selected from a database of over 240 compounds evaluated based on the occurrence levels and detection frequency in wastewater influents and effluents, their properties and ability to be measured by current analytical techniques. Toxicological relevance was a secondary selection criterion. The compounds were classified into different bin groups based on their biotransformation kinetics as sorption characteristics during biological treatment processes.

8.1.4.3 Research on Emerging Monitoring Tools

As noted above, ultimately, effluent limits for CECs are impractical for individual compounds or even groups of compounds and other endpoints will need to be identified to manage the risk imposed by these compounds on the environment and public health. Thus researchers have focused on identifying new methods for identifying wastewater impacts on the receiving environment.

While there have been significant advances in the number of compounds that can be measured, at increasingly lower detection limits, the approach to linking the detection of CECs to human health or ecological effects is not clear cut. For example, many pharmaceuticals, steroids, and biogenic and anthropogenic hormones are chemically changed by human or animal digestive tracts by formation of glucuronide or sulfate conjugates (Berg et al., 2007). The pharmaceuticals ingested by mammals are often excreted as the unaltered parent compound to only a small degree., Thus in addition to studying the parent compound, it is necessary to examine the metabolic by-products of these compounds, which may be radically different than the parent compounds from a treatment perspective. The formation of conjugates is a mechanism by which certain chemicals are rendered more water soluble and thereby more excretable. Organic weak acids, including alcoholic, phenolic, and carboxylic acid functional groups, react with glucuronic acid *in vivo* to form glucuronide conjugates (Berg et al., 2007). For example, gemfibrozil, a lipid regulating pharmaceutical, is excreted mostly as the glucuronide conjugate, with less than 2% excreted as unchanged gemfibrozil; it is also of note that approximately 76% of the actual administered dose is excreted (RxList, 2014). When the hydrophobicity–ionogenicity profile for the parent compound is compared to the glucuronide conjugate, it can be concluded that the conjugate is more hydrophilic than the parent compound, indicating that it is more challenging to remove from wastewater by sorption processes (Wells, 2006).

Considering the number of possible chemicals and their degradates that could be analyzed, our historical and current paradigms for evaluating occurrence, fate, and toxicity cannot keep pace with chemical development and

commercialization, let alone regulatory evaluation. The objective of identifying all of the constituents and their degradation products that may be of concern in wastewater effluent is an impossible task. Thus, many researchers have focused on developing an understanding of the bulk characteristics of the residual organic carbon that remains in treated wastewater and the biological effects of the mixtures of compounds that exist in these waters (Snyder, 2014).

8.1.4.3.1 Characterization of Bulk Organic Matter

Residual organic carbon is of interest because it is associated with a broad spectrum of potential concerns. Three groups of residual organic chemicals require attention (Drewes and Jekel, 1998):

- Constituents of emerging concern added by consumers or generated as disinfection by-products (DBPs) when chlorine-based oxidizing agents are applied, or during the disinfection of water and wastewater, and
- Soluble microbial products (SMPs) formed during the wastewater treatment process and resulting from the decomposition of organic compounds.
- Natural organic matter (NOM), if present in water supplies will be present in wastewater.

In addition to traditional methods for measuring organic carbon content in samples, emerging methods such as UV fluorescence excitation/emission matrix (EEM) spectroscopy can be used to provide characterization of organic constituents in water samples. This allows indirect measurement of changes in water quality through a treatment train. Spectra or "maps" are generated in which specific spectral signatures or "fingerprints" of organic matter can be localized. EEM, or 3D fluorescence, is a technique that can be used to characterize the organic matter present in waters from diverse sources. When organic matter present in wastewater is excited at a particular wavelength, only part of the organic matter emits light, fluorescence. Fluorescence occurs when a molecule absorbs energy in the form of electromagnetic radiation (ultraviolet and visible light) and re-emits that energy as light. Most molecules do not fluoresce, but re-emit the light energy absorbed in the form of motion (kinetic energy) or heat (thermal energy). Therefore, the technique is limited to molecules containing fluorophores (sub-parts of molecules that have the ability to re-emit energy in the form of light). Many naturally-occurring organic compounds (humic and fulvic acids, amino acids, proteins, and microorganisms) and anthropogenic organic compounds will fluoresce.

Water samples are excited at certain wavelengths (200–600 nm), and fluorescence intensity emitted is collected in a certain range (200–650 nm), resulting in a three-dimensional map: an excitation, emission, and fluorescence-intensity matrix. By this representation, it is possible to localize fluorescence centers related to particular groups of fluorophores, or fingerprints (*i.e.* Yan et al., 2000; Baker, 2001; Chen et al., 2003; Christensen et al., 2006; Stedmon and Markager 2000; Sierra et al. 2005). In a typical river water sample, discrete fingerprints have been identified: tryptophan (λEX, 275; λEM, 350 nm); fulvic-like (λEX, 320–340 nm; λEM, 410–430 nm); and humic-like (λEX, 370–390 nm; λEM, 460–480 nm) (Baker, 2001). In addition, it is possible to distinguish different sources such as sewage dominated by tryptophan-like proteins (Baker, 2002).

Therefore, an innovative mapping procedure for a subset of surrogates or representatives of important chemical classes of potential contaminants has been developed based on fluorescence spectroscopy. Spectra or "maps" are generated in which specific spectral signatures or "fingerprints" of organic matter can be localized. Visualizing a 3D EEM map is similar to looking down on elevations of a mountain in a topographic map. A 3D EEM spectrum can be represented as a contour map just as many topographic maps are, but in these data the height of the elevations (intensity of fluorescence) is denoted by variations in color (**Figure 8-18**).

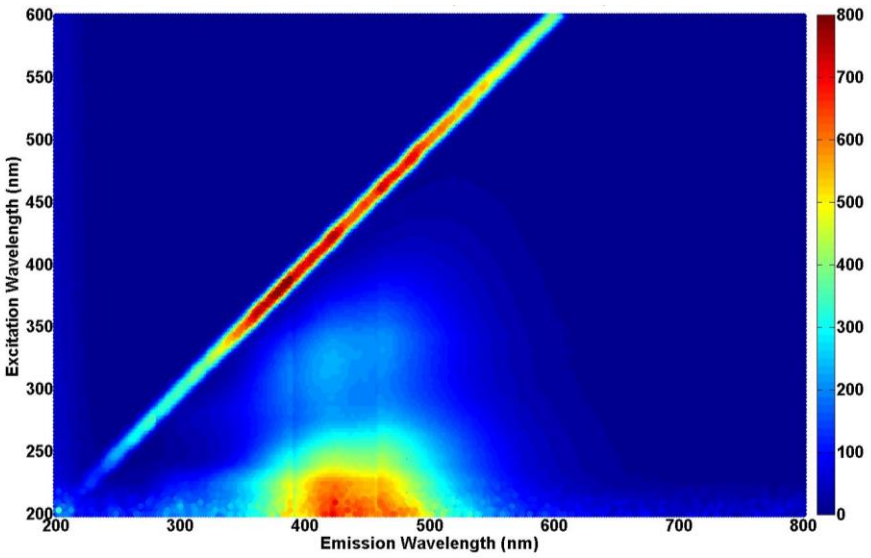


Figure 8-18 Example of a 3D EEM Map Obtained in a Recent Study Tracking Effluent Organic Matter in an Environmental Sample

In the 3D EEM maps presented in **Figure 8-18**, the x-axis represents the emission wavelengths, the y-axis represents excitation wavelengths and the z-

axis (represented by the color bar, and coming out of the plane of the page toward the viewer) indicates the intensity of the corrected fluorescence at a specific excitation-emission wavelength pair (x,y data point). The intensely colored diagonal stripe in the 3D maps, located where the excitation wavelength is equal to the emission wavelength, is not due to fluorescence but results from scattering of light (by atoms, molecules, particles) and is referred to as first-order Rayleigh scattering. Of note is the importance of data processing which should include corrections for 2nd order Rayleigh scatter, the Raman spectrum of water, and the inner filtering effect when environmental samples are evaluated.

8.1.4.3.2 Potential Toxicity Impacts

With respect to monitoring for potential biological impacts we can utilize biological sentinels, such as the canary in the coal mine which was relied on for more than 100 years by miners who used these birds to ensure that air within mines was suitable for humans to breathe. The use of biological surrogates has had a long history in protecting human health and, in fact the current risk assessment framework includes testing using *in vivo* animal models to extrapolate endpoints that can be translated to regulatory limits (http://www.epa.gov/riskassessment/) for risk assessment method, e.g., MCL for drinking water. However, with the number of chemicals and mixtures of chemicals and chemical transformation products, this approach is limited and high-throughput screening methods are being evaluated to provide information on the mechanisms of biological toxicity at a relatively small cost (Snyder, 2014).

In the United States, bioassay monitoring is already required by the USEPA for wastewater discharge through whole effluent toxicity testing requirements (http://water.epa.gov/scitech/methods/cwa/wet/). And, researchers are investigating analogous approaches to using assays and endpoints appropriate for human health. Thus, even with the limitations of extrapolation from a cellular response to human health outcomes, high throughput assays could provide a more comprehensive view of chemical constituents present in water as well as an assessment of their cumulative (mixture) toxicity.

Equipment to perform most *in vitro* cellular bioassays is significantly less expensive than those required for mass spectrometric techniques used for targeted analyses. Although many cell bioassays, such as the Ames test or Microtox®, are available commercially, EPA continues to develop a wide array of assays that could be made publically available for very little cost to water agencies. Cell culture equipment is already available in many water laboratories, and plate-scanning spectrophotometers can be procured at reasonable costs that are at least an order of magnitude less than commonly employed liquid chromatography tandem mass spectrometer equipment. The

proliferation of 384 well-plate assays along with robotics for liquid handling also will continue to decrease labor and supply costs while simultaneously increasing reproducibility. These types of high throughput assays will continue to be developed and applied for water quality evaluations, allowing for rapid and relatively inexpensive characterization of the mixtures of chemicals that may occur in water (Snyder, 2014).

Recently, a comprehensive survey of bioassay tests that are indicative of a wide range of responses has been published (Escher et al., 2014) along with the results of an interlaboratory study investigating a range of bioassay methods. This research evaluated bioassays that have been identified to be sensitive to induction of specific modes of toxicity such as: mutagenicity and genotoxicity, xenobiotic toxicity, reactive toxicity, cytotoxicity, endocrine disruption, among other modes of action. The conclusions of the study show that while there are currently limitations to bioassay techniques, they are a valid tool for water quality assessment that complements chemical analyses. Additionally, it may be that a battery of bioassays may be necessary to represent the various pathways that are related to evaluating relevant to human health and more research in this area is needed.

8.1.4.3.3 Risk Assessment for CECs in Water

There are a number of federal agencies (e.g., United States Food and Drug Administration [U.S. FDA]) or even other regulatory programs within the USEPA (e.g., the Office of Pesticides Programs [OPP]) that establish risk-based guidelines for various chemicals. Many of these programs establish limits based on the same data that the U.S. EPA Office of Drinking Water utilizes, but usually focus on a reference dose (RfD) so the actual value of a compound would need to be converted to a drinking water equivalent level (DWEL). The acceptable daily intake (ADI) or the margin of exposure (MOE) used by OPP, and the minimum risk level (MRL) used by the Agency for Toxic Substances and Disease Registry (ATSDR) are similar approaches. These approaches may not consider relative source contribution (RSC) that is usually routinely applied by the Office of Drinking Water when establishing maximum contaminant levels (MCLs) or health advisories (HAs).

Researchers have proposed that these numbers can be brought into line with a DWEL by distributing the ADI into 2 L of water. The RSC values for drinking water are usually in the 20- to 80-percent range, with 20 percent being the most common default value for noncarcinogens, if there is not adequate data to assign another value. The RSC default is effectively an additional safety factor on the RfD; RSCs are not used in the risk calculations for carcinogenic chemicals where incremental risk is the metric. 2-liter-equivalent values are sometimes used, especially for volatile organic compounds (VOCs) where exposure contributions for inhalation and dermal exposure from bathing and

showering may be incorporated in arriving at a benchmark drinking water value (WRRF, 2013).

Thus identifying *de minimis* risk associated with various pharmaceuticals that are used safely in therapeutics, cannot be approached in the same way as the risk benchmarks described above. Reference doses for pharmaceuticals are developed based upon clinical experience in humans, and the data are frequently derived from controlled clinical trials. The lowest therapeutic dose as a benchmark for estimating "safe levels" for pharmaceuticals in drinking water is one approach that has been used. The adverse effects that are identified in standard texts may be based upon clinical trials and good incidence data may be available for these effects. However, adverse drug reactions that have been reported over the history of the drug's therapeutic use form a substantial portion of the assembled database and the nature of these side effects needs to be taken into account when assigning additional uncertainty factors (Bull et al., 2011).

Several publications (e.g., Physicians' Desk Reference, Drug Information Handbook, Facts and Comparisons) are based primarily upon the U.S. FDA database on drugs in use, but do provide some evaluation of the primary literature. Bull et al. (2011) proposed that the lowest therapeutic dose be considered the equivalent of a Lowest Observed Adverse Effect Level (LOAEL) and that appropriate uncertainty factors be applied to adjust for the frequency and severity of the adverse effects associated with the drug's use. This literature also specifically identifies drugs that have been shown to be developmental toxins in animals, as well as humans. It identifies the adverse effects of compounds with some summary evaluation of the strength of evidence. As a LOAEL taken from human studies, uncertainty factors as low as 100 could be applied, but greater uncertainty factors should be applied to adjust for drugs with short-term clinical courses (usually the case with antibiotics and antimicrobials), and those identified as teratogens or developmental toxins. Those compounds identified as carcinogens should be assessed using linear extrapolation, if the data are available. If not, it has been suggested that dividing the lowest therapeutic dose by 500,000 (Bull et al., 2011), which would produce a cancer risk estimate at approximately the 10-6 lifetime risk (this assumes that the lowest therapeutic dose might have produced a 50-percent response, which is a conservative assumption because, with the exception of chemotherapeutic agents, most often cancer data are from animals and the doses in cancer studies in animals are generally higher than the therapeutic dose).

Finally, while there are standard approaches for developing risk assessments of various CECs, these do not account for the multitude of metabolic products that may occur along with these compounds, nor do they address the

complexities of mixtures of compounds. Thus, it is important to continue to evaluate other means of assessing bulk toxicity, such as through the cellular bioassay methods as indicators of risk, as described in 8.1.4.3.2.

8.1.5 Impacts of Rising Sea Level on Wastewater Treatment

Recent sea level rise projections indicate that sea level is projected to rise between 24 and 34 inches by the end of the century with a 95 percent uncertainty range of 36 to 45 inches (Zhang et al, 2014) as shown by **Figure 8-19**. Sea level rise has significant implications regarding on-site wastewater treatment systems for parcels within low-lying coastal areas.

As published in the Suffolk County Standards for On-Site Wastewater Disposal Systems (SCDHS, 1995), the minimum separation distance from the bottom of a leaching pool system to the highest groundwater elevation recorded at the site is 3 feet to ensure adequate treatment in the unsaturated zone prior to discharge to groundwater. In some instances, the minimum separation distance may be reduced to 2 feet for alternative treatment systems, as approved by SCDHS. As per the Standards, for a single-family household with 4 or fewer bedrooms, a minimum depth to water of 9 feet is required or an alternative system must be designed. For larger residences (5 to 6 bedrooms), the minimum depth to water is 11 feet due to the increased wastewater flow.

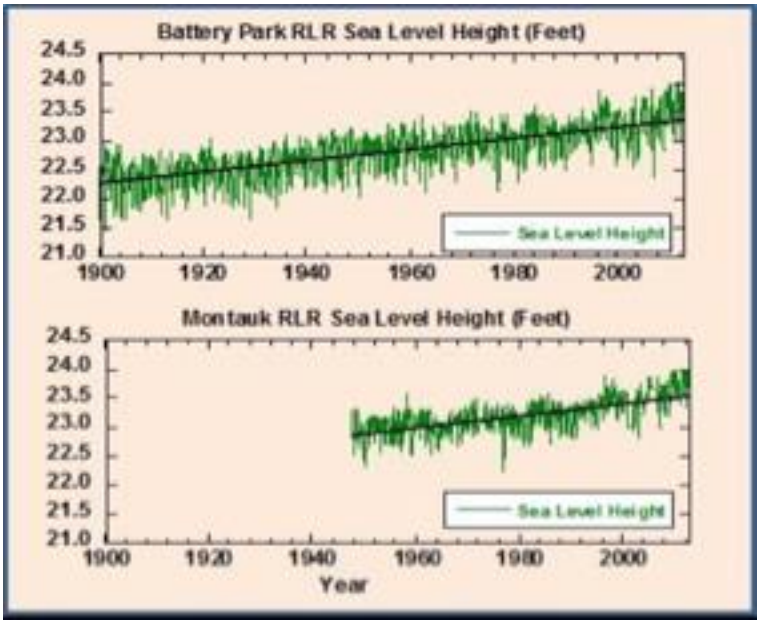


Figure 8-19 Monthly Sea Level Height over Time (Relative to the Revised Local Reference (RLR); from Zhang et al, 2014)

As described in Section 3, sea level rise may result in water table increases of more than 3 feet in coastal areas. This rise in the water table may result in a reduced treatment capability for systems installed within the 9 foot depth to groundwater range or may in fact cause flooding in older systems installed prior to the development of the 1995 Standards. This would result in a direct discharge of sanitary effluent to the groundwater with minimal or no treatment from travel through the unsaturated zone.

8.1.5.1 Groundwater and Sea Level Trends

As discussed in Section 3, the regional groundwater models that were developed for Suffolk County were used to simulate projected sea level rise to the year 2100. Using the "business as usual" scenario outlined in Zhang et al (2014), a sea level rise of 34 inches was projected. The groundwater model simulations incorporated a monthly increase in sea level assuming a linear increase to 2100. The simulated water table position was saved out over time and subtracted from the surface elevation to estimate the resulting depth to groundwater. Areas where depth to water is less than 9 to 11 feet (outside of currently sewered areas) are at risk of having a reduced treatment efficiency from the septic tanks/leaching pools and would be target areas for enhanced wastewater treatment.

8.1.5.2 Groundwater Model Simulation Results

8.1.5.2.1 Main Body

Simulated depth to water under baseline (2013), 2035 and 2100 conditions is shown on **Figure 8-20**, highlighting areas where the depth to water is less than 10 feet from the surface As shown on the figure, much of this area is along the south shore or along the shoreline of the Peconic Bay. It should also be noted that there are large portions of the coastline that are developed and currently have a depth to water of 10 feet or less. It is likely that these areas were developed long before the establishment of Suffolk County Sanitary Code Article 6 or the standards for wastewater treatment. These areas currently have a reduced treatment capability, which would be even further reduced following any increase in the water table elevation.

As discussed in Section 3, streams act as a flow relief valve and a control to the rising water table. Although it appears from **Figure 8-20** that there isn't a significant difference between areas that have a depth to water of less than 10 feet under baseline conditions to 2100, the water table does rise in these areas (see Section 3) and therefore, treatment effectiveness of on-site wastewater disposal systems would be even further reduced than it currently is.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Baseline

2035

2100

Long Island Sound

Peconic Bay

Atlantic Ocean

Nassau County

N

Miles

0 2.5 5 10

Stream

Area Served by Sanitary Sewer

Depth to the Water Table (ft below grade)

<= 5

5 to 10

>10

CDM Smith

Simulated Depth to the Water Table
Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 8-20

As sea level continues to rise, the barrier island communities are at risk of significant flooding. If the water table is simulated to intersect the ground surface elevation in the groundwater model, the model will simulate a discharge (baseflow or groundwater seepage) at the surface at that point. As shown on **Figure 8-21**, most of these discharge nodes occur along the streams. The sum of this discharge would equal the baseflow of a particular stream. Looking at the baseline condition, there are only a couple of these discharge nodes along the barrier island. However, as sea level rises, additional discharge nodes begin to appear. In 2035, these nodes are primarily located along the immediate coastline, as the groundwater seepage face adjusts in response to the rising sea level. However, note that by 2100, discharge is simulated to occur within currently developed communities along the barrier island, this is anticipated to result in flooding, not only of the septic systems, but at the surface as well.

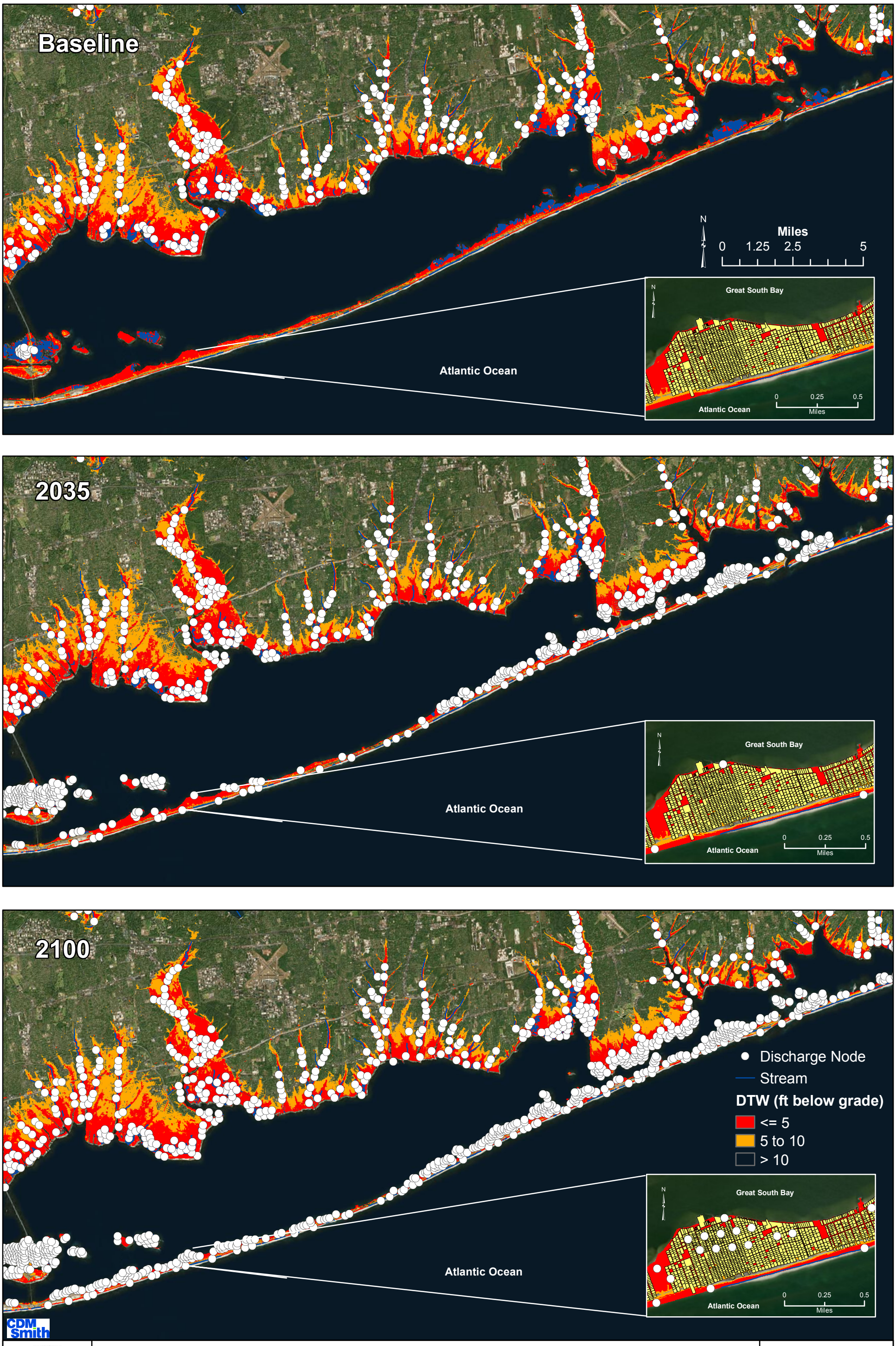
8.1.5.1.2 North Fork

Similar to the results of the main body flow model, the projected 34-inch sea level rise results is simulated to result in an increased groundwater elevation of approximately 3 feet on the North Fork. As discussed in Section 3, this increase results in some encroachment of the saltwater interface. From a wastewater treatment perspective, the increase results in various areas that are at risk of reduced treatment from the septic systems, particularly on the peninsulas and Orient Point. Simulated depth to water maps for baseline, 2035 and 2100 conditions are shown on **Figure 8-22**. The model results for the North Fork provide a good opportunity for use as a planning tool and can highlight the areas on the North Fork that could be prioritized for sewering or the installation of alternative systems. Evaluating **Figure 8-22** at a small scale, it is difficult to see which areas in particular are impacted. However, when evaluating on a larger scale, impacts are more apparent. As shown on **Figure 8-23**, developed (residential, commercial, industrial, institutional land uses) parcels near Jamesport and Aquebogue currently have a depth to groundwater greater than 10 feet or between 5 and 10 feet. However, as sea level rises, those parcels ultimately become at risk for reduced wastewater treatment as the depth to water at many of these parcels is less than or equal to 5 feet by 2100.

8.1.5.1.3 South Fork

Simulated depth to groundwater on the South Fork is shown on **Figure 8-24**. Similar to results from the other models, depth to water is currently fairly low near the coast and along water bodies. However, these areas become further impacted due to sea level rise. This is clearly shown around the vicinity of Mecox Bay and just west of Napeague State Park. In addition, the area where depth to water is less than or equal to 5 feet below grade clearly expands in North Haven.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Simulated Discharge Nodes at Surface Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 8-21

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

N

Miles

0 1.5 3 6

Baseline

Long Island Sound

Peconic Bay

Atlantic Ocean

2035

Long Island Sound

Peconic Bay

Atlantic Ocean

Stream

Sewered Areas

Simulated Depth to Water (feet below grade)

< = 5

2100

Long Island Sound

Peconic Bay

Atlantic Ocean

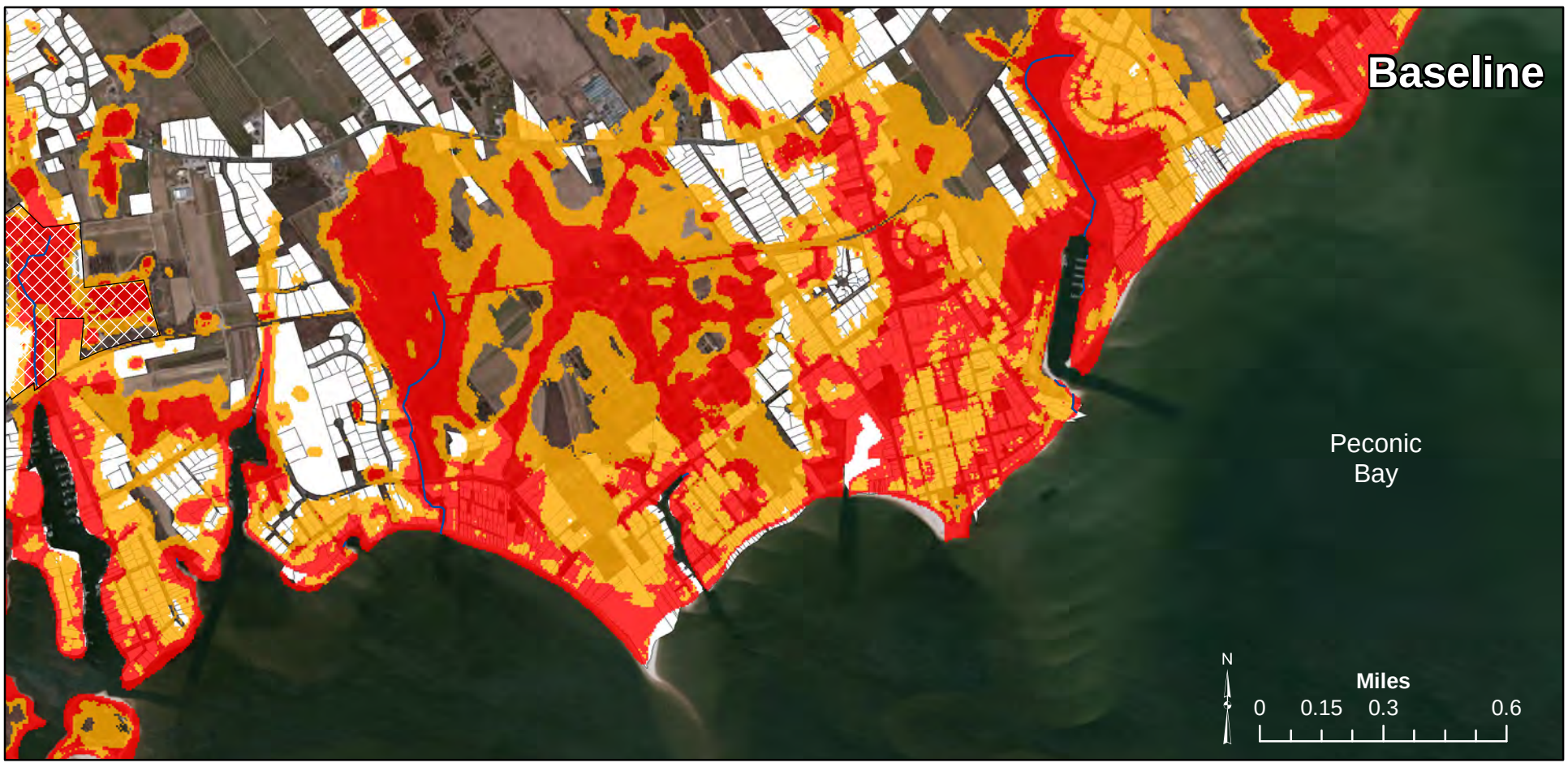
CDM Smith

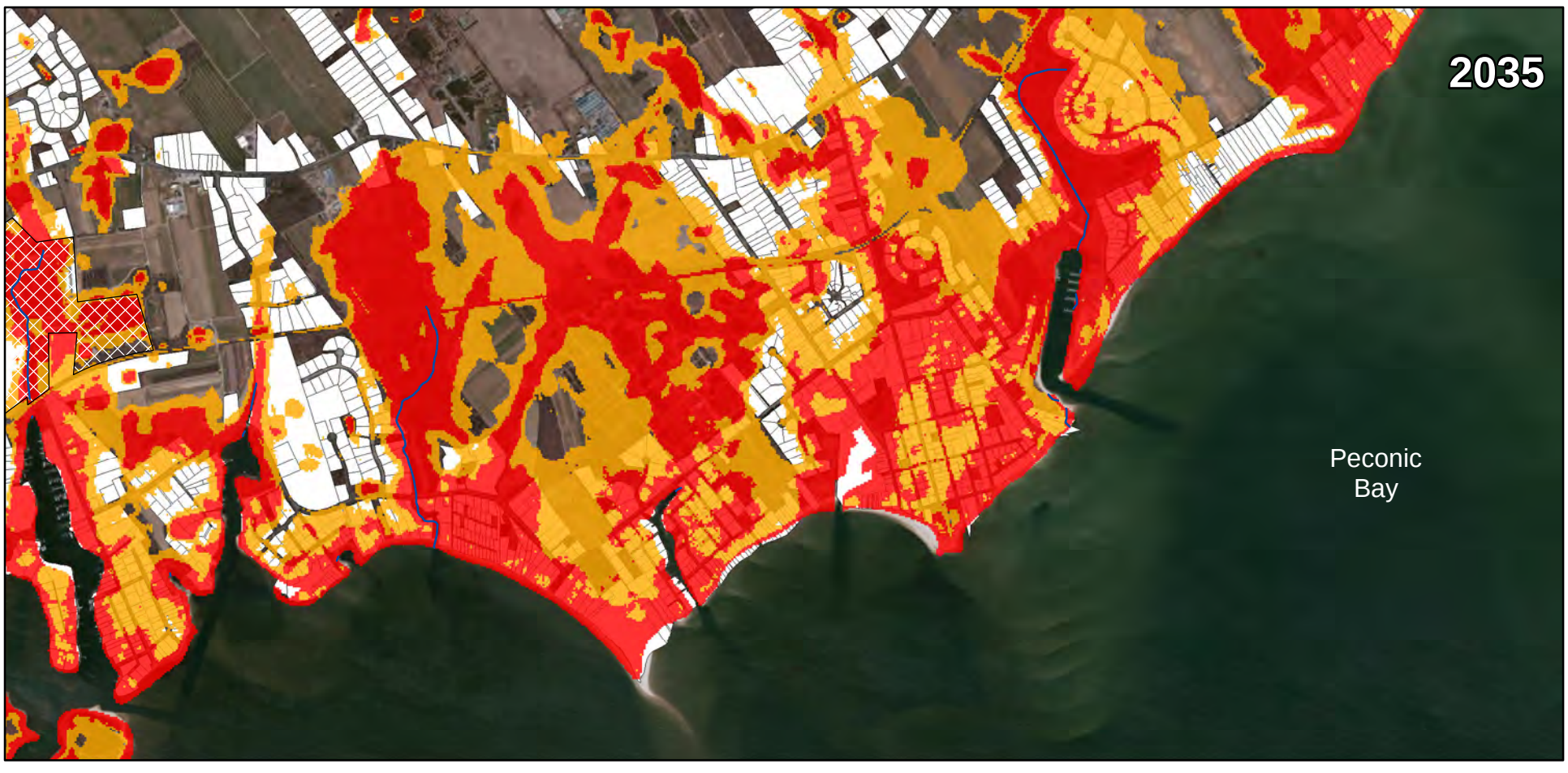
Simulated Depth to Groundwater on the North Fork Sea Level Rise of 34 Inches by 2100

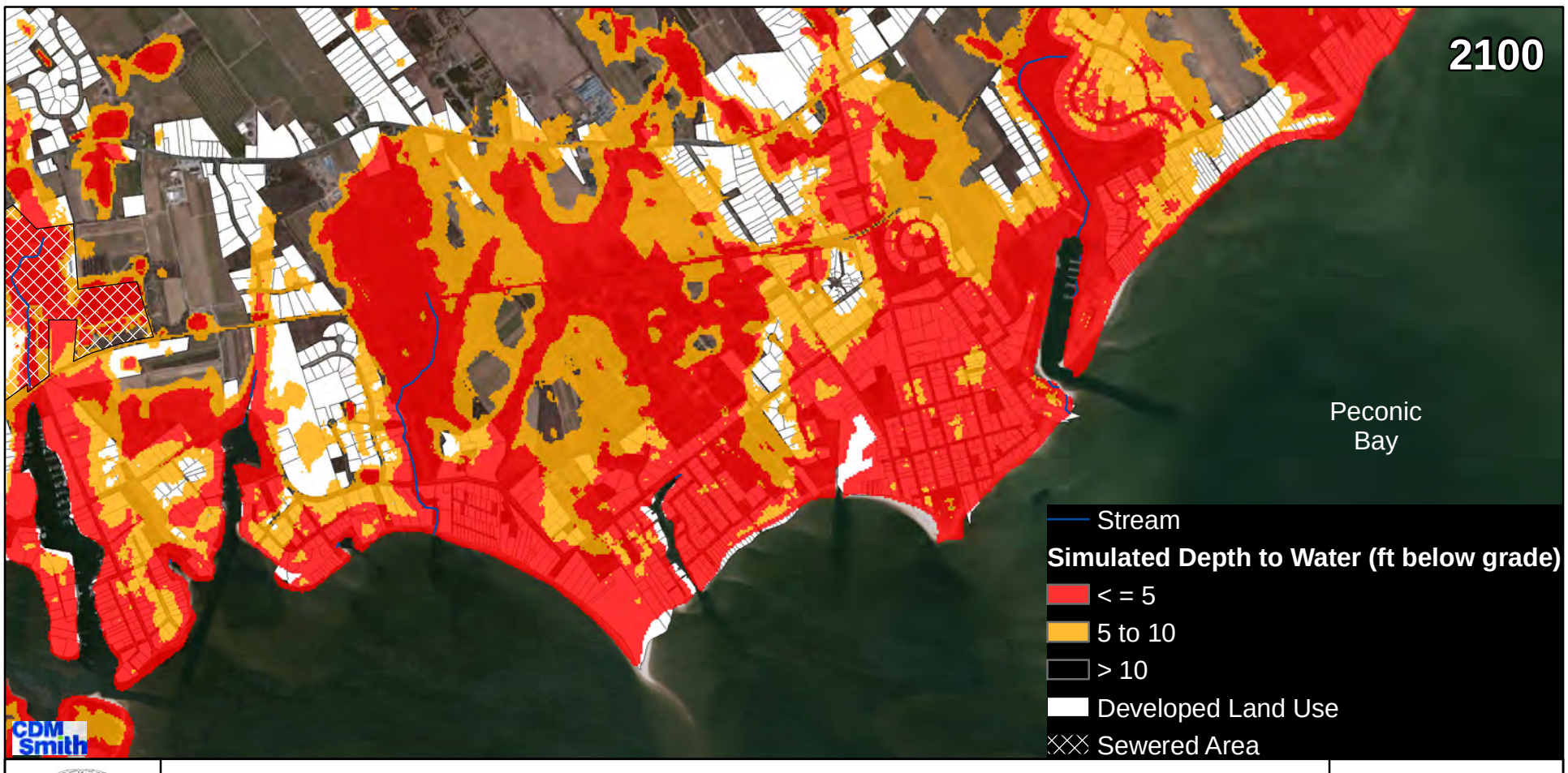
Suffolk County Comprehensive Water Resources Management Plan

Figure 8-22

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





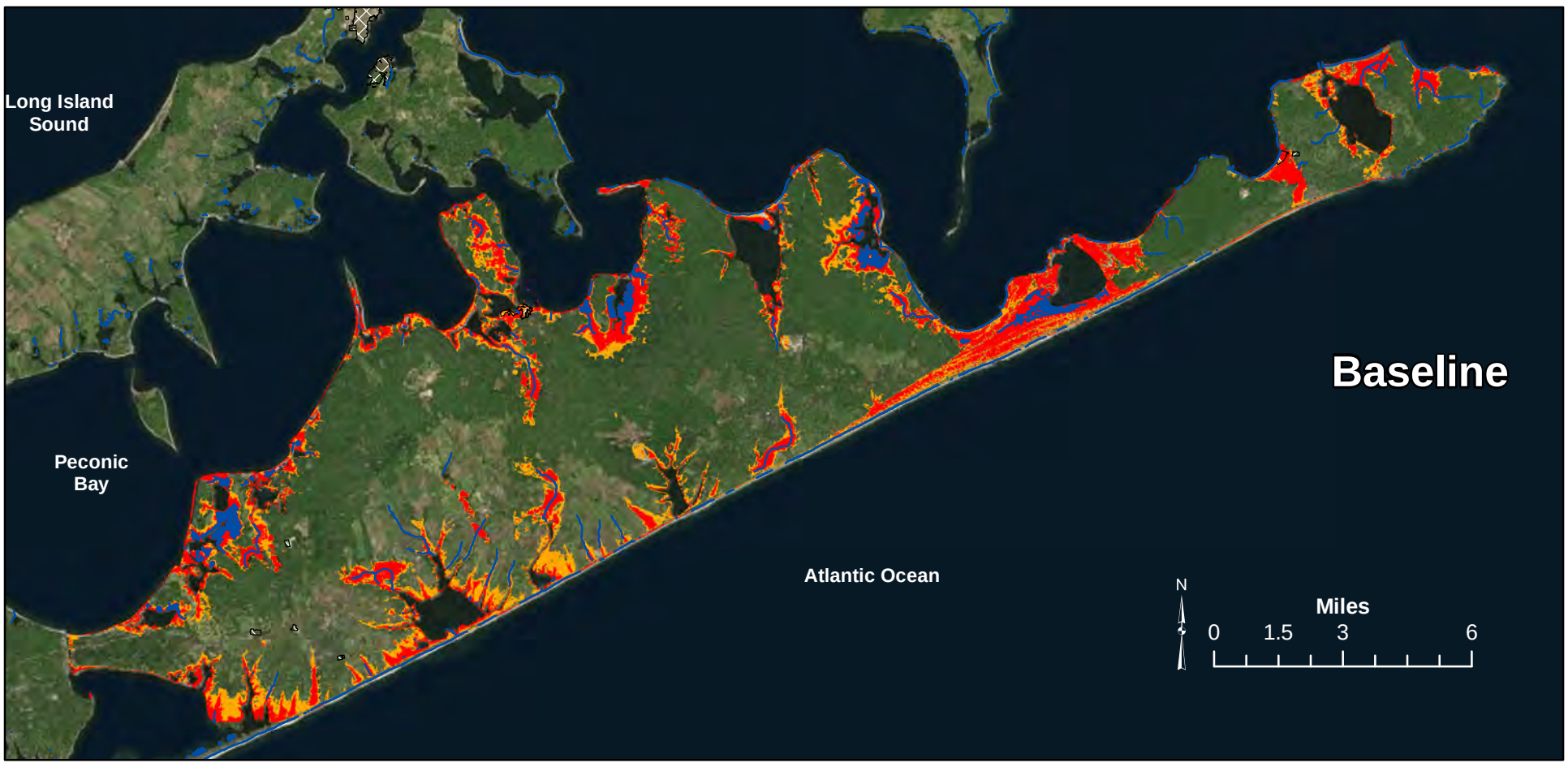


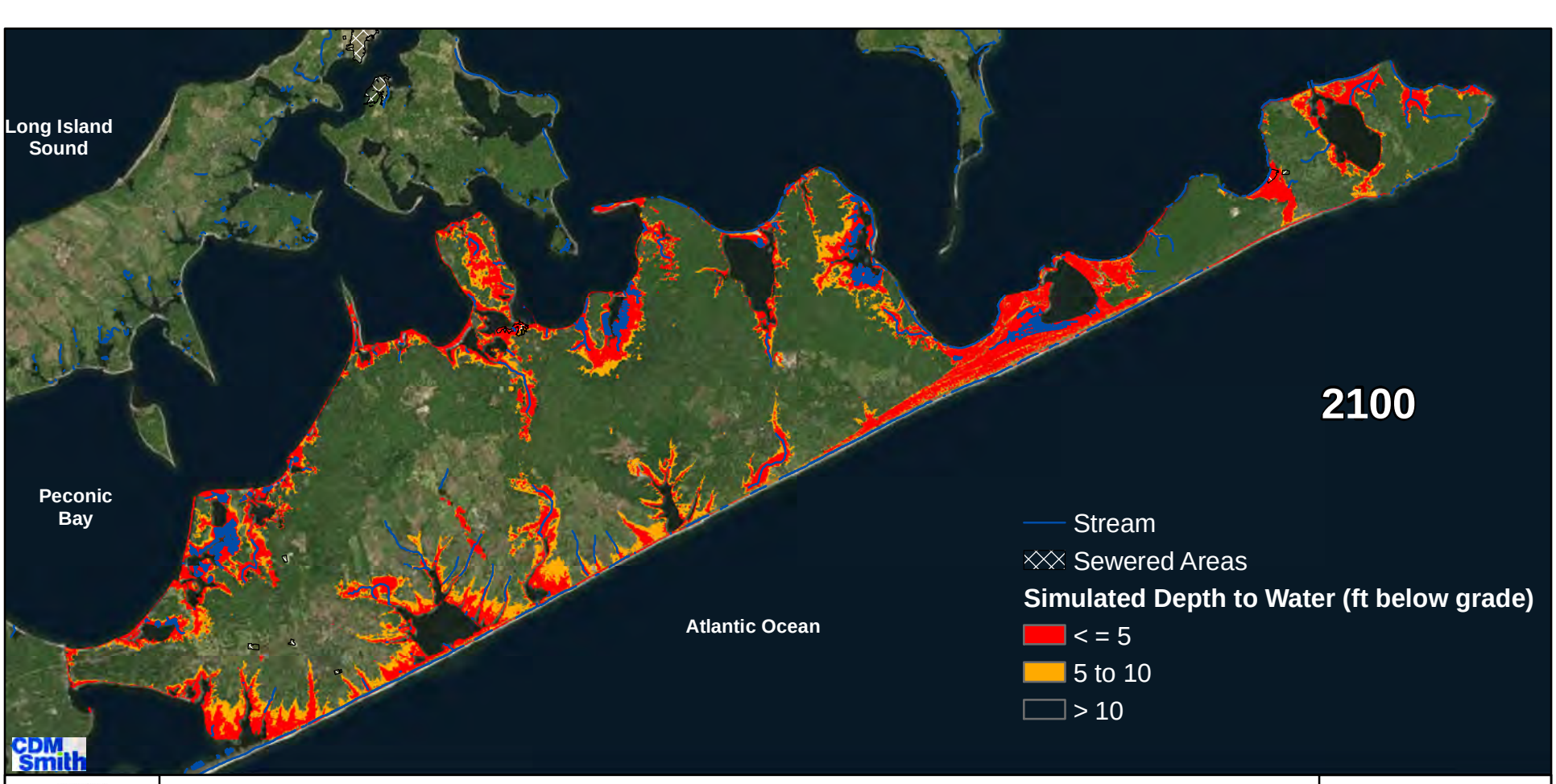
Impact of Rising Sea Level on Select Parcels on the North Fork
Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 8-23

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





Simulated Depth to Groundwater on the South Fork Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 8-24

8.1.5.1.4 Shelter Island

The simulated depth to groundwater on Shelter Island during sea level rise simulations is shown for baseline, 2035 and 2100 conditions on **Figure 8-25**. The Ram Island peninsula and areas surrounding West Neck Bay currently have a shallow depth to water in numerous locations, but these areas expand as sea level rises. By 2100, the depth to water throughout much of Little Ram Island and West Neck have is less than 10 feet. The area between the West Neck Bay channel and Menantic Creek as well as the western shore of Coecles Harbor near Congdons Creek are also at risk for shallow water table.

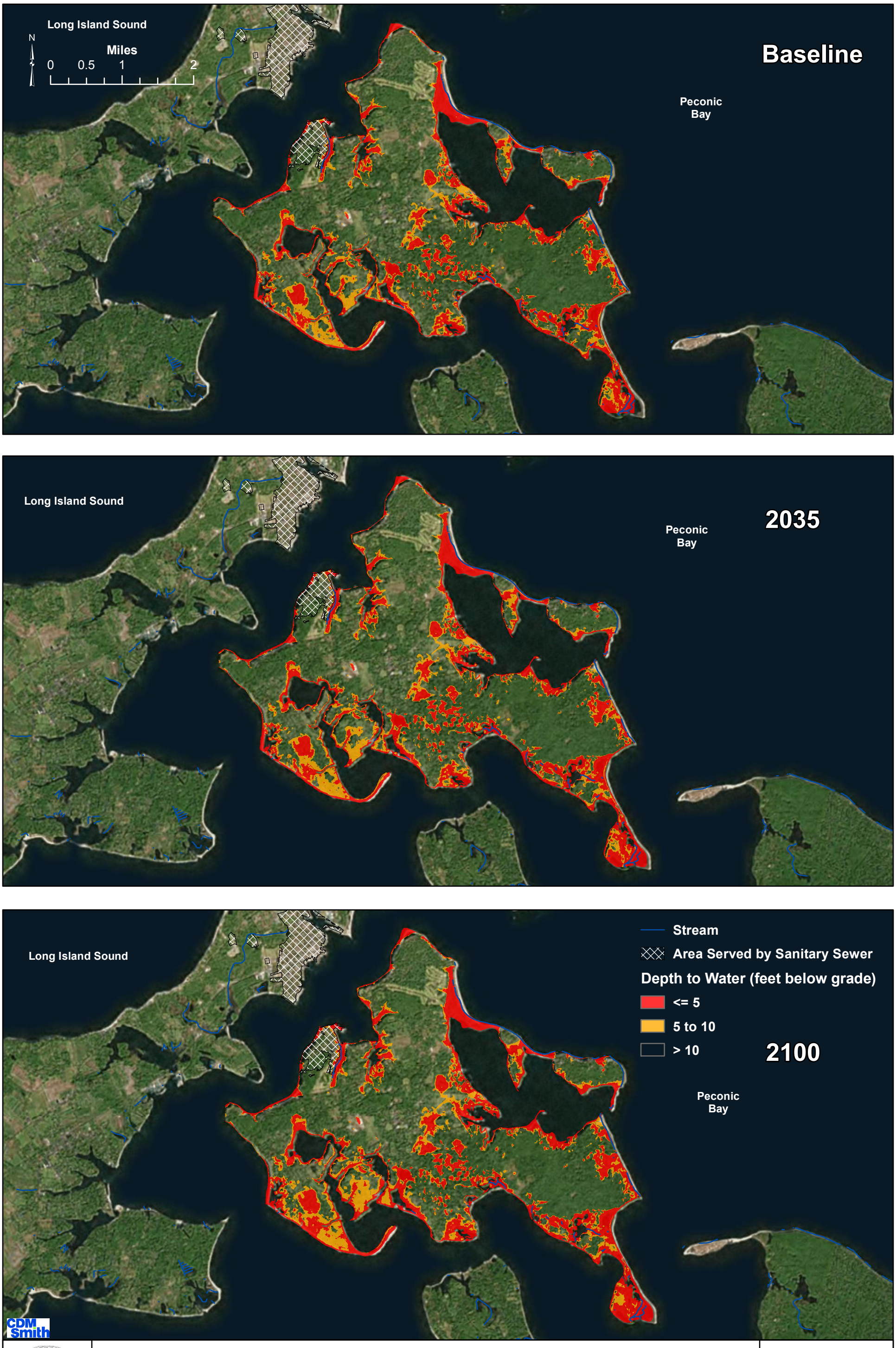
8.1.5.3 Summary

There are many areas along the coast that are currently developed where the existing depth to groundwater is less than 10 feet below grade. These areas also generally correspond with areas that are projected to be further impacted by rising sea level. It is possible that many of the systems within these areas are currently just above the seasonal high water table and may become flooded as sea-level rises in the future. This would not only reduce treatment capability of existing on-site treatment systems, but could completely eliminate the functionality of the system(s).

At greatest risk to elevated sea level are the communities along the south shore barrier island. Not only does the water table rise significantly, but much of the land area becomes flooded, similar to a wetland as the groundwater system adjusts to the rising sea level.

The groundwater table was simulated using long term average rates of precipitation and recharge and current (2013) conditions of water supply pumping. Considering that pre-1972 Suffolk County standards identified a minimum distance of one foot from the bottom of a cesspool to groundwater (providing nine feet from ground surface to the water table), and current standards identify a minimum distance of three feet (providing eleven feet from ground surface to the water table), the number of unsewered parcels where the depth to groundwater is less than ten feet were estimated, based on the simulated water table. On a County-wide basis, it is estimated that over 80,000 of the existing 360,000 unsewered parcels, or over 20%, are currently located in areas where groundwater is less than ten feet deep. These areas should be prioritized for evaluation of appropriate wastewater management alternatives. Shallow depth to groundwater that potentially compromises septic system effectiveness will be exacerbated with increasing sea level rise. Based on recent mid-range projections of sea level rise, it is projected that over 10,000 additional unsewered parcels (total of more than 90,000 parcels) may be located in areas where the depth to groundwater will be less than 10 feet by the turn of the century.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Simulated Depth to the Water Table on Shelter Island
Sea Level Rise of 34 Inches by 2100

Suffolk County Comprehensive Water Resources Management Plan

Figure 8-25

These estimates are based on mid-range estimates of sea level rise resulting from climate change models incorporating the greenhouse gas emissions resulting from "business as usual" and reasonable assumptions regarding precipitation and recharge. It is not reasonable to expect that sea level rise can be predicted to the turn of the century, as estimates of climate change and sea level rise are being re-evaluated and updated as new information becomes available. In addition, some climate change models predict increased precipitation over this part of the world, which will also affect these projections. Nonetheless, the information presented in this section is helpful in identifying the areas of potential concern, as well as the order of magnitude of change that could be expected in the decades to come.

8.1.6 Section Summary

Approximately 69 percent of the total nitrogen affecting our ground and surface water supplies emanates from wastewater, specifically onsite sewage disposal systems. Approximately 74 percent of Suffolk County is unsewered utilizing onsite sewage disposal systems with limited ability to reduce wastewater nitrogen. There are approximately 360,000 onsite sewage disposal systems located in Suffolk County with approximately 209,000 of these systems located in identified priority areas and an estimated 252,530 of the 365,00 pre-dating the requirement for a septic tank. Suffolk County has been experiencing population growth and is expected to reach 1.65 million residents by 2035.

Currently, nitrogen discharge from onsite wastewater treatment systems is regulated by lot size through the implementation of the Suffolk County Sanitary Code Article 6. Based on differences in regional hydrogeological and groundwater quality conditions, Article 6 delineated boundaries of the eight Groundwater Management Zones (GWMZ) for protection of groundwater quality. The Goal of creating the GWMZ was to limit groundwater nitrogen to 4 mg/l in GWMZ III, V, and VI and to 6 mg/l in the remaining zones. Many areas of Suffolk County were built before the Article 6 density restrictions or prior to conventional treatment system requirements. It is these many homes and businesses that are contributing to the pollution of groundwater in Suffolk County as well as the surface waters and ecosystems of the County.

Alternatively to meeting the density requirement of Article 6 of the Suffolk County Sanitary Code to protect water resources, connection to community wastewater treatment systems is an acceptable method of reducing nitrogen. Unfortunately only 26 percent of Suffolk County is connected to sewer systems. The last major expansion of sewers was the creation of the Southwest Sewer District and extension of sewers to existing homes and commercial buildings located within the district. This project was completed in the early

1980s and there has not been a sewer project of its kind in Suffolk County in over 30 years. Evidence has shown that sewering can help reduce nitrogen loads to surface waters, for example the average nitrogen in the Carlls River located by the SWSD was 3.2 mg/l in the 1970s and in the 2000s dropped to 1.8 mg/l. After Super Storm Sandy impacted structures along our coastline in 2012, the need for increased wastewater treatment to reduce nitrogen was realized to improve our valuable water resources. The first major sewer expansion in Suffolk County will occur through a funding reward of $383 million from New York State to install sewers and connect approximately 10,000 properties to sanitary sewer systems.

Innovative/alternative onsite sewage disposal systems, which have been proven in other jurisdictions to reduce wastewater nitrogen to 19 mg/l or less are currently being evaluated to reduce nitrogen discharges from on-site wastewater treatment systems. These types of systems would replace conventional onsite sewage disposal systems. In 2014, Suffolk County began its first demonstration project for I/A OWTS. The demonstration project is intended to provide field-testing and technology verification to determine if a particular I/A OWTS can function effectively in Suffolk County. In addition to nitrogen removal, anticipated rising groundwater and sea level elevation are of concern. Leaching pools are required at a minimum to be 2 feet above the groundwater table. Updated sea level rise projections indicate sea level will rise approximately 24 to 34 inches by the end of the century. Therefore, Suffolk County should review the separation distance between the bottom of leaching structures and groundwater by investigating shallow leaching systems, which may also provide additional nitrogen removal.

In addition to nitrogen, PPCPs are becoming additional contaminants of concern in wastewater discharges based on their potential impacts to ground and surface water resources. In recent years, very low levels of PPCPs, also sometimes referred to as pharmaceutically-active compounds (PhACs) or organic wastewater contaminants (OWC), have been detected in the environment. As most pharmaceuticals are designed to be water soluble, and to be persistent long enough to serve their designated therapeutic purposes, they can be present in dissolved form in receiving ground and surface waters. PPCPs are continuously introduced into the environment by sewage treatment plants and by on-site wastewater disposal systems (e.g., septic tanks and leach fields) in unsewered areas. Advanced treatment units whether sewage treatment plants or I/A OWTS have shown evidence of removing emerging contaminates of concern but further research is required.

In order to combat against the wastewater nitrogen impacting our water resources and maintaining a balance between protecting our water resources while maintaining our ability to dispose of wastewater to protect public health

and stimulate development in order to promote economic growth and stability, Suffolk County must implement a responsible wastewater management plan to limit the impacts of nitrogen from wastewater and other emerging wastewater constituents (personal care products, pharmaceuticals, etc.) on the County's water resources to preserve and protect these resources for future generations.

8.2 Goals and Objectives

In order to reverse the degradation of our water resources and to create a process to improve and protect our groundwater and surface water quality for future use over an anticipated timeline, Suffolk County must develop a well-defined and organized wastewater management plan. The wastewater management plan shall address wastewater pollution emanating from the approximately 360,000 onsite sewage disposal systems and handful of remaining secondary sewage treatment plants located within Suffolk County. The basis of the plan shall be to address the goals and objectives outlined in this section.

8.2.1 Goals to Meet Water Quality Initiatives

8.2.1.1 Direct Wastewater Effluent Discharge Goals

Goal 1: Improve groundwater quality to maintain a potable water supply to serve existing and future populations by reducing effluent nitrogen loads from existing and future onsite sewage disposal systems and sewage treatment plants.

Goal 2: Improve surface water quality to increase coastal resiliency and rehabilitate and maintain a vibrant coastal ecosystem by improving dissolved oxygen levels, reducing harmful algal blooms, and controlling nutrient levels through the reduction of effluent wastewater nitrogen loads from existing and future onsite sewage disposal systems and sewage treatment plants.

Goal 3: Reduce and/or eliminate the impacts of pharmaceuticals and personal care products from wastewater effluent for increased public health and marine life protection.

8.2.1.2 Indirect Goals Attributed to Direct Wastewater Effluent Discharge Goals

Goal 4: Provide development opportunities for continued economic growth to support future population growth while limiting wastewater nitrogen discharge.

Goal 5: Improve operations and maintenance of onsite sewage disposal systems and sewage treatment plants to maintain compliance with effluent

nitrogen limits and achieve more stringent discharge goals where feasible and appropriate to protect ground/surface waters.

Goal 6: Provide funding sources to the residents of Suffolk County to permit affordable upgrades to existing onsite sewage disposal systems or connection to community sewers.

Goal 7*:* Promote the reuse of effluent wastewater for irrigation and grey water uses to preserve the volume of potable groundwater water supply to serve anticipated future population growth.

8.2.2 Objectives to Meet Water Quality Initiatives

8.2.2.1 Wastewater Management Plan Implementation Timeline to Meet Goals

Objective 1: Suffolk County shall follow the subsequent proposed timeline to meet the wastewater water quality goals

> 2015 – 2017: Initiate development and implementation of a wastewater management plan to reduce nitrogen loads to ground and surface waters
>
> 2018-2035: Full-scale implementation of the wastewater management plan to reduce nitrogen loads via upgrading onsite sewage disposal systems to I/A OWTS or connecting parcels to sewers.
>
> 2035 and beyond: Continue on-site sanitary system upgrades and/or parcel connections to community sewers in the high priority areas. The total nitrogen load to ground and surface waters is reduced as onsite sewage disposal systems are upgraded or connected to sewers.

As the Plan is implemented, the County shall re-evaluate the wastewater management plan to refine and update the plan to meet the water quality goals and objectives (e.g. 5 year evaluation, 10 year evaluation, etc.)

8.2.2.2 Sewering Objectives to Meet Wastewater Goals

Objective 2: Suffolk County shall clearly identify and prioritize tax parcels to be connected to community sewers (centralized or decentralized) to reduce the nitrogen load to ground and surface waters.

Objective 3: Suffolk County shall determine the sewage treatment plant capacity requirements to permit the connection of identified parcels to an existing, expanded, or new sewage treatment plants/districts.

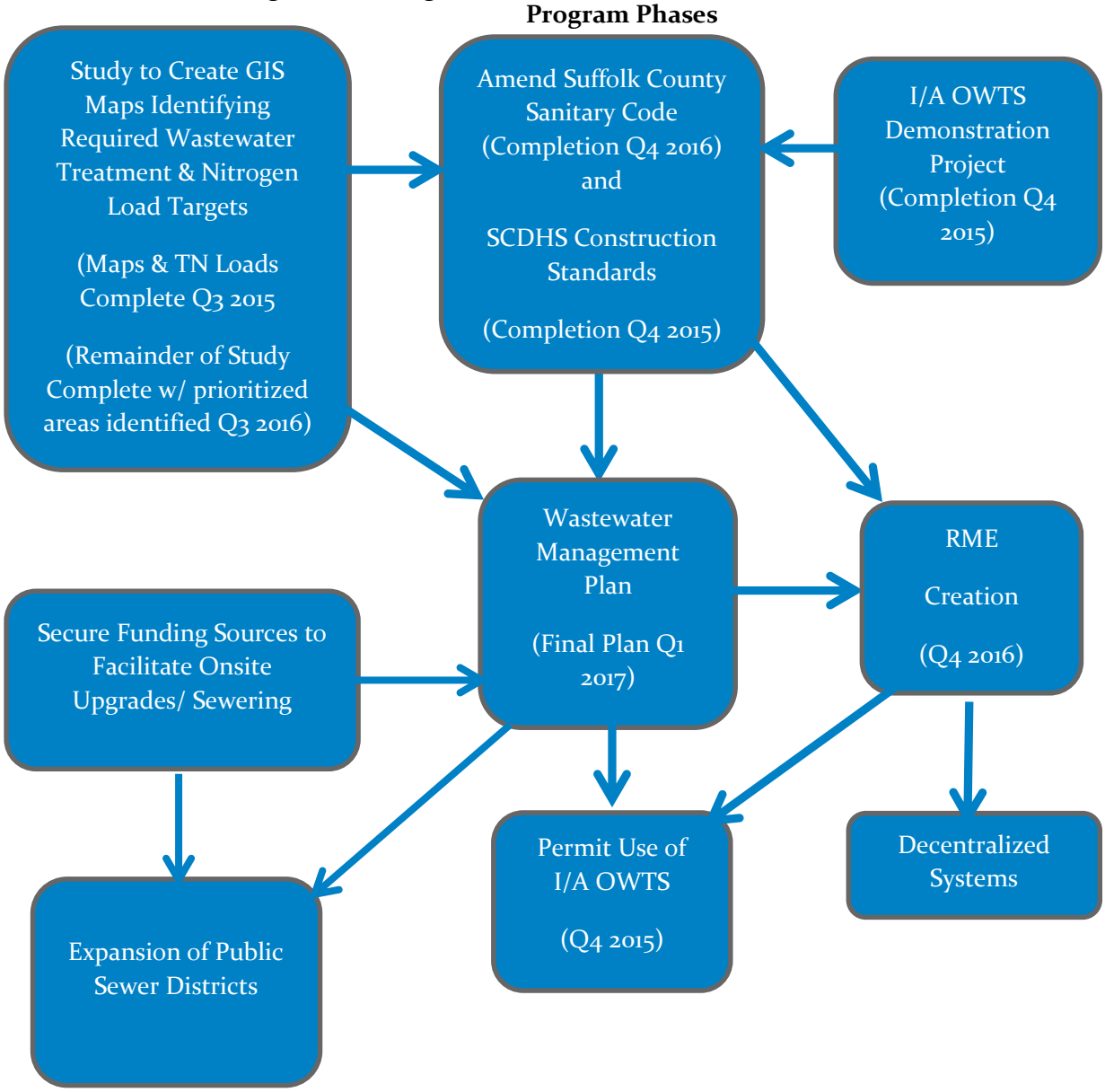
Objective 4: Suffolk County shall continue to identify and implement new sewage treatment technologies to improve wastewater effluent quality to

reduce impacts to ground and surface water resources and for permitting water reuse.

Objective 5: Suffolk County shall create and/or determine funding sources and costs associated with meeting sewering objectives:

i. To expand and/or create new sewer districts (e.g. sewer extensions, construction of new sewage treatment plants, expansion of existing sewage treatment plants, etc.)
ii. To improve existing sewage treatment plant technologies
iii. For staffing, permitting, enforcement, and operations and maintenance of sewer districts

Figure 8-26 Diagram of Timeline and Interconnections between Program Phases



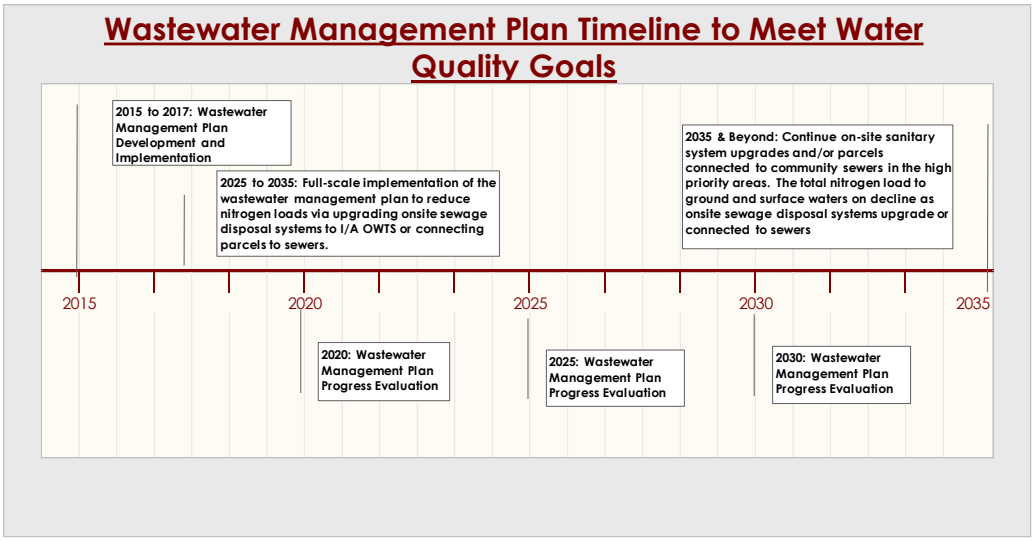


Figure 8-27 Wastewater Management Timeline

8.2.2.3 On-Site Wastewater Treatment System Objectives to Meet Wastewater Goals

Objective 6: Suffolk County shall clearly identify and prioritize tax parcels that shall be required to install an I/A OWTS to reduce the nitrogen load to ground and surface waters.

Objective 7: Suffolk County shall adopt regulations and standards to permit and/or require the use of I/A OWTS capable of reducing effluent wastewater nitrogen to 19 mg/l or less.

Objective 8: Suffolk County shall create and develop an onsite sewage disposal system technology evaluation program to simplify the approval process of various on-site sewage treatment technologies for use within Suffolk County to reduce wastewater impacts to water resources. Such systems for evaluation shall be, but not limited to, treatment systems, leaching systems, water reuse systems, etc.

Objective 9: Suffolk County shall evaluate the feasibility of adopting rules and regulations requiring the upgrading of existing onsite sewage disposal systems to conventional onsite sewage disposal systems or I/A OWTS under an established schedule based on location within Suffolk County to promote the protection of public health and marine life.

Objective 10: Suffolk County shall evaluate amending the Suffolk County Sanitary Code Article 6 to revise Groundwater Management Zone 4 density

requirements to conform to Groundwater Management Zones 3, 5, and 6 to improve groundwater protection in the zone and improve surface water quality in the Peconic Estuary.

Objective 11: Suffolk County shall determine a required pump-out schedule for I/A OWTS to ensure the proper operation of the system to meet effluent nitrogen parameters. In addition, Suffolk County shall determine the required scavenger plant capacity to permit system pump-outs based on an established schedule.

Objective 12: Suffolk County shall create a Wastewater Management District with a Responsible Management Entity (RME) to oversee the financing, operation, maintenance, and enforcement of I/A OWTS and decentralized sewer system programs.

Objective 13: Suffolk County shall create and/or identify funding sources and costs to meet onsite sewage disposal system objectives:

i. To create financing/funding options for the upgrade or repair existing onsite sewage disposal systems
ii. To review and approve new onsite sewage disposal system technologies to enhance wastewater treatment
iii. For the creation and operation of a Responsible Management Entity
iv. To provide the Suffolk County Department of Health Services Office of Wastewater Management with staffing and equipment required to facilitate the wastewater management plan

8.2.3 Section Summary

With approximately 360,000 onsite sewage disposal systems located in Suffolk County the nitrogen emanating from these systems must be addressed to protect the County's valuable water resources. Nitrogen from onsite sewage disposal systems has been identified as one of the culprits degrading our water resources. The County established Suffolk County Sanitary Code Article 6 to control nitrogen discharge from onsite sanitary systems by requiring minimum lot sizes when building residential or commercial structures. The implementation of the Suffolk County Sanitary Code Article 6 has been mostly effective in cases where the minimum lot size requirements have been followed. Unfortunately there are many smaller parcels that predate the enactment of the Suffolk County Sanitary Code Article 6, which utilize onsite sewage disposal systems that negatively impact our water resources.

Suffolk County has prioritized the reduction of nitrogen from wastewater impacting ground and surface water resources. In order to tackle this problem, a set of goals and objectives have been established to guide Suffolk County in

the preparation of a wastewater management plan to address excess nitrogen from onsite sewage disposal systems and the handful of secondary sewage treatment plants that remain in the County. These goals require the County to reduce wastewater effluent nitrogen from onsite sewage disposal systems and sewage treatment plants to preserve and protect our ground and surface water resources for its existing residence and future population growth. To attain these goals a set of objectives have been defined for sewering and onsite sewage disposal systems with a hypothetical timeline for development, implementation, and reversal of nitrogen trends. Some of these objectives included prioritizing areas for sewering or installation of I/A OWTS, evaluation and implementation of new technologies for sewering and onsite sewage disposal systems, development of a responsible management entity to oversee an I/A OWTS program, and revising the Suffolk County Sanitary Code Article 6 to amend the requirements for groundwater zone IV. These goals and objectives shall be the basis for formulating a responsible wastewater management plan to address nitrogen impacts (and other wastewater effluent constituents) to Suffolk County's water resources.

8.3 Recommendations

To create an effective wastewater management plan for Suffolk County based on the goals and objectives outlined in Section 8.2 four major areas must be addressed. These areas are:

- Establishment of nitrogen loads for watersheds,
- Improvement of onsite sewage disposal system technologies,
- Expansion and/or creation of new Suffolk County operated sewer districts, and
- Creation of privately-run decentralized sewer districts.

8.3.1 Establish Wastewater Nitrogen Load Targets for Sub-Watersheds and Public Water Supply Well to Maintain and Improve Water Quality

The Suffolk County Sanitary Code Article 6 was implemented for the primary purpose of groundwater protection. The intent of Article 6 was to limit groundwater nitrogen concentrations to 4 mg/l in groundwater management zones 3, 4, and 5 and 6 mg/l in the remaining groundwater management zones. This was to be accomplished by requiring minimum lot sizes in each groundwater management zone, as stated in section 8.1, when utilizing an onsite sewage disposal system. Unfortunately there are many lots that predate the enactment of Article 6, which are the major cause of the degradation of

ground and surface water quality. In addition, Article 6 did not directly address maintaining surface water quality.

It is recommended that Suffolk County establish specific nitrogen load targets for each of the sub-watersheds and public water supply wells located in and around the County in addition to maintaining the minimum lot size requirements established under Article 6. The creation of these targets shall take into account the need to improve drinking water quality, improve coastal resiliency, decrease harmful algal blooms, revitalize fin and shell fisheries while supporting future population growth. These load targets shall provide the basis for the County to determine the specific level of wastewater nitrogen reduction required for maintaining and improving the water quality of ground and surface water resources. The nitrogen load reduction targets will enable the County to determine the types of wastewater treatment required to be installed to meet these targets such as connecting unsewered lots to community sewage disposal system capable of reducing nitrogen to 10 mg/l or less, installing I/A OWTS capable of reducing nitrogen to 19 mg/l, or permitting the use of conventional onsite sewage disposal systems. In conjunction with determining required wastewater treatment, Suffolk County should review the minimum lot size requirements for Groundwater Management Zone 4.

8.3.1.1 Create a GIS Based Wastewater Treatment Map Defining Wastewater Treatment Options for Suffolk County Based On Established Nitrogen Load Targets

After the nitrogen load targets have been established for each of the sub-watersheds and public water supply wells, boundaries of each area should be created defining the acceptable means of wastewater treatment to meet the established nitrogen load targets, considering effluent nitrogen requirements, distance to existing sewer districts, depth to groundwater, soil conditions, distance to surface waters, SLOSH zones, and FEMA flood zones. As an example, the methods of wastewater treatment could be grouped into six categories based on required effluent nitrogen limits according to **Table 8-18**. Categories A1, B1, and C are minimum wastewater requirements to meet effluent nitrogen target loads. Categories A2, A3, and B2 are increased treatment requirements due to high groundwater conditions, location within SLOSH or FEMA flood zones, distance to sewers, etc.

A GIS map should be created depicting each area with recommended category rating to enable property owners and Suffolk County to ensure the proper type of wastewater treatment is proposed and installed for existing or new construction to reach the desired nitrogen target loads to meet water quality goals.

Table 8-18 Example of Wastewater Treatment Categories Based on Future Study to Establish Nitrogen Load Targets

Category	Minimum Effluent Nitrogen Requirement	Minimum Wastewater Treatment Option
A1	Wastewater Nitrogen Effluent > 30mg/l	Conventional Onsite Sewage Disposal System
A2		Innovative/Alternative Onsite Sewage Disposal System
A3		Community Sewage Treatment (Centralized or Decentralized)
B1	Wastewater Nitrogen Effluent <30mg/l & >10mg/l	Innovative/Alternative Onsite Sewage Disposal System
B2		Community Sewage Treatment (Centralized or Decentralized)
C	Wastewater Nitrogen Effluent <10mg/l	Community Sewage Treatment (Centralized or Decentralized)

8.3.2 Implement an On-Site Sanitary System Upgrade Program and Sewage Treatment Plant Upgrade Program

There are approximately 360,000 onsite sewage disposal systems located within Suffolk County, which contribute approximately 69% of nitrogen load to ground and surface waters in the County. It has been estimated that over 250,000 residential onsite sewage disposal systems pre-date the requirements for septic tanks and precast leaching pools, which means there are many existing onsite sewage disposal systems within Suffolk County consisting of a cesspool, which provides the bare minimum wastewater treatment. In addition, block cesspools are prone to collapse under certain conditions such as during periods of heavy rain. For example, during a period of heavy rain, soils around a cesspool swell and may place unwanted pressure on the walls of a cesspool, if the cesspool is empty and constructed of block or precast cesspool without steel reinforcement then the pressure can cause the cesspool to collapse as shown on **Figure 8-28**.

Figure 8-28 Picture of a Collapsed Cesspool

Another issue with onsite sewage disposal systems installed prior to the enactment of standards requiring precast reinforced septic tanks and leaching pools is that early residential construction standards (prior to 1972) permitted cesspools to be placed a minimum of 1 foot above ground water elevation. Since the implementation of these standards groundwater elevations in Suffolk County have risen and are predicted to rise approximately 3 feet by the end of the century, therefore placing cesspool originally installed 1 foot above the groundwater table in groundwater. This creates a direct flow path of contaminants such as pathogens into groundwater impacting drinking water and surface water resources.

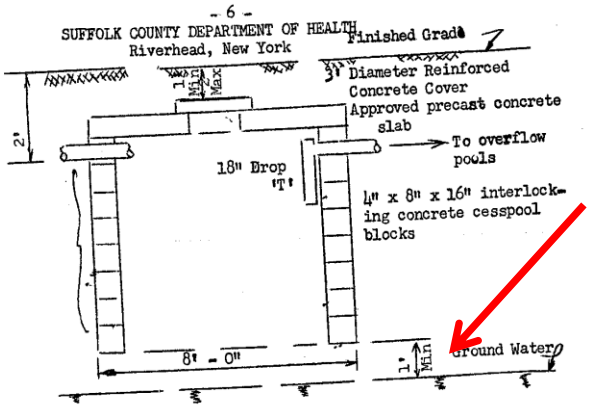


Figure 8-29 SCDHS Leaching Pool Detail with Requirement to Maintain 1 ft above Groundwater Prior to 1972

One final issue with cesspools and conventional onsite sewage disposal systems is that they provide minimal wastewater nitrogen reduction. These types of systems are major contributors to the nitrogen load impacting our water resources in areas where they are utilized on small lots that pre-date the enactment of the Suffolk County Sanitary Code Article 6.

To protect and improve our water resources, it is recommended that Suffolk County assess the feasibility of adopting an onsite sewage disposal upgrade program to expedite the upgrading of existing onsite sewage disposal systems to protect public health from injury due to a collapsed cesspool, to improve public health, and to improve and protect our water resources. A number of jurisdictions throughout the United States have implemented these types of programs. A team from Suffolk County visited leaders from the Maryland Department of Environment, New Jersey Pinelands Commission, University of Rhode Island New England Onsite Wastewater Training Program, and Barnstable County Department of Health Massachusetts Alternative Septic Systems Test Center. Each of these areas have onsite sanitary system upgrade programs, which are outlined in the "Advanced Wastewater & Transfer of Development Rights Tour Summary" report issued by the Suffolk County Departments of Economic Development & Planning, Health Services, and Public Works included in Appendix G.

One type of upgrade requirement, which is already in place in Suffolk County, is the requirement to upgrade a sanitary system when additions to dwellings are proposed. Based on the previous five years of applications, if Suffolk County were to solely depend on this requirement to upgrade sanitary systems there would be only approximately 242 sanitary upgrades to I/A OWTS per year based on addition applications processed by the SCDHS (See **Table 8-19**). This would reduce total nitrogen in Priority Areas by 12.1 lbs./per day assuming 300 gpd/property based on SCDHS standards and 39 mg/l effluent from a conventional system compared to 19mg/l total nitrogen effluent from an I/A OWTS.

The most common upgrade program instituted in the jurisdictions visited were upgrades of onsite sewage disposal systems at the time of property transfer. New Jersey requires sanitary systems with cesspools to be upgraded at the time of property transfers to a conventional septic system. An area not visited, Macomb County, Michigan requires an evaluation report to be submitted to the Health Department prior to property transfer. If the Department determines the system is failing then the property owner must submit a remedial action plan to bring the system into compliance.[13] Bringing a system into compliance could be a minor repair, complete replacement of the system to conforming system, or connection of the property to public sewers.

Table 8-19 Predicted SCDHS I/A OWTS Applications for Additions to Existing Dwellings

Estimated SCDHS Sanitary Upgrade Applications Due to Addition to a Dwelling						
Year	2009	2010	2011	2012	2013	Notes: Estimated % Priority Systems [209000/360000]-= 0.58 or 58% Estimated % of Applications that are not constructed =0.55 or 85%
Number of Upgrade Applications Submitted to SCDHS	496	522	500	456	484	
Yearly Average	491					
Adjusted Average For I/A OWTS Upgrades in priority Areas	**242**					
(491 average addition applications per year) x .85 x .58 = 242 (See Notes)						

A second common onsite sewage disposal system upgrade program is the requirement to upgrade an onsite sewage disposal at the time of failure. Another jurisdiction not visited is Oneida County, Wisconsin, which requires inspection of onsite sewage disposal systems every three years. Per their "Oneida County Private Onsite Wastewater Treatment Systems Ordinance" they define minor repairs, which do not have to be approved by the department, and major repairs, which have to be reviewed by the department. Major repairs can range from connecting a property to sewers, replacing a leaching field, or complete upgrade of a system. [14]

A third type of program is a cesspool phase out program mandating that sites utilizing existing cesspools be upgraded. Rhode Island enacted a Cesspool Phase-Out Act in 2007 requiring all existing parcels utilizing cesspools to be upgraded with a new onsite wastewater treatment system or connected to a sewer system by 2014. Cesspools located within the Special Area identified by Rhode Island's Coastal Resources Management Council were required to be upgraded to nitrogen reducing system.

Suffolk County should investigate the feasibility of implementing our own onsite sewage disposal system upgrade program to expedite the upgrading of systems to protect and improve ground and surface water resources. Upgrade programs should be a combination of the programs above. This will enable

properties not located in an identified priority area to be upgraded from cesspools to conventional onsite sewage disposal systems to meeting current standards, and accelerate the upgrading of properties located in priority areas to be upgraded to an I/A OWTS or connected to sewers. For example, **Table 8-20** estimates the number of upgrades of existing sanitary systems in priority areas to I/A OWTS at the time of Property Transfer. Based on the figure, there could be approximately 2,573 I/A OWTS installed at the time of property transfers per year reducing the total nitrogen load in priority areas by 129 lbs./per day assuming 300 gpd/property based on SCDHS standards and 39 mg/l effluent from a conventional system compared to 19mg/l total nitrogen effluent from an I/A OWTS.

Table 8-20 Predicted SCDHS I/A OWTS Applications for Existing Dwellings at the Time of Property Transfer

Example of Number of Onsite Sewage Disposal System in Suffolk County That May Be Required to be Upgraded Per Year in Priority Areas at Property Transfer				
SC Home Sales (non-Condo)	**2011**	**2012**	**2013**	**Notes:** Estimated % Priority Systems [209000/360000]- = 0.58 or 58% Estimated % Sub-Standard Systems (from Fig. x) [252530/360000] =0.70 or 70% Estimated % Unsewered = 74% SCDHS Final 3 Year Avg. (1397 + 1200 + 1328)/3 = 1308 (Includes Condo's and therefore 1308 is an overestimate)
	9,460	10,735	9431	
Average Home Sales for 3 Year period	9875			
Average SCDHS Residential Construction Permits Issued Final During the same 3-year period	1308			
Number of Homes In Priority Areas Requiring Sanitary System Upgrade At the Time of Transfer Per Year		**2573** (See Below)		
Assumes 74% parcels unsewered, 58% systems priority systems, 70% systems are sub-standard – See Notes				
[9875-1308] x .74 x .58 x .70 = 2537 upgrades per year				
Housing data from www.tax.ny.gov				

If upgrades of sanitary systems at the time of an addition of bedrooms and property transfer were both used to upgrade onsite sewage disposal systems to I/A OWTS then approximately 2,815 systems would be upgraded. This would result in a total reduction of nitrogen loading of 140.8 lbs./per day assuming 300 gpd/property based on SCDHS standards and 39 mg/l effluent from a conventional system compared to 19mg/l total nitrogen effluent from an I/A OWTS.

8.3.3 Onsite Wastewater Treatment System Technologies

There are many existing onsite sewage disposal system technologies that have been modified over the years and new onsite sewage disposal system technologies that have been brought to market to improve wastewater treatment. These types of systems will enable Suffolk County to combat against wastewater nitrogen pollution, treat for emerging contaminants of concern in wastewater, and protect against sea and ground water level rise. These systems include advanced treatment units and leaching systems. Historically the main components of an onsite septic system were the septic tank and leaching field. Septic tanks are designed to reduce suspended solids and provide a small degree of BOD reduction. Leaching systems provide the means for septic tank effluent to be disposed into the ground. Newer types of treatment systems have been designed to increase the reduction of BOD and nitrogen. These types of systems are considered advanced treatment units. Advanced treatment units combined with septic tanks (if required) and leaching systems are considered to be innovative/alternative onsite sewage disposal systems. It should be noted that some types of leaching fields are under investigation for nitrogen removal capabilities, which will be discussed in section 8.3.3.2. It is recommended that Suffolk County develop an active program as part of their wastewater management program to begin requiring I/A OWTS in identified priority areas.

8.3.3.1 Develop an Innovative/Alternative Onsite Wastewater Treatment System Program

As part of the wastewater management plan Suffolk County should implement an I/A OWTS program to promote the use of nitrogen removing sewage disposal systems to serve single-family, multi-family, and commercial buildings where community sewers are not available in identified priority areas or for property owners wishing to install them in non-priority areas. These types of systems usually are mechanical systems containing pumps and/or blowers to assist in the treatment of wastewater to reduce suspended solids, BOD, and nitrogen. Evidence indicates that some advanced treatment systems also reduce and/or remove some contaminants of emerging concern.

Maintenance of I/AWTS is essential in ensuring their continued ability to reduce nitrogen.

Suffolk County should take the following action steps to develop an I/A OWTS program:

1. Develop a pilot program to evaluate I/A OWTS systems on an experimental basis in Suffolk County to gather information on effluent quality, installation, and operation, and maintenance requirements before full scale implementation of these types of systems are permitted. Many jurisdictions that permit the installation of I/A OWTS such as Maryland and Rhode Island have piloting programs in place.

   The Maryland Department of Environment (MDE) established the Best Available Technology (BAT) Verification Program to review proposed I/A OWTS. An application is submitted to Maryland Department of Environment. The BAT Review Committee, comprised of the Bay Restoration Fund (BRF) chair, the division chief of MDE and county represented, evaluates 3rd party evaluation/certification's test methods, independent performance evaluations and test results to verify the vendors' claim. If the Committee accepts the claims then provisional technologies enter a Field Verification Process. Twelve systems plus three reserve systems may be installed during the field verification process and must be sampled four times each year with a minimum of 1 winter sample. The average total nitrogen concentration in the effluent must be below 30 mg/l. After passing the Field Verification Process a final report with sample results is submitted to the BAT review committee for evaluation. If the committee accepts the report then the system is classified as "Best Available Technology, Field Verified".[15]

   Rhode Island implemented the Rhode Island Onsite Wastewater Demo Projects, 1996 to 2005, conducted by the New England Onsite Wastewater Treatment Center (NEOWT). The knowledge gained from the project was transferred to the Department of Environmental Management (DEM), which helped with policy/rule revisions. The demonstration project was a series of five demonstration projects in seven communities. They installed 58 demonstration systems on sites with failed septic systems. Sites were selected using a lottery for homeowners that had failed septic systems. The program provided reduced costs or no costs to owners for a 3-year access period, to allow

staff to install, test, and maintain systems. Labor was provided gratis as means of developing expertise in the installation of new technologies. Today alternative treatment systems are approved for use by the RI DEM. New alternative treatment systems can be approved by the RI DEM as nitrogen reducing systems per the DEM Onsite wastewater treatment (OWTS) rules governing pilot systems.[15]

Suffolk County is in the process of conducting an I/A OWTS demonstration project for single-family dwellings. Suffolk County initiated the demonstration program by issuing a Request for Expressed Interest (RFEI) in April, 2014. The demonstration permits the installation of two types of I/A OWTS. The first type of system are those certified by the USEPA Environmental Technology Verification Program ("ETV") or the National Sanitation Foundation/American National Standards Institute (NSF/ANSI) Standard 245 testing program ("NSF 245") to be demonstrated on a limited number of private residential properties. The second type of system includes systems not yet certified by ETV/NSF 245 for testing on County municipal property which will require the authorization of the County Legislature.

The demonstration program is intended to provide field-testing and technology verification to determine if a particular alternative technology can function effectively in Suffolk County. A technology may only be approved when the SCDHS has determined, based on relevant technical data, that the proposed alternative is capable of a level of environmental protection at least equivalent to that of a system designed in accordance with the Suffolk County Sanitary Code Article 6, and other applicable state or local provisions.

Suffolk County accepted four manufacturers to participate in the demonstration program. These manufacturers and systems are provided in **Table 8-5.** The manufacturers have committed to installing a total of 19 demonstration systems on residential properties located throughout Suffolk County through a lottery setup by the County. Suffolk County selected the nineteen properties in 2014 and expects installation of the demonstration systems by the spring of 2015. The treatment systems to be installed are the Norweco Singulair TNT (**Figure 8-33**), Norweco Hydro-Kinetic 600 FEU (**Figure 8-34**), Busse MF 400 (**Figure 8-35**), Orenco Systems AdvanTex AX20 (**Figure 8-36**), Orenco Systems AdvanTex AX-RT (**Figure 8-37**), and Hydro Action

(**Figure 8-38**). Each of these treatments systems has submitted data to Suffolk County with their applications indicating they can achieve target effluent total nitrogen of 19 mg/l or less.

Suffolk County has developed an anticipated timeline of the approval process of I/A OWTS as depicted in **Figure 8-30**. The figure depicts two timelines: Standard approval model and RFEI accelerated approval model. The manufacturers who participate in the demonstration project with NSF 245 or ETV certifications are permitted to fast track the standard approval model, provided results of their sampling during the demonstration meet total nitrogen effluent requirements and other factors are deemed satisfactory. The County should continue to provide demonstration opportunities to manufacturers in order to provide more treatment options to property owners.

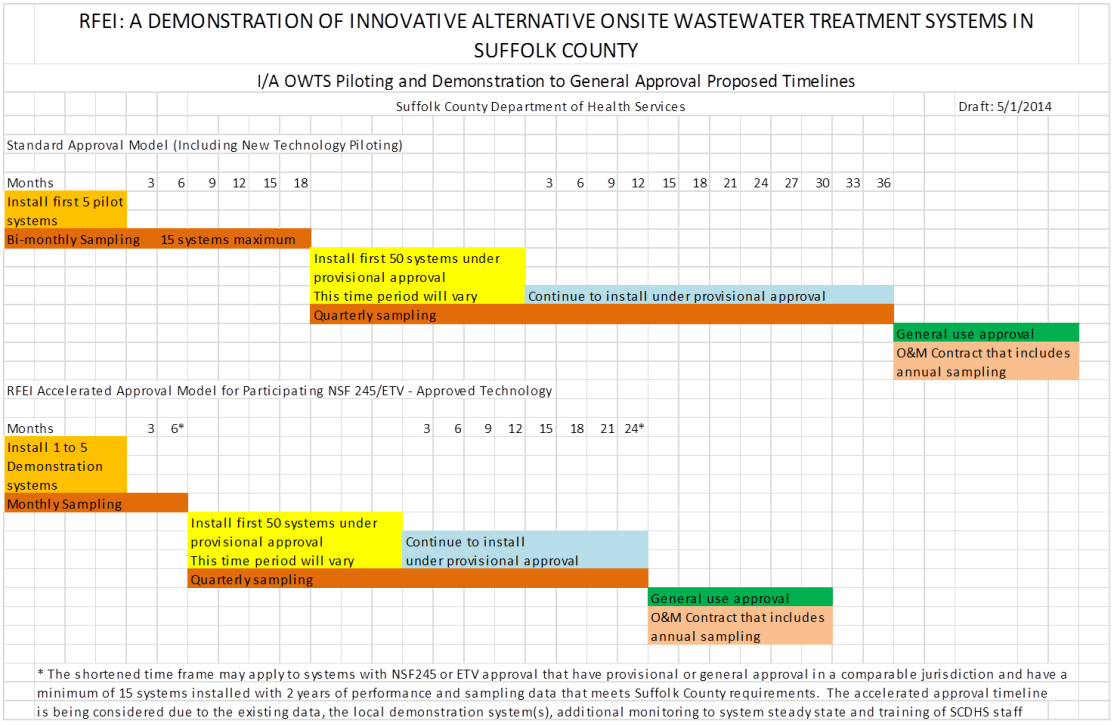


Figure 8-30 Example of I/A OWTS Approval Timeline

The USEPA has recently started to promote the creation of a means of sharing I/A OWTS data between jurisdictions. Some of the Chesapeake Bay states are in the process of implementing their own data sharing program for I/A OWTS. This will allow jurisdictions to use data from other states to prove the effectiveness of a system. For example, if

Suffolk County implemented the standard approval model depicted in **Figure 8-29**, during the pilot phase a manufacturer would be required to install five systems and sample them for 18 months within Suffolk County before moving to provisional approval. If Suffolk County joined a cooperative program with other jurisdictions such as the Chesapeake Bay States program, then instead of a manufacturer installing five pilot systems the County could review the systems installed in the Chesapeake Bay States and evaluate the data of the systems. If the data is found to be acceptable then the system could move directly to the provisional approval stage without a manufacturer installing a single system within Suffolk County.

2. Creation of a Responsible Management Entity (RME) to oversee an I/A OWTS program. The SCDHS maintains the authority over the location and means of sewage disposal systems and water supplies. According to the EPA "**Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems**", March 2003, a responsible management entity is a legal entity responsible for providing various management services with the requisite managerial, financial, and technical capacity to ensure the long-term, cost effective management of decentralized onsite and/or cluster wastewater treatment facilities in accordance with applicable regulations and performance requirements. RMEs can be operated by private companies, public utility companies, or Government agencies.

   In the EPA's guide overview of five management models are presented. EPA Management Model 4 is the RME operation and maintenance model which resembles the kind of RME required in Suffolk County. Model 4 is acceptable where there are large numbers of onsite sewage disposal systems and decentralized systems that must meet water quality requirements to protect the environment and the systems are maintained in private ownership. In Suffolk County there are approximately 360,000 onsite sewage disposal systems and over 150 decentralized STPs that are privately owned. SCDHS already monitors the operation and maintenance of the privately owned sewage treatment plants located within the County. With the proposal to upgrade many of the existing onsite sewage disposal systems located within high priority areas to I/A OWTS to meet water quality goals a RME is required to ensure that the systems are maintained and function properly to produce effluent with reduced nitrogen.

The RME's responsibilities in Suffolk County would be to provide financing options for property owners to permit them to install or repair an I/A OWTS or decentralized STP's in an affordable manner, oversee the operation and maintenance of I/A OWTS and STP's, participate in the technology piloting process for I/A OWTS, and enforcement.

During Suffolk County's Septic Tour, the team gathered information about each jurisdiction's funding sources to provide grants and/or low interest loans to property owners to upgrade existing onsite sewage disposal systems. Suffolk County would also need to provide funding opportunities to property owners to upgrade their onsite sewage disposal systems; this would be managed by the established RME. The jurisdictions had robust involvement, commitment, and investment from state agencies to fund the installation of I/A OWTS. Rhode Island, with the most number of systems installed, provides low interest loans to homeowners to upgrade their septic systems to I/A OWTS through the use of a portion of their "big pipe" Federal Clean Water Act Revolving Fund to the State, that were then loaned to local government agencies at low to zero interest rates. The local government would then issue a loan to homeowners with an interest rate of 2% [RI] to 5% [MA] at a 10 or 20 year term. The Maryland Department of Environment provides grant funding to pay for I/A OWTS only (excludes the cost of leaching field and septic tank) through a State bill creating the Bay Restoration Fund (BRF). The BRF is funded through a fee assessed to the property and added as a property tax or part of a separate bill depending on municipality. The State of Massachusetts offers a tax credit for repair or replacement of failed cesspools or septic systems for 40% of the cost up to $6000, spread over 4 years at $1500 per year. **Table 8-21** summarizes the financing opportunities for property owners in each jurisdiction.[15]

Table 8-21 Summary of I/A OWTS Available Funding for Installation

Region	Loan	Grant	Tax Incentive
Maryland	--	Bay Restoration Fund Provides grants for total cost of treatment unit. Funded by $60/year fee assessed to onsite septic system owners	--
NJ Pinelands	NJ Environmental Infrastructure Financing Program can provide funding to replace failing systems. The local governing body or utilities authority must form a septic management district to receive financing.	---	---
Rhode Island	RI Clean Water Finance Agency issues loan to local community (w/ plan) at 0% which issues to the borrower @ 2% for 10 years with at a max of $25,000	---	---
Barnstable County, MA	Barnstable Community Loan Program 5% for 20 years. 0% loan for composting unit	---	tax credit for 40% for repair or replacement of failed cesspools or septic systems up to $6000, spread over 4 years @ $1500/year

In addition, the established RME must have the capabilities to track operations and maintenance of I/A OWTS installed within the County. For example, Barnstable County, MA deployed a tracking database designed by Carmody Data Systems. All maintenance and sample results must be entered into the tracking system. The system identifies failure rates and pumping rates to determine if a system is failing. Alerted to operation and maintenance contract expiration, the County calls the owner and sends a letter notifying the homeowner. Upon a 2nd alert, a certified letter is issued and the homeowner may be called into a hearing. Local Boards of Health can fine (approximately $250) homeowners if operation and maintenance contract is not maintained. The Carmody System also provides the ability to generate graphs depicting the sample data for public view.

Figure 8-31 depicts a sample graph of nitrogen data for 449 BioMicrobics FAST systems installed in Barnstable County. BioMicrobics FAST is a type of I/A OWTS. It should be noted that some of the data falls outside the average effluent nitrogen ranges required, which may be due to system downtime due to maintenance or fluctuations in water usage, nitrogen and BOD loading, and temperature.[15]

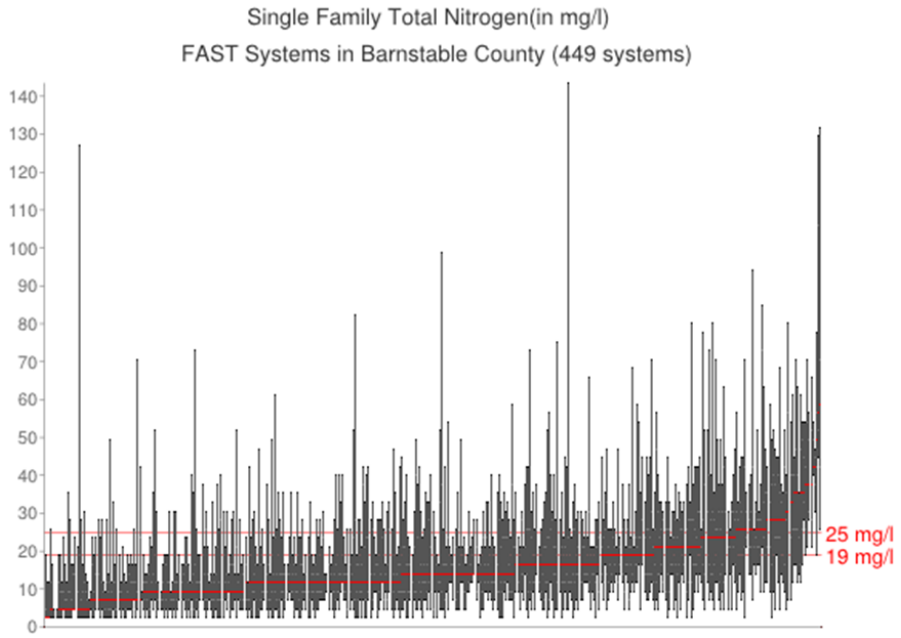


Figure 8-31 Barnstable County BioMicrobics FAST Total Nitrogen Effluent Data Graph

3. In order to implement an I/A OWTS and an onsite sewage disposal systems upgrade program some existing codes and standards must be amended. SCDHS enforces Suffolk County Sanitary Code Article 6 which defines the means and methods for wastewater treatment requirements in Suffolk County with respect to new construction (including additions to existing buildings or changes of use of existing buildings), but does not provide the authority to Suffolk County to enforce upgrading of existing onsite sewage disposal systems to a conventional onsite sewage disposal system or innovative/alternative onsite sewage disposal system when no new construction is proposed. In addition, SCDHS has developed and implemented the "Standards Approval of Plans and Construction – Sewage Disposal Systems for Single-Family Residences" (Residential Standards) issued November 13, 1995 and "Standards for Approval of Plans and Construction for Sewage Disposal Systems for Other Than Single-Family Residences" (Commercial Standards), issued July 15, 2008 which do not require property owners to make an application to the SCDHS to upgrade or repair their onsite sewage disposal system and do not permit the use of I/A OWTS.

   There are many codes/standards/regulations already on the books pertaining to I/A OWTS, which SCDHS could use as models such as Massachusetts Tile 5 Septic System Regulations, which outlines the requirements for I/A OWTS to be permitted to be installed in the States. The Macomb County, Michigan "Regulations Governing On-Site Sewage Disposal and On-site Water Supply System Evaluation and Maintenance" is another example that defines requirements for system evaluations at the time of transfer, maintaining operations and maintenance contracts, and when failed systems are required to be upgraded.

   Suffolk County should add a new article to the Suffolk County Sanitary Code and update existing articles of the Suffolk County Sanitary Code to address the following:

   i. Define when a property owner will be required to have their existing onsite sanitary system inspected by a licensed inspector and report submitted to SCDHS for review with included exemptions (e.g. property transfer, failure, etc.);

ii. Define the license requirements for individuals permitted to inspect onsite sewage disposal systems and submit an inspection report to SCDHS or RME for review;
iii. Define when an existing onsite sanitary system must be upgraded or repaired;
iv. Define a minor versus major repair (major repairs would require an application to the SCDHS;
v. Define the type of onsite sanitary system upgrade required (connection to sewers, new conventional system, new I/A OWTS, repair of existing system);
vi. Define operation and maintenance requirements for I/A OWTS (O&M Contracts, Sampling, RME, I/A OWTS operating permit, etc.);
vii. Address enforcement by SCDHS or RME; and
viii. Requirement for SCDHS to maintain a database of existing onsite sewage disposal systems.

The SCDHS Residential and Commercial should be revised to address:

i. Inspection requirements and upgrade requirements of onsite sewage disposal systems and
ii. Provide I/A OWTS construction standards;

Legislation may be required to implement the recommended changes to the Sanitary Code.

8.3.3.2.1 Innovative/Alternative Onsite Wastewater Treatment Systems Capable of Reducing Total Effluent Nitrogen

Innovative/alternative onsite wastewater treatment systems (I/A OWTS) are considered treatment systems that have the ability to reduce effluent total nitrogen. Multiple technologies that have been used for large-scale wastewater treatment systems to reduce nitrogen have been scaled to serve as treatment units for individual residential lots. These types of processes consist of sequencing batch reactors, extended aeration, membrane bioreactors, and recirculating filters, among others. Many of these treatment systems provide some degree of wastewater nitrogen removal. A few of these technologies, such as membrane bioreactors, have also shown some ability to remove personal care products and pharmaceuticals. **Table 8-22** lists a number of I/A OWTS products capable of reducing wastewater nitrogen.

Innovative/alternative onsite wastewater treatment systems can be broken into non-proprietary and proprietary I/A OWTS. Non-proprietary I/A OWTS are systems that are not mass produced by a company who has exclusive rights to the system. Two non-proprietary I/A OWTS are recirculating sand filters

(RSF) and recirculating constructed wetlands systems (also known as recirculating gravel filter). When properly designed these systems have the capability of reducing effluent total nitrogen to levels less than a conventional onsite sewage disposal system. **Figure 8-31** depicts an example of a RSF. Flow from the house enters the septic tank where solids settle then the septic tank effluent is discharged by gravity to a pump chamber. Per **Figure 8-32**, the pump chamber has two functions. The first function is to transport septic tank effluent to the sand filter. The second function is to act as an anoxic tank were denitrification occurs with the assistance of facultative bacteria and septic tank effluent as a carbon food source (See section 8.3.5 overview of the nitrogen reduction process). The flow from the pump chamber is discharge to the top of the sand filter were aeration occurs and bacteria help in the nitrification process. When the flow reaches the bottom of the sand filter, a portion of the flow is discharged to the leaching structures and a portion is returned to the pump chamber.

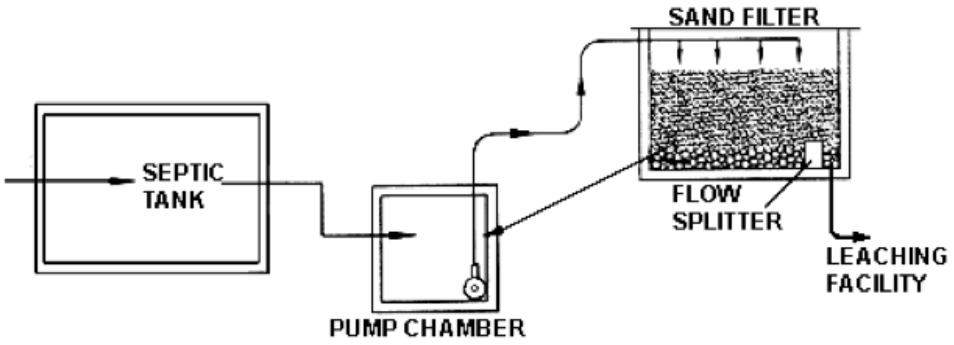


Figure 8-32 Example Recirculating Sand Filters (RSF)

Recirculating constructed wetlands are another type of non-proprietary I/A OWTS. They can either be horizontal flow where the flow moves horizontally across the system or vertically where the flow moves from the planted layer down. **Figure 8-33** is an example of a recirculating vertical flow constructed wetlands system. Flow from the septic tank enters the bottom portion of the wetlands system which is an anoxic environment. Flow travels across the gravel section to a pump pit. From the pump pit flow is either discharged or recirculated to the top section of the wetlands and dispersed so it flows down towards the gravel section. The top section of the wetlands is where aeration and some evapotranspiration occur.

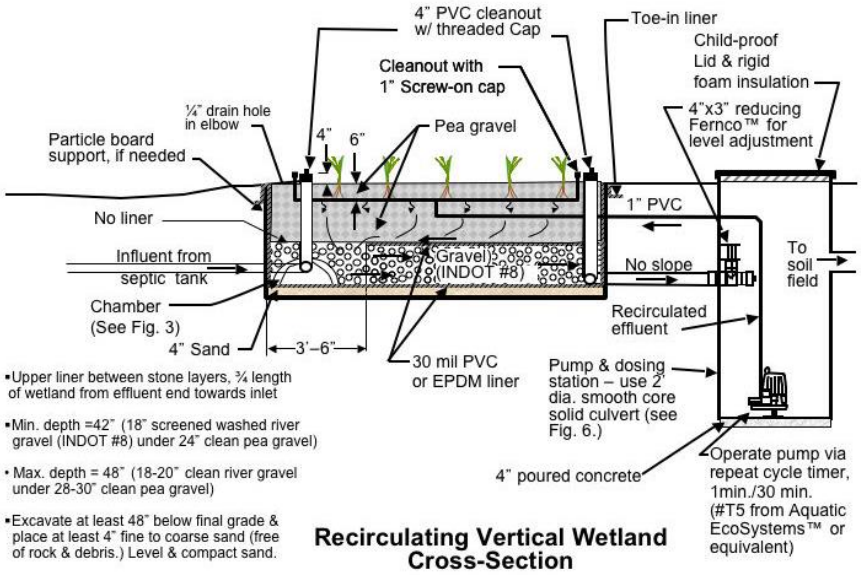


Figure 8-33 Recirculating Constructed Wetlands Systems (AKA recirculating gravel filter)

There are many proprietary I/A OWTS that are capable of reducing total nitrogen as listed in **Table 8-22**. These systems are extended aeration, SBR, MBR, and fixed film processes.

Below are some brief descriptions of the systems selected for the Suffolk County demonstration project. It is essential for the County to continue reviewing other onsite treatment options, besides the demonstration systems, to determine which systems would meet operation, maintenance, and effluent nitrogen requirements to provide I/A OWTS selection flexibility to property owners.

*(1) Norweco Singulair TNT (***Figure 8-34***)*

Based on the Norweco website the Singulair TNT reduces total effluent nitrogen by 68 percent. Treatment in the Singulair TNT is accomplished by an extended aeration process. The system consists of one precast treatment tank containing a pretreatment chamber, aeration chamber, and clarifier chamber. Flow enters the pretreatment chamber which acts as an equalization tank. Flow is transferred from the pretreatment chamber to the aeration section via a transfer tee. Aeration in the aeration chamber is supplied by a mechanical aerator. Flow from the aeration chamber flows under a baffle wall into the clarifier chamber. Solids from the clarifier chamber are returned to the aeration chamber via the company's

Bio-Static Sludge Return system. Effluent flow from the clarifier is discharged to leaching pools via the Bio-Kinetic System.[18]

Table 8-22 Types of Nitrogen Reducing Systems (IFAS – Integrated Fixed Film Activated Sludge Process, SBR – Sequence Batch Reactor, MBR – Membrane Bioreactor)

Nitrogen Reducing Innovative/Alternative Onsite Wastewater Systems		
Amphidrome	F.R. Mahony & Assoc	Fixed Film SBR
Bioclere	Aqua Point Inc	Modified trickling filter
Cromaglass	Cromaglass Corp	SBR
Fast	Bio-Microbics, Inc	IFAS
MicroFAST	Bio-Microbics, Inc	IFAS
Bio Barrier	Bio-Microbics, Inc	MBR
Busse GT	Busse Green Tech.	MBR
Hoot ANR	Hoot Systems, LLC	Extended Air
SeptiTech	SeptiTech, LLC	IFAS
Singulair TNT	Norweco	Extended Air
Singulair Green	Norweco	Extended Air
AdvanTex AX20	Orenco	Packed bed textile-recirculating filter
AdvanTex AX100	Orenco	Packed bed textile-recirculating filter
Advantex AX-RT	Orenco	Packed bed textile-recirculating filter
RUCK	Innovated RUCK	
Waterloo Biofilter	Waterloo biofilter	Attached growth Trickling Filter
Recirculating Sand Filters		Recirculating Sand filter
Nitrex	Lombardo Associates	Trickling Filter

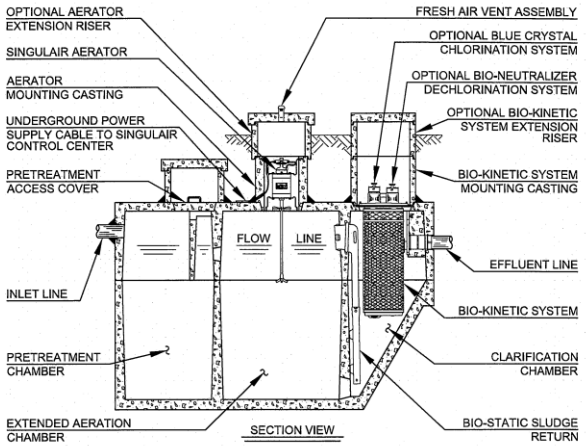


Figure 8-34 Norweco Singulair TNT

(2) *Norweco Hydro-Kinetic 600 FEU* **(Figure 8-35)**

According to Norweco's website the Hydro-Kinetic system achieved results of 7.9 mg/l total nitrogen during their NSF 245 tests. The Hydro-Kinetic system uses an extended aeration and attached growth process to treat wastewater. The treatment occurs within two pre-cast concrete tanks. The first tank contains the pretreatment chamber, anoxic chamber, aeration chamber, and clarification chamber. The second tank contains the influent chamber and hydro-kinetic FEU filter. Flow enters the pretreatment chamber where some solids settle. Flow from the pretreatment overflows into the anoxic tank through a drop tee. Denitrification will occur in the anoxic chamber. The flow from the anoxic chamber enters the aeration chamber for denitrification and BOD reduction. After the aeration chamber flow enters the clarifier chamber through the inlet zone, which reduces turbulence in the clarifier. A portion of the flow is recirculated to the anoxic chamber and a portion is moved forward towards the influent chamber. Flow than travels from the influent chamber to the Hydro-Kinetic filter for further reduction in organic matter before discharging to the leaching field. The system can also be fitted with a UV unit for additional treatment.[19]

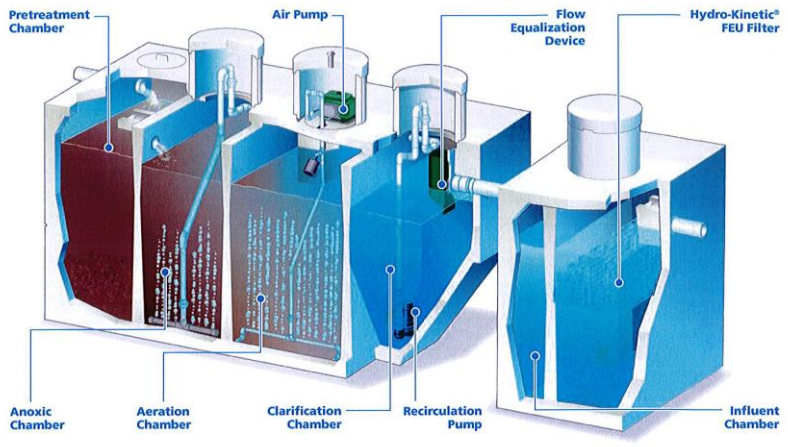


Figure 8-35 Norweco's Hydro-Kinetic System

(3) *Busse Green Technologies, Inc. BUSSE MF 400* **(Figure 8-36)**
The BUSSE MF is membrane bioreactor, which uses Kubota flat sheet membranes. The unit can be installed in a basement or above grade after an existing septic tank in a storage shed or garage. As an example, the BUSSEMF-440, which can be installed in a basement prior to an existing sanitary system, utilizes two balance tanks and two MBR tanks. Flow is transferred between balance tanks and to the MBR tanks via airlifts. Balance tank 1 is the primary sedimentation tank to remove settleable and floating coarse matter. Flow is transfered from Balance tank 1 to Balance tank 2 via an airlift. Balance tank 2 is used to store surplus activated sludge. Flow is transferred to the two MBR tanks from Balance tank 2 via an airlift. From the MBR tanks flow is discharged to the leaching field.[20]

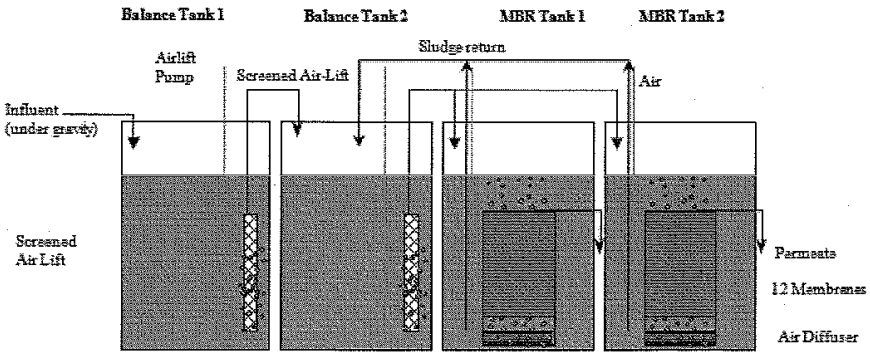


Figure 8-36 Busse Green Technologies, Inc. BUSSE MF 400

*(4) Orenco Systems AdvanTex AX20 (***Figure 8-37** *)*

Orenco systems has a document located on their website with the heading `"AdvantTex Performance Summary #2 Nutrient Reduction: TN, NH3, TP, Rev 1.4, 3/12" which indicates the AX20 and AX-RT units can produce effluent total nitrogen of less than 19 mg/l. Both units can be fitted with a UV unit for additional treatment. The AdvanTex AX20 is a packed bed textile-recirculating filter. The AX-20 works in conjunction with a septic tank. The septic tank can be modified to become a processing tank with the addition of the Biotube pumping package and additional piping. Flow enters the processing tank where scum, sludge, and liquid effluent are separated. The filtered effluent is dosed to the filter pod via the Biotube pumping package. Effluent is then sprayed over the textile sheets. The effluent then percolates down through the textile sheets and is distributed between the recirculation and discharge to the leaching field.[2]

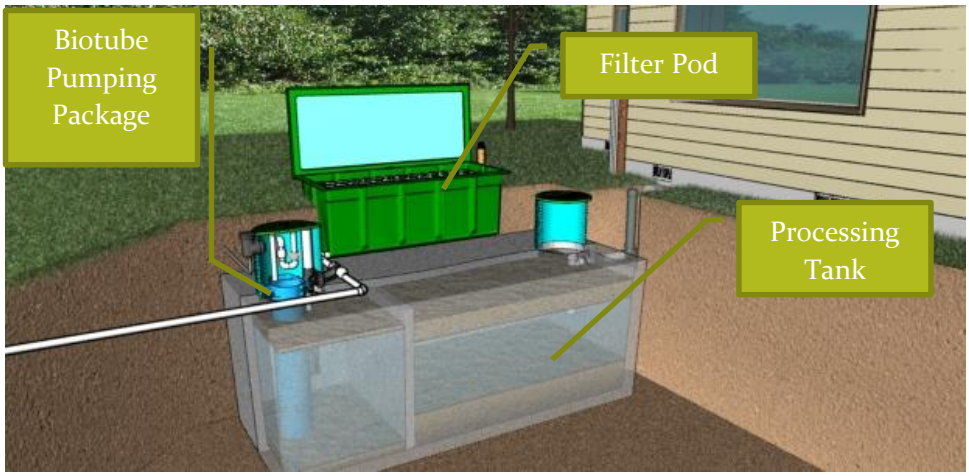


Figure 8-37 Orenco Systems AdvanTex AX20

*(5) Orenco Systems AdvanTex AX-RT (**Figure 8-38**)*

Orenco's AdvanTex AX-RT is the same process as the AX20 unit and has the ability to reduce effluent total nitrogen to less than 19 mg/l. A septic tank precedes the AX-RT unit. Flow enters the septic tank where scum, sludge, and liquid effluent are separated. Flow then exits the septic tank through the Biotube effluent filter discharging to the AX-RT recirculating section of the tank, which contains the Biotube pump package. Effluent is then sprayed over the textile sheets. The effluent then percolates down through the textile sheets and is distributed between the recirculation and

discharge chambers by means of the AX-RT baffle. Periodically, a pump in the discharge chamber doses effluent to the leaching field.[21]

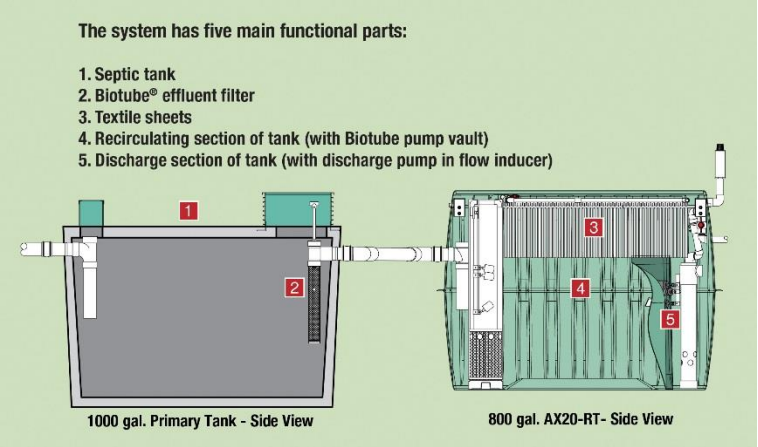


Figure 8-38 Orenco Systems AdvanTex AX-RT

(6) *Hydro-Action Industries, Hydro Action AN Series*

Prior to treatment in the Hydro-Action tank effluent must undergo pretreatment in a septic tank to remove solids. Then flow enters the hydro-action treatment system to complete the treatment of wastewater to reduce nitrogen.

8.3.3.2.2 Leaching system

Suffolk County currently uses leaching pools, leaching galleys, and infiltrators for leaching systems. Leaching galleys and infiltrators are normally used on sites with high groundwater conditions. There have been some claims of properly designed leaching fields having the capability of reducing nitrogen. The types of leaching systems are usually shallow systems located approximately 1 foot below grade. These shallow systems take advantage of contact with organic soils to enhance oxygen transfer, increase plant uptake, and retention of nutrients. One of these systems is a geomat flat with pressure dosing (Figure 8-39) by Geomatrix. Due to plant uptake these systems can help with irrigation of home lawns. Suffolk County should investigate the use of alternate types of shallow leaching systems to increase nitrogen removal and protect against rising sea and groundwater levels due to the increased separation between the bottom of the leaching system and groundwater.

Figure 8-39 Geomat Flat leaching system by Geomatrix

The Wasteflow dripline with rootguard by Geoflow, Inc is a subsurface drip system, another shallow drainfield manufactured product. The Dripline piping is flexible 1/2" polyethylene tubing coated on the inside with an anti-bacterial lining to inhibit bacterial growth. There are emitters installed and spaced evenly along the tubing. The dripline is placed 6-10 inches below the surface, directly into the biologically active soil horizon. Effluent cycles through a self-cleaning filter out to the dripfield, providing slow, even application of effluent. The system returns back to the pump tank or treatment tank in a closed loop, and is kept clean with regular flushing (See **Figure 8-40**). The Massachusetts Alternative Septic Test Center tested the product performance and also tested the nitrogen reducing capabilities of the shallow system. Nitrogen entering the leaching system had an average total nitrogen concentration of 33.91 mg/l and the system was found to reduce total nitrogen in the range of 25% to 47%.[22] When using a shallow system, effluent filters on the septic tank are required.

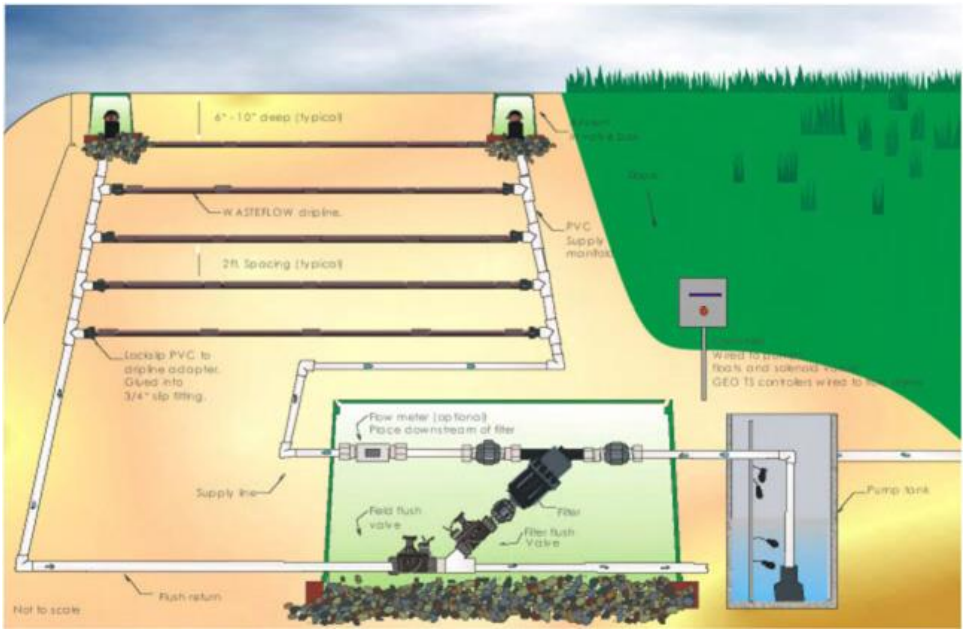


Figure 8-40 Wasteflow Dripline with Rootguard by Geoflow Example Layout

8.3.4 Expanding and/or Creating New Sewer districts (Centralized or Decentralized)

One of the means of improving water quality is to extend sewers to lots currently utilizing onsite sewage disposal systems. Sewering helps to reduce nitrogen loads impacting drinking water wells as well as increase coastal resiliency. This has been known for years but funding to extend sewers to unsewered areas has been lacking for approximately 30 years until SuperStorm Sandy. After SuperStorm Sandy impacted structures along our coastline in 2012, the need for increased wastewater treatment to reduce nitrogen was realized to improve our valuable water resources. The first major sewer expansion in Suffolk County will occur through a funding award of $383 million from New York State to install sewers and connect approximately 10,000 properties to these sewers.

Suffolk County must continue to promote expansion or creation of community sewage systems whether by municipalities creating centralized sewer systems or individual property owners joining together to create a decentralized sewer system. Per Article 6 of the Suffolk County Sanitary Code community sewer systems are defined as a system utilized for the collection and disposal of sewage or other waste of a liquid nature, including various devices for the treatment of such wastes, serving more than one parcel, whether owned by a municipal corporation, private utility, or otherwise. The major components of a community sewage system are the wastewater treatment plant and the collection system used to transport wastewater to the treatment plant. The

wastewater treatment plants are designed to reduce suspended solids, BOD, and Nitrogen to meet applicable discharge standards. The collection system is the network of sewer pipes, structures and devices installed for the purpose of collecting and transporting sewage to the wastewater treatment plant. Collection systems may be compromised of gravity sewers or pressure sewers or the combination of both.

Suffolk County has already embarked on the path to create or expand community sewerage systems by performing sewer feasibility studies throughout the County. These studies include expansion of sewers into Wyandanch, Deer Park, West Babylon, North Babylon, and West Islip as depicted in **Figure 8-41**. In addition, the feasiblity of sewering areas of Mastic-Shirley, Sayville, Bellport, North Bellport, Flanders, Southampton Village, and Lake Ronkonkoma HUB was also studied, as depicted in **Figure 8-42**.

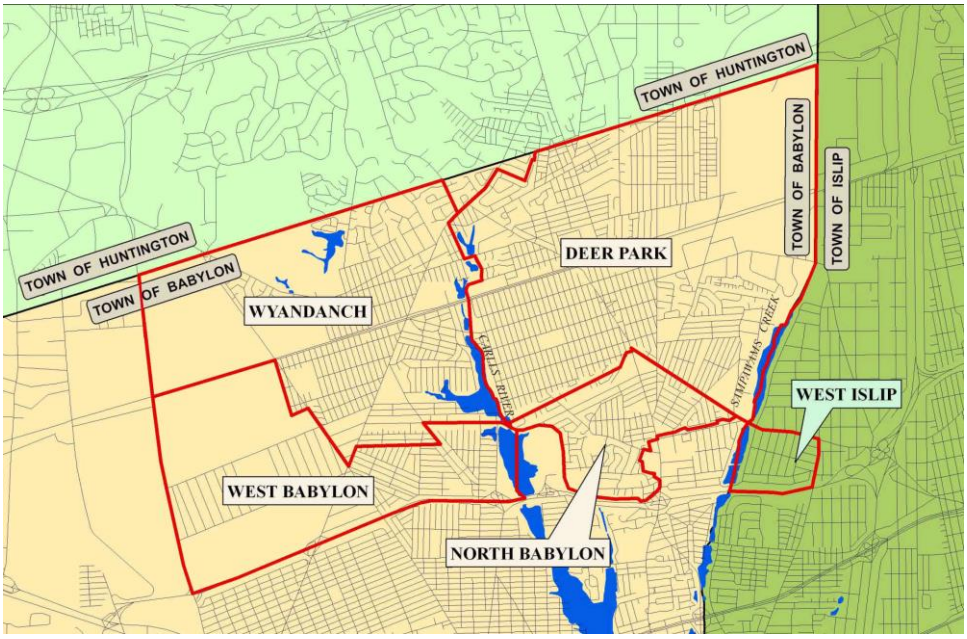


Figure 8-41 Map of Wyandanch, Deer Park, West Babylon, North Babylon, and West Islip Sewer Feasibility Study Area

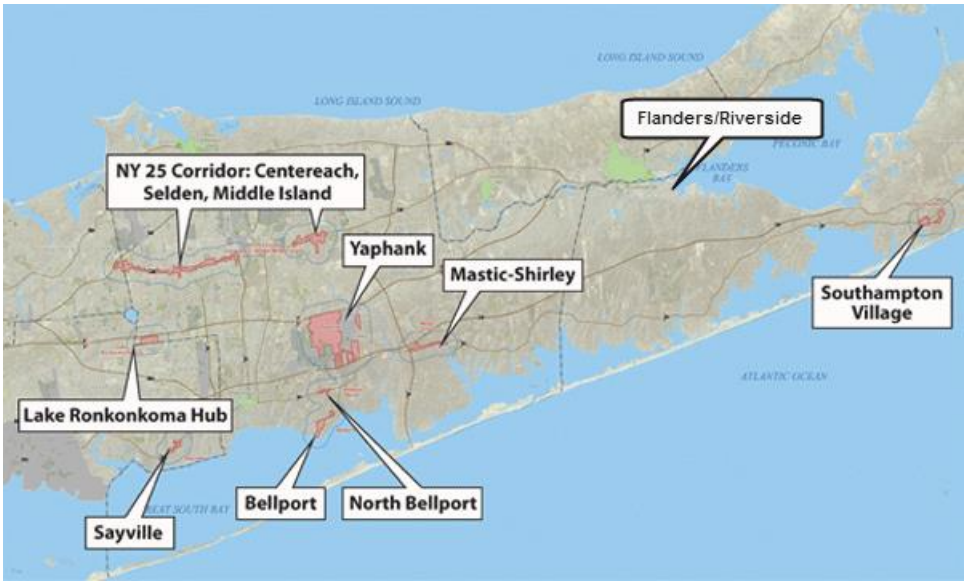


Figure 8-42 Map of Yaphank, Mastic-Shirley, Sayville, Bellport, North Bellport, Flanders, Southampton Village, Lake Ronkonkoma HUB, and NY 25 Corridor Sewer Feasibility Study Areas

8.3.4.1 Bellport Feasibility Study

The Bellport Feasibility Study considered a 56 acre area consisting 131 parcels located in two geographically distinct areas; (1) Bellport Village downtown area and (2) properties surrounding the Long Island Railroad Bellport Station located in North Bellport on Montauk Highway. The Final study was completed in June 2014.

These areas were selected for a feasibility study due to groundwater impacts to surface waters down gradient of Bellport Village, the Town of Brookhaven's desire to improve the local economy of the area, and to establish a transit oriented development. The projected wastewater flow from the study area was estimated to be 160,000 gpd. The study proposed using a combination sewer collection system consisting of gravity sewers and low-pressure sewers.

It was recommended that the North Bellport portion of the project be serviced by gravity sewers while the Bellport Village portion would be serviced by low-pressure sewers due to the elevation of the groundwater table. The study recommended that the wastewater flow from the North Bellport area be transported by gravity sewers to a pump station located by the train station and wastewater flow from the Village of Bellport be transported to the same pump station via low-pressure. From the pump station by the train station the wastewater flow would be transported to the Village of Patchogue STP. The

Village of Patchogue STP was selected to process the wastewater from the study area since it was found to be the most viable solution.

The report estimated if the project was approved it could be implemented in six to seven years at an estimated cost of $38,907,000. The proposed project would reduce nitrogen loading to area groundwater from existing conditions by approximately 2 pounds per day.[23]

Concurrently, as part of a separate study, an additional option of sending the flow to the County's Sewer District 7 – Woodside STP was made available by the Town of Brookhaven by providing additional land for potential expansion of the effluent recharge area; this option was evaluated by the Town and its consultant in a separate study in coordination with SCDPW.

8.3.4.2 Flanders Riverside Sewering Feasibility Study

The Flanders Riverside corridor feasibility study was performed based on the anticipated opportunities to improve the local economy, housing, and improve water quality due to the close proximity of the study area to the Peconic River, Flanders Bay, and Pine Barrens. The study evaluated an 85 acre area including 89 parcels for sewering with a total estimated wastewater flow of 160,000 gpd. In addition, the study evaluated the sewering of a smaller portion of the study area known as the Phase 1 area with a proposed flow of less than 15,000 gpd.

Collection of wastewater for the overall area was recommended to be via gravity lines with seven remote pump stations to minimize operation and maintenance requirements. However to reduce capital costs for Phase 1 a low-pressure system was recommended. Treatment of the wastewater would occur at a new treatment plant built for the study area. To treat the 160,000 gpd flow scenario a MBR was recommended to reduce effluent total nitrogen in the range of 3 mg/l to 5 mg/l. For the 15,000 gpd Phase 1 scenario an alternative systems such as a Nitrex system was recommended.

Two more alternatives described below were identified as a result of an April 2014 stakeholder meeting facilitated by Suffolk County and attended by representatives from both Southampton and Riverhead.

One additional alternative for the Phase I area would include construction of a low pressure collection system to convey wastewater from the Phase I area to the existing Riverhead STP for treatment. This alternative would require each property owner to purchase and maintain a grinder pump station, and the existing Riverhead Sewer District would be extended into Southampton to include the Phase I redevelopment area.

Another alternative for treating 160,000 gpd flow would be construction of a gravity collection system, pump stations and treatment at the Town of

Riverhead's Calverton STP. This alternative would require that the existing Calverton Sewer District be extended into Southampton to include the area to be sewered.

If approved, the project would take approximately five to six years to implement. The cost to sewer the overall study area (160,000 gpd scenario) with an MBR plant would be approximately $33,827,000, and the cost to sewer the Phase 1 (15,000 gpd scenario) with an alternative system such as a Nitrex plant would be $3,746,000. It is estimated that sewering the overall study area would reduce the nitrogen load to the groundwater by approximately 2 pounds per day, over the nitrogen loading that would had occurred if the area were to be developed in accordance with existing zoning, but remain unsewered.[24]

8.3.4.3 Mastic/Shirley Sewering Feasibility Study

The Mastic-Shirley area was selected to allow the implementation of the "Montauk Highway Corridor Study and Land Use Plan for Mastic Shirley" and to improve the quality of the groundwater base flow to the Forge River. The study evaluated a 1,400 acre area with a total estimated wastewater flow of 1.36MGD.

The study proposed using a combination collection system consisting of gravity sewers and low-pressure sewers. Low-pressure sewers would be used in areas where groundwater is less than 10 feet below grade based on USGS mapping. Treatment of the wastewater would occur at a new treatment plant built for the study area located on a 14.9-acre parcel located at the Town of Brookhaven Calabro Airport. Since water quality of the Forge River was a major reason for undertaking the sewer feasibility study, an MBR STP was recommended to reduce effluent total nitrogen down to the range of 3 mg/l to 5 mg/l.

If approved, the sewering program could be fully implemented within 13 years at a cost of $315,009,010. Under existing conditions, the estimated nitrogen load reduction to local groundwater would be approximately 167 pounds per day. This would provide significant improvement in shallow groundwater quality and in the groundwater baseflow to the Forge River.[25]

8.3.4.4 Sayville Feasibility Study

The Sayville Study includes an area of 71 acres with 167 tax lots generally located along a one mile stretch along Montauk Highway and Railroad Avenue in Sayville. The study area was identified as a critical area in need of sewers to provide environmental, economic, and/or social benefits to the area.

The wastewater flow of the area is estimated to be 130,000 gpd. Collection of the wastewater would be through a low pressure system due to the high

groundwater and the area being an already established Main Street Business District. The wastewater would ultimately be conveyed to the Village of Patchogue STP. If approved, the sewering program could be implemented in 6 to 7 years to complete at a cost of $35,301,000. The sewering would help reduce nitrogen to groundwater by a small measurable amount, which was not defined in the report.[26]

8.3.4.5 Southampton Village Feasibility Study

The Southampton Village study includes an area of 62 acres with 151 tax lots within the Village's business district. The study area was identified as in critical in need of sewers to provide environmental, economic, and/or social benefits to the area. Meetings with Village stakeholders identified the two most significant factors for upgrading sanitary sewage infrastructure in the business district as groundwater impacts to Lake Agawam and the Village's desire to implement their own vision plan.

The wastewater flow of the area is estimated to be 145,052 gpd. Collection of the wastewater would be through a low-pressure system due to the high groundwater and the area being an already established Main Street Business District. Treatment of the wastewater would occur at a new treatment plant built for the study area. Based on the desire to reduce impacts to Lake Agawam an MBR STP was recommended to treat the 145,052 gpd wastewater flow to a total effluent nitrogen in the range of 3 mg/l to 5 mg/l.

If approved, the sewering program could be implemented in 5 years to at a cost of $29,300,000. It is estimated that sewering would reduce the nitrogen load to area groundwater by approximately 20.6 pounds per day and reduce the groundwater nitrogen concentration beneath the Southampton Study area to approximately 2.6 mg/l.

8.3.4.6 Deer Park, North Babylon, West Babylon, Wyandanch, Wheatley Heights, and West Islip Feasibility Study

The sewering feasibility study encompassed the communities of Deer Park, North Babylon, West Babylon, Wyandanch, Wheatley Heights and West Islip. The study area was identified as a critical area in need of sewers to help address environmental and health concerns associated with on-site wastewater disposal systems, potential to encourage business investment, and increase workforce-housing opportunities.

The wastewater flow of the area is estimated to be between 4.1 to 5.5 MGD to sewer approximately 18,000 parcels. Collection of wastewater for the overall area was recommended to be via gravity lines with remote pump stations. The wastewater would ultimately be conveyed to the Bergen Point STP. If

approved, the cost to sewer the entire study area would be approximately $2 billion.[6]

One overarching issue identified during each study is the cost. Costs ranged in the millions to billions of dollars to sewer the studied areas. If the annual debt service for the cost of installation of the sewers was required to be paid by the property owners then they would incur significant annual debt for connecting to sewers above current annual property tax payments. As an example, **Table 8-23** depicts the annual cost to homeowners in the proposed Sayville sewer study area of approximately $5,947/year based on a 30 year loan. Therefore, these projects would become economically feasible for residential property owners only if significant grant funding was provided or some other type of established funding stream was created to fund these and future sewer extension projects.

Table 8-23 Annual Costs for Property Owners Located in the Sayville Sewer District

Annual Costs for Typical Property Owners (Sayville Sewer District Created)						
Property Type	"Typical " Assessed Value ($)	Annual Debt Service (Sewer Assessment)	Annual Electricity Cost & Service Contract	Annual O&M	Village of Patchogue Sewer User Fee	Total Annual Amount
Sayville Commercial Property	$45,000	$4,677	$1,850	$1,500	$8,270	**$16,297**
Sayville Residential Property	$45,000	$4,677	$375	$150	$745	**$5,947**

8.3.5 Improvements to Sewage Treatment Plant Technologies

In 2013, there were 197 sewage treatment plants (STP) operating in Suffolk County. 171 STP's are designed to remove total nitrogen below 10 mg/l (tertiary STP), and the remaining 26 STP's are designed to remove suspended solids and BOD (secondary plants). The life expectancy of a STP is approximately 30 years. Many plants in Suffolk County have been in operation for approximately 25 to 40 years. Many of these STPs undergo upgrades or modifications periodically to replace aging parts or to improve process. Modifications include separating blowers for aeration to improve process control or converting an entire treatment process to a new process.[28]

SCDHS monitors the performance of all STPs located within the County. In addition, SCDHS has been actively requiring older STPs that are

underperforming and/or lacking nitrogen removal capability, to undertake major renovations or replacement by a new STP. SCDHS and/or an established RME should continue these duties into the future. During the past 15 years 20 existing STPs were constructed to replace aging/underperforming STPs. In 2013 there were 26 tertiary plants that were non-compliant with their SPDES permits and undergoing upgrades and/or repairs. Thirteen of the 26 existing secondary plants were in the process of transitioning to tertiary treatment to provide nitrogen removal. Two additional secondary treatment plants were completely abandoned and replaced by pump stations to transport untreated wastewater to a municipal plant.

Secondary plants are designed to reduce total suspended solids and biochemical oxygen demand (BOD). A common measurement method of BOD is the five-day BOD, or BOD_5, which is the quantity of oxygen consumed by microorganisms during a five-day period to measure the amount of biodegradable organic material in, or strength of, sewage. BOD has traditionally been used as a measure of the strength of effluent released from conventional sewage treatment plants to surface waters or streams. High effluent BOD can deplete oxygen in receiving waters, causing fish kills and ecosystem changes. New York State SPDES Permits require secondary plants to have a maximum effluent suspended solid of 30 mg/l and BOD of 30 mg/l. **Figure 8-43** depicts a conventional extended aeration process capable of reducing suspended solids and BOD.[29] Reduction of BOD occurs in the aeration tank and reduction of suspended solids occurs by the screen, grit separator, and secondary clarifier. Unfortunately most secondary plants lack the ability to appreciably reduce nitrogen to required standards. Therefore, most secondary plants are upgraded to include the capability of reducing nitrogen to 10 mg/l or less with the exception of Bergen Point WWTP that discharges 2 miles off Fire Island into the Atlantic Ocean.

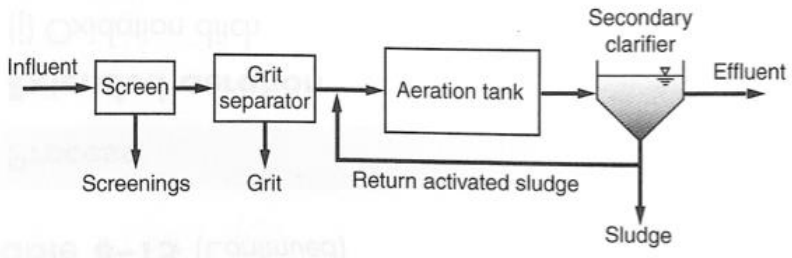


Figure 8-43 Conventional Extended Aeration Process

The basic principle of removing nitrogen in tertiary wastewater plants (in addition to reducing BOD and suspended solids) is to nitrify then denitrify the wastewater converting ammonia to nitrogen gas. Nitrification is competed by

the addition of oxygen and aerobic bacteria (Nitrosomonas and Nitrobacter) to convert ammonia (NH_4) to nitrite (NO_2^-) to nitrate (NO_3^-).

Nitroso-bacteria

$2NH_4^+ + 3\ O_2 \rightarrow 2NO_2^- + 4H^+ + 2H_2O$

Nitro-bacteria

$2NO_2^- + 2\ O_2 \rightarrow NO_3^-$

Denitrification occurs under anaerobic conditions (oxygen levels close to zero) where facultative bacteria assist in the reduction of nitrate to nitrogen gas (N_2).

$[\text{Carbon Source}] + NO_3^- \rightarrow N_2 + CO_2 + H_2O + OH^-$

However, the bacteria require a carbon food source, which is accomplished with the addition of chemicals such as methanol (**See Figure 8-44**) or by using the incoming untreated wastewater as the carbon food source (See **figure 8-45**). [29]

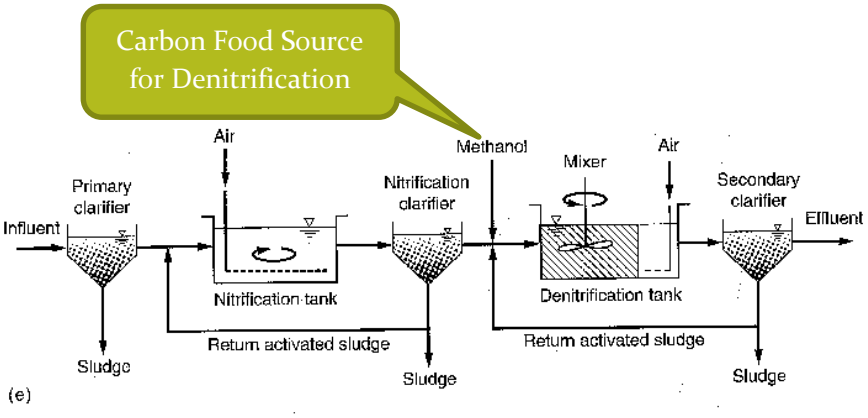


Figure 8-44 Denitrification Process with Addition of Methanol as Carbon Food Source

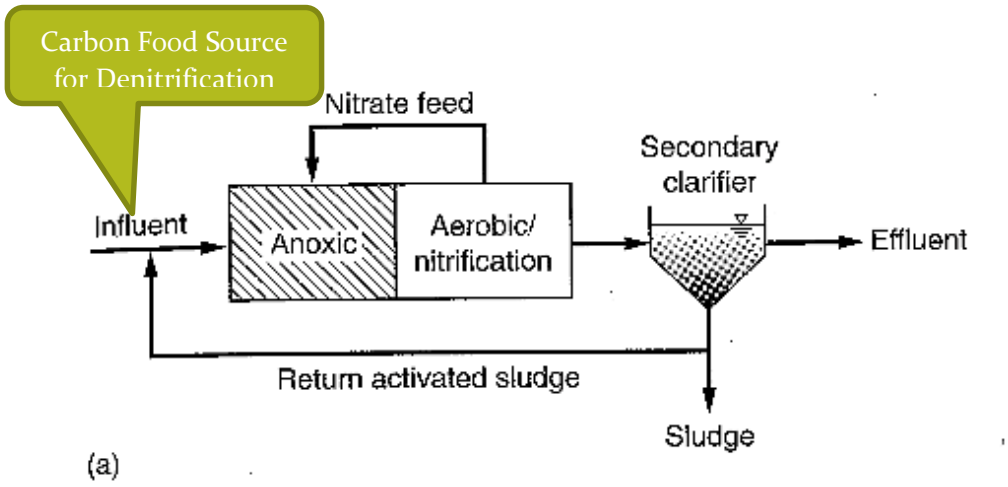


Figure 8-45 Denitrification Process with Incoming Effluent used as Carbon Food Source

The most popular types of tertiary STP plants used to remove nitrogen below 10 mg/l in Suffolk County are as follows:

(1) *Extended Aeration with Denitrification Filter*

Suffolk County has 43 plants that utilize an extended aeration process with denitrification filter to reduce effluent nitrogen to 10 mg/l or less. Historically, conventional extended aeration systems were designed as secondary sewage treatment plants as previously described (**See Figure 8-42**) but have been modified to provide nitrogen removal via a denitrification filter. An example of a denitrification filter is depicted in **Figure 8-46**. **Figure 8-46** depicts an upflow continuous-backwash filter. In order to promote denitrification a carbon source must be added to the filter.[30]

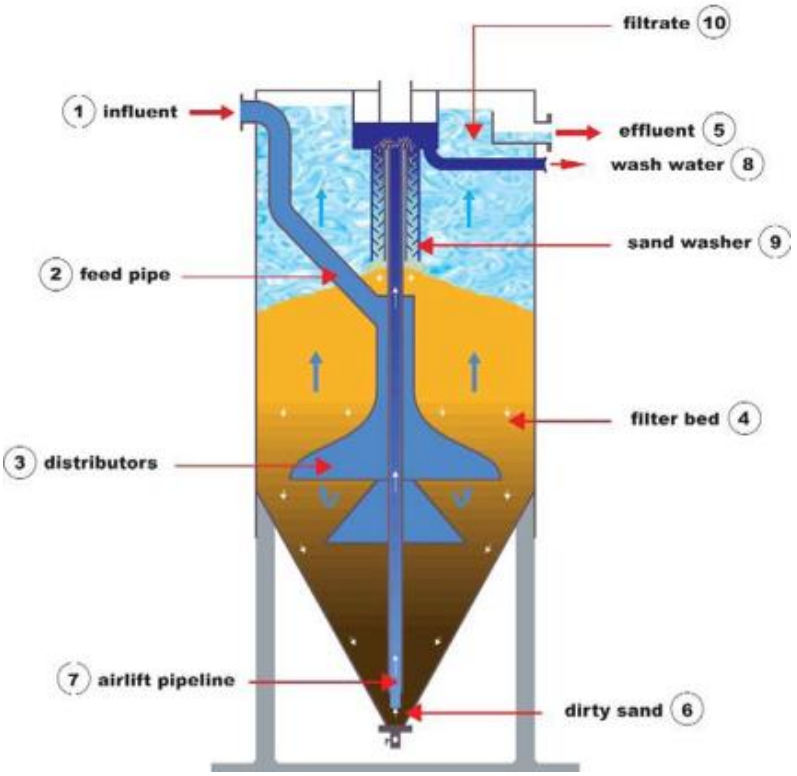


Figure 8-46 Upflow Continuous-backwash Filter

(2) *Rotating Biological Contractors with Denitrification Filters:*
There approximately twelve RBCs with denitrification filters installed in Suffolk County. An RBC consists of a series of closely spaced circular disks of polystyrene or polyvinyl chloride that are submerged in wastewater and rotate throughout it.[29] The disks are rotated approximately 1 to 1.6 revolutions per minute via a mechanical or air-driven drive unit. Aeration is provided for BOD and nitrification reduction when the disk is rotated out of the wastewater and exposed to the atmosphere. **Figure 8-47** is a typical example of an RBC. Wastewater flows through a primary clarifier or fine screen then into the RBC unit then to the secondary clarifier to remove additional solids. Similar to the extended aeration process, a denitrification filter is added to the process to reduce nitrogen.

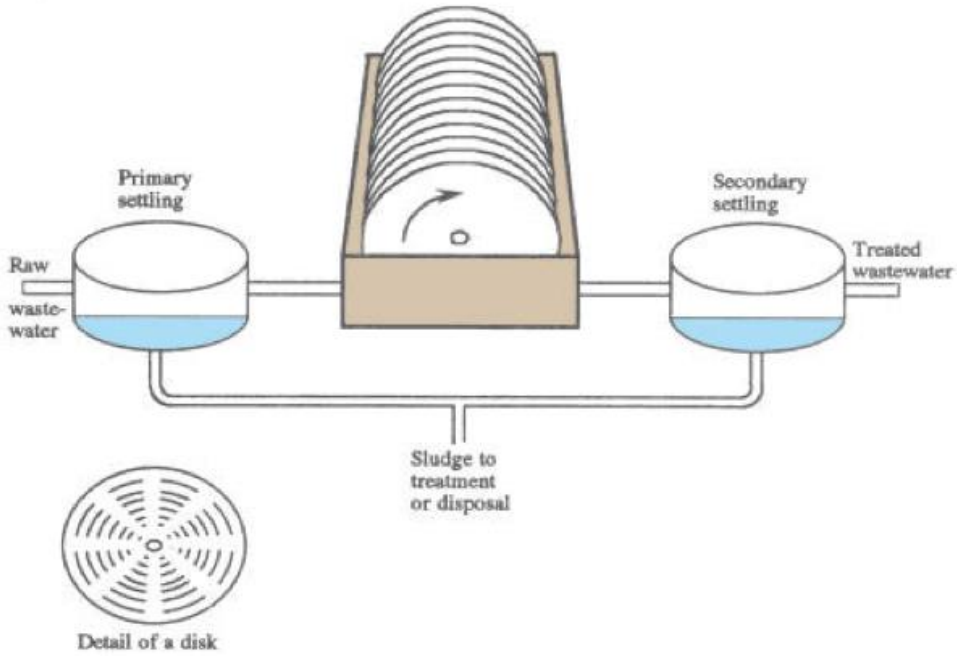


Figure 8-47 Rotating Biological Contractors

(3) Sequencing Batch Reactor:

There are currently approximately sixty-six sequencing batch reactors (SBRs) operating in Suffolk County. Conventional SBRs are an activated sludge process, which operates on fill draw principles. The nitrification, denitrification, settling, and decanting steps all occur sequentially in a single treatment tank on a cyclic basis. Nitrification usually occurs in the aeration phase with the use of aeration blowers and mixers are used during the anoxic phase to complete denitrification by promoting bacterial breakdown of nitrate to permit nitrogen gas to escape.[29] **Figure 8-48** depicts the Sanitaire Intermittent Cycle Extended Aeration (ICEAS) process. The Sanitaire ICEAS process differs slightly from a conventional SBR due to the addition of a pre-reaction tank, which allows continuous flow to enter the SBR tanks even during the settling and decant phase.

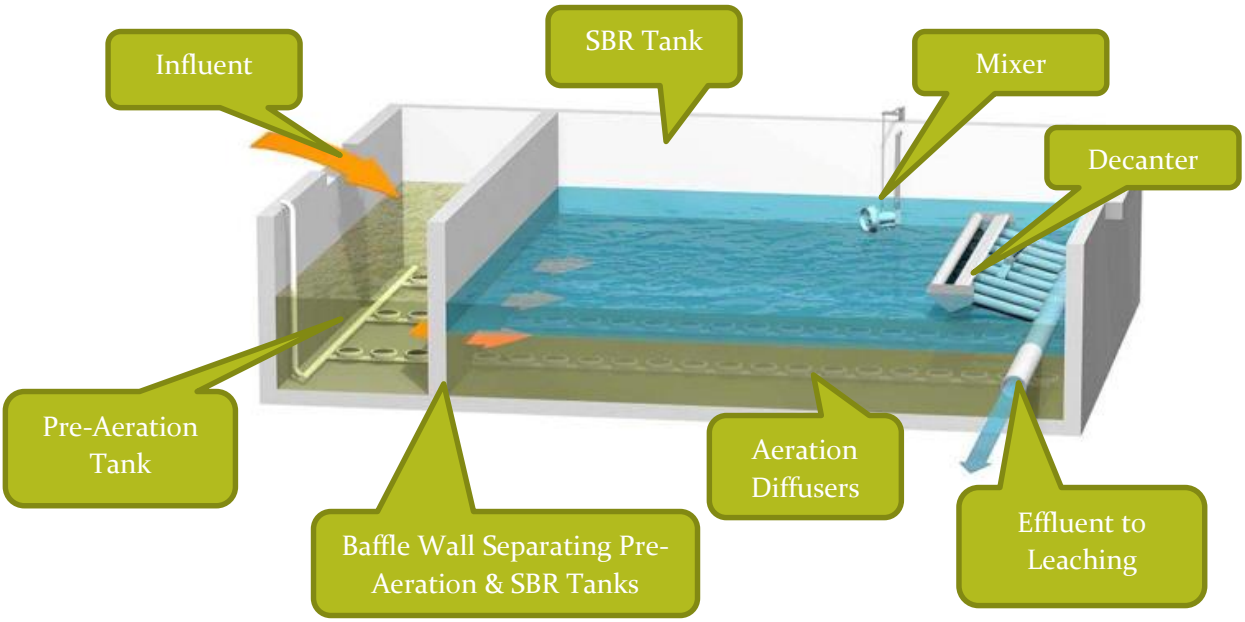


Figure 8-48 Sequencing Batch Reactor with Pre-aeration Tank[31]

(4) CromoFlow:

There are approximately thirty-one CromoFlow (also known as Cromoglass) systems located within Suffolk County. CromoFlow is also a SBR process approved for use in Suffolk County for design flows up to 15,000 gpd. The system uses pumps and venturi aspirators to aerate and mix. In addition, the clarifier section has a baffle wall separating the compartment to permit a continuous flow into the system. These systems are prefabricated packaged systems capable of reducing total nitrogen to 10 mg/l or less when properly operated.

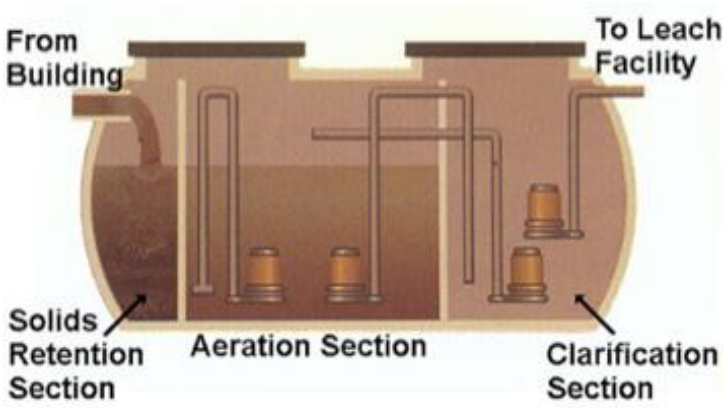


Figure 8-49 CromoFlow Process Tank

(5) *Biologically Engineered Single Sludge Treatment (BESST):*

A 15,000 gallon per day BESST system manufactured by Purestream, inc. was initially installed in Suffolk County Sewer District #12 (Birchwood STP) for piloting purposes in 2001. Some of the incoming wastewater to the sewer district plant was diverted to the BESST system to test the operation and treatability of the system. After successfully completing the pilot with effluent nitrogen below 10 mg/l, the system was permitted to be installed in Suffolk County. The main components of the BESST system are the anoxic compartment, aeration compartment, and clarifier. Since there are no valves isolating the compartments the systems essentially operates as one treatment tank. The anoxic compartment is where denitrification occurs under anaerobic conditions with the use of incoming untreated wastewater as the carbon food source for the microorganisms to assist in the reduction of nitrate to nitrogen gas. Oxygen is provided to the aeration compartment through the use of blowers to complete nitrification as well as reduce BOD. The clarifier is the final step to reduce suspended solids and discharge a portion of the flow to the recharge beds while returning activated sludge (RAS) to the anoxic zone. Therefore the process order follows these steps: (1) influent enters the anoxic zone, (2) flows to the aeration zone, (3) flows to the clarifier were some flow (4A) exits the plant to the leaching system or (4B) RAS is returned to the anoxic tank (See **Figure 8-50**). Some operational keys to reducing nitrogen are the amount of oxygen provided to the aeration zone and the return rate of the RAS. There are currently six BESST systems in operation within Suffolk County.

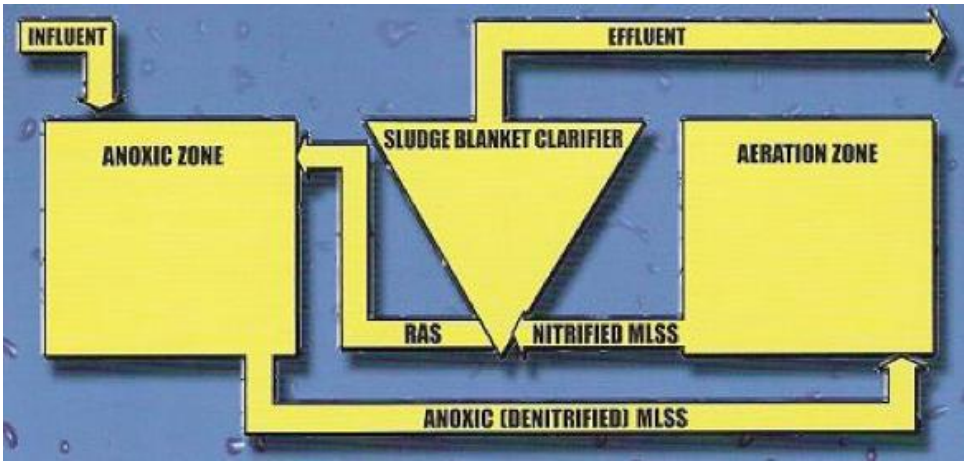


Figure 8-50 Biologically Engineered Single Sludge Treatment (BESST) Flow Diagram

(6) Membrane Bioreactor (MBR):

MBRs are the newest technology to be installed in Suffolk County. They have been used for treatment of sanitary wastewater as well as industrial wastewater. MBRs have been known to provide effluent comparable to a combination of secondary clarification and microfiltration. [29] This type of STP requires smaller footprints then a SBR or extended aeration processes. This is due to the membranes filtering the wastewater which eliminates a clarifier and allows the process to operate at a higher MLSS in the range of 8,000 mg/l to 12,000 mg/l as compared to other processes. The major components of these systems are: (1) preliminary treatment to remove inorganic solids such as a bar screen, screw screen, etc. (2) an anoxic zone for denitrification (3) pre-aeration zone for nitrification and BOD reduction, (4) aerated membrane zone for further nitrification, BOD reduction and discharge. **Figure 8-51** depicts a general MBR setup with the exception of the pre-aeration zone. In the figure, flow enters the anoxic zone, similar to the BESST process then overflows into the aeration/MBR zone. In the aeration/MBR zone a portion of the flow is recirculated to the anoxic zone for denitrification with the incoming untreated wastewater as the carbon food source.
(http://www.hitachi-aqt.com/products/membrane.html)

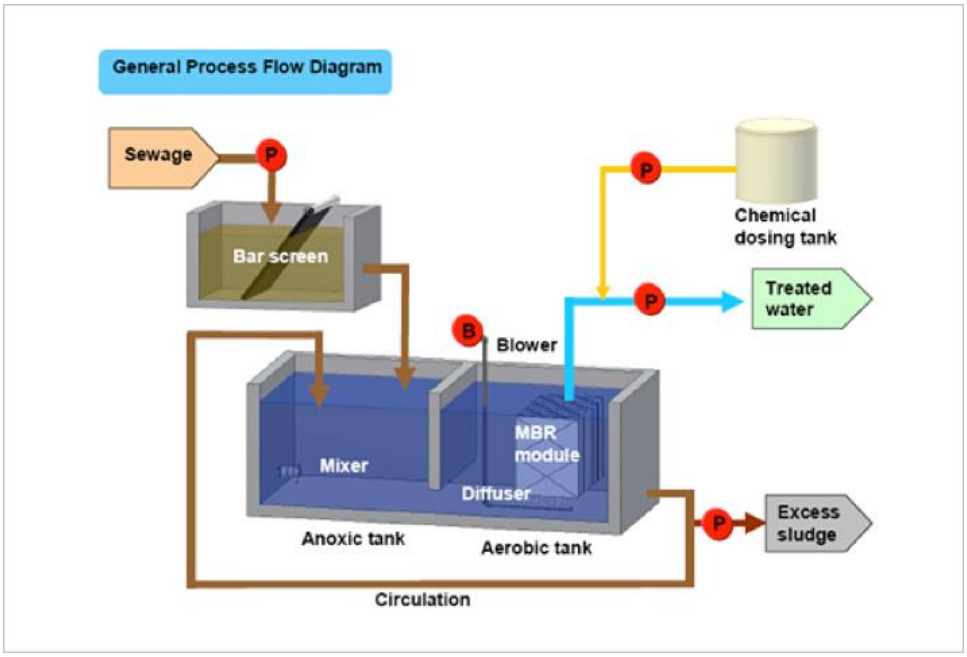


Figure 8-51 Membrane Bioreactor (MBR) Flow Diagram

There are currently two operational MBR plants within Suffolk County which were replacements of two aging STPs. As of 2014 there is one additional MBR plant under construction to replace an outdated secondary plant serving an apartment complex in Commack. Fairfield Properties Commack apartment complex was constructed in approximately 1970 with 256 rental apartment units. A secondary STP was installed on the site to treat the wastewater using an extended aeration process. The plant is over 40 years old and is coming to the end of its useful life. Due to reduced area to construct a new STP, the engineers designing the new plant decided to use MBR technology to reduce nitrogen since it requires a reduced footprint as shown by **Figure 8-52**.

Figure 8-52 New and Existing STP's at Fairfield Commack (Top), Inside Existing Extended Aeration STP at Fairfield Commack (Bottom Left), and Inside New MBR STP at Fairfield Commack (Bottom Right)

Another use of MBR technology is treatment of wastewater for reuse. For example, the Town of Riverhead is constructing an MBR to be used as a wastewater polishing step. Municipal wastewater completes treatment via an SBR process. After the SBR process the effluent will enter the MBR unit for further treatment then pass through a UV system. This will permit the reuse of the effluent for irrigation on the neighboring Indian Island Golf Course. A process schematic is depicted in **Figure 8-53.** [32]

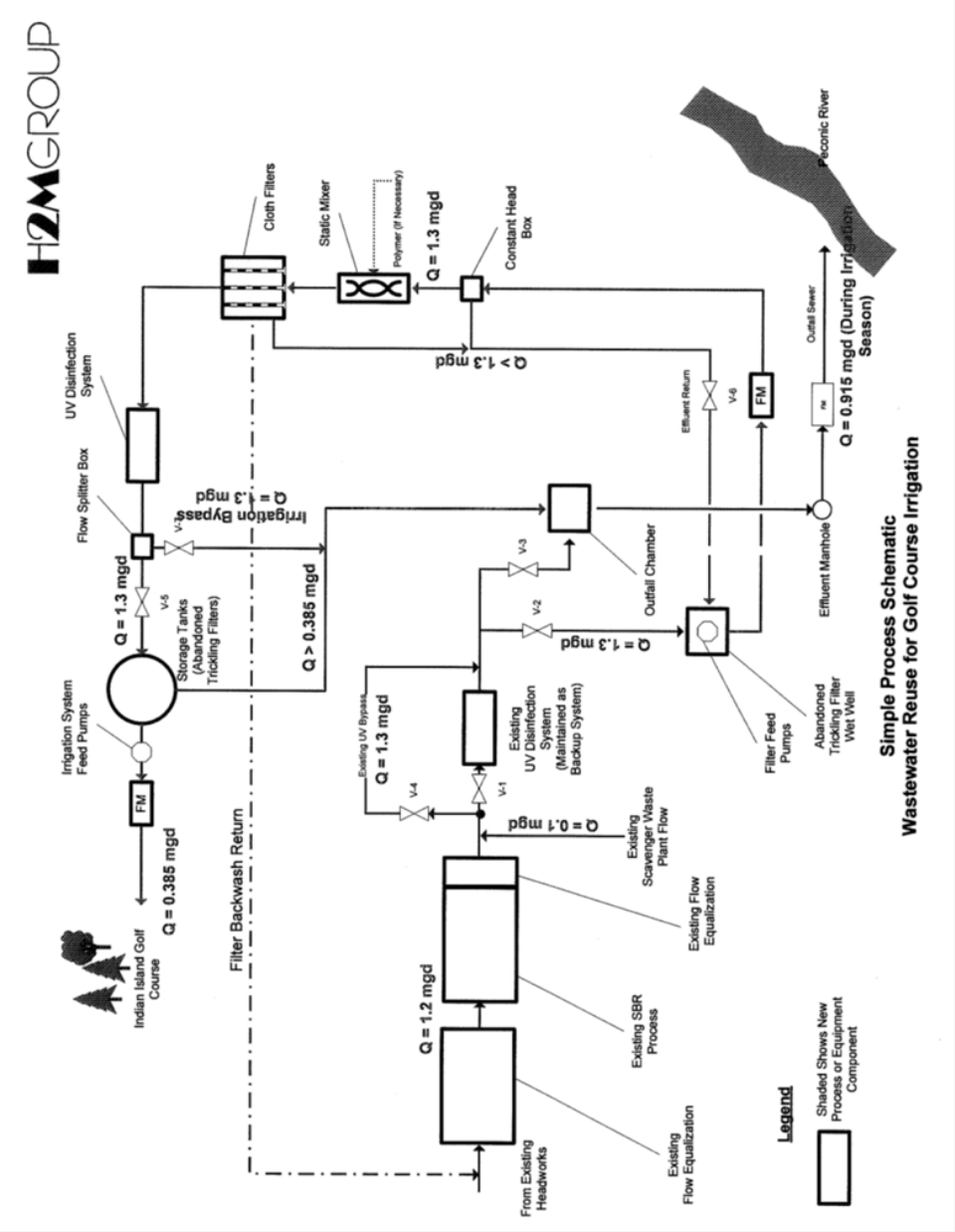


Figure 8-53 Town of Riverhead STP Water Reuse Schematic

Suffolk County Department of Public Works (SCDPW) has been repairing/upgrading and/or replacing sewage treatment plants. In the past 15 years three major sewer district STPs were replaced and/or upgraded. Suffolk County Sewer District # 1 located in Port Jefferson was upgraded from an RBC process to an SBR process. **Figure 8-54** depicts the plant in 2004 and the plant in 2010 after the upgrade. The improvement expanded capacity and reduced effluent nitrogen.

Figure 8-54 Aerials of SCDPW Port Jefferson STP in 2004 (Left) and 2010 (Right)

Suffolk County Sewer District # 6 located in Kings Park was also upgraded from an extended aeration process to an SBR process to reduce total nitrogen and increase capacity for future development. **Figure 8-55** depicts the plant in 2001 and after the plant after the upgrade in 2013.

Figure 8-55 Aerials of SCDPW Kings Park STP in 2001 (Left) and 2013 (Right)

Suffolk County Sewer District # 18 has recently been upgraded to an SBR to improve nitrogen reduction and increase capacity for additional connections to the plant. Sewer District #18 originally consisted of two plants SD# 18N and SD #18S. Both plants were demolished and merged into one plant known as SD#18. SD#18N was an extended aeration with denitrification filter process which was demolished and converted to the leaching area for SD #18. SD# 18S was an RBC with denitrification filter which was demolished and converted to an SBR process. **Figure 8-56** depicts SD#18S in 2010 before the conversion and

the site in 2014 (Picture Google Earth) after the construction was completed. Figure 8-57 depicts SD#18N before the demolition in 2004 and the site in 2014 after the demolition.

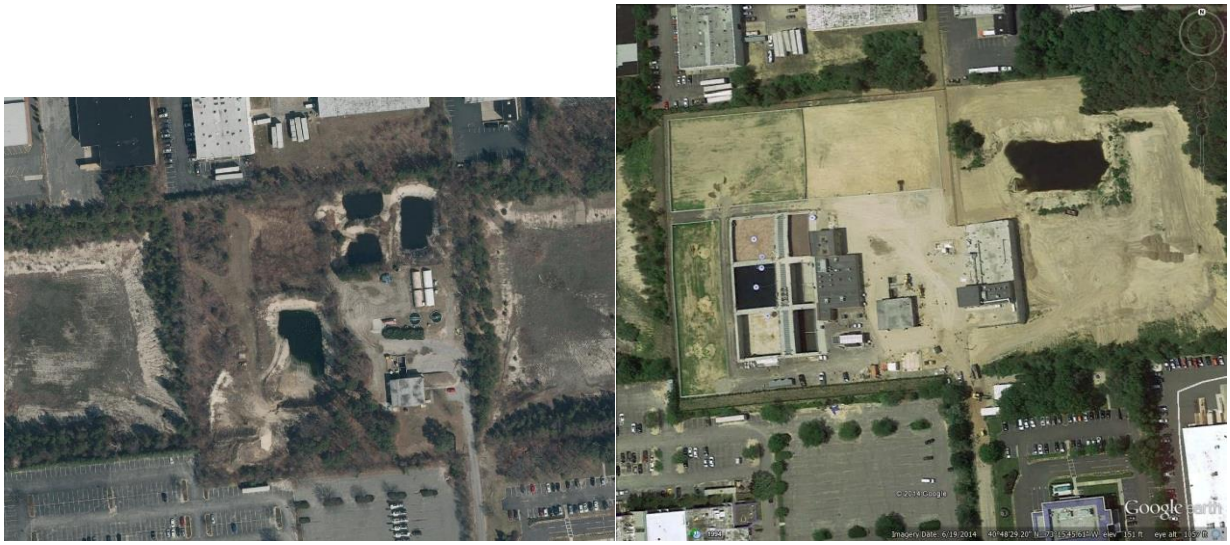


Figure 8-56 Aerials of SCDPW Hauppauge STP in 2004 (Left) and 2014 (Right)

Figure 8-57 Aerials of SCDPW Hauppauge STP Leaching in 2004 (Left) and 2014 (Right)

The SWSD, known as sewer district # 3 is currently undergoing an expansion to increase the capacity from 30 MGD to 40 MGD to permit the connection of

additional facilities (commercial, industrial, and/or residential structures) to the sewer district. In addition, the Bergen Point WWTP recently received a $13.6 million loan from New York State's Storm Mitigation Loan Program for wastewater and storm resiliency improvements at the plant.33

SCDHS and SCDPW must continue to investigate new technologies for modifications to existing treatment plants to increase performance and/or permit effluent reuse (e.g. pumping equipment, aeration equipment, flow measuring equipment, nutrient monitoring equipment, screening equipment, effluent treatment equipment such as UV disinfection, etc.). SCDHS and SCDPW should investigate new treatment processes and consider piloting them at existing SCDPW STPs, such as the pilot of the BESST system, to provide more options for treatment of wastewater. In addition, with the growing concern of emerging contaminants due to increased use of PPCPs, Suffolk County should continue to monitor research progress for new wastewater solutions to help reduce these containments in effluent wastewater streams. The County should evaluate when these new treatment solutions should be implemented, for an example STPs treating effluent from medical facilities such as hospitals, rehabilitation centers, nursing homes, and assisted living facilities. Currently there are approximately 23 STPs operating in Suffolk County serving these types of facilities.

8.3.6 Section Summary

Suffolk County must achieve their wastewater goals and objectives by establishing a wastewater management plan. The plan should clearly identify nitrogen target loads that will reverse ground and surface waters trends such as reversing the increasing level of nitrates in groundwater. The target loads should be used to establish a GIS based map indicating the level of nitrogen treatment for individual parcels to improve water quality. The identified treatment level would be connecting parcels to sewers, installation of I/A OWTS, or installation of a conventional onsite sewage disposal system.

Suffolk County should establish an I/A OWTS program that includes the establishment of an RME to oversee operations, maintenance, enforcement, and financing of systems, create a pilot program that includes demonstration projects, and amend the Suffolk County Sanitary Code and SCDHS Construction standards to permit the an the establishment of an I/A OWTS program.

Suffolk County should build on its $383 million award to sewer approximately 10,000 homes located in Mastic/Shirley, Great River, Patchogue Village, and North Babylon and continue seeking funding sources for future projects to sewer additional areas to improve water resources. In addition, SCDPW should continue developing sewer feasibility studies which will help to prioritize

future sewering projects within the County. Suffolk County should encourage towns and villages to develop their own sewering plan such as the Village of Patchogue sewering plans. In addition, Suffolk County should assist and encourage multiple property owners to form their own privately run decentralized sewer districts to improve water quality.

SCDHS should continue to require the remaining secondary STPs to upgrade to tertiary plants that can remove nitrogen and existing aging tertiary plants that are not meeting required nitrogen discharge limits. In addition, SCDPW should continue on the path of upgrading older STPs to newer technologies and expanding the capacities of existing STPs to permit additional sewer connections. Both SCDPW and SCDHS should continue to evaluate new treatment technologies such as treatment plant technologies or equipment technologies to improve wastewater treatment processes to further reduce nitrogen or PPCPs and permit the reuse of effluent for irrigation.

8.4 Implementation

Improvement of water quality by implementing the goals, objectives and recommendations requires Suffolk County, the Responsible Management Entity, property owners, design professionals, and contractors to play a part in the implementation process. The overall effectiveness of the wastewater management plan can be measured by the acceptance and willingness of these players to implement the plan. This will ensure our water resources are protected and on the path of improvement.

8.4.1 Responsibilities of Suffolk County

Suffolk County's main responsibility is to take the lead in creating an effective wastewater management plan and continue to evaluate and permit technologies to improve wastewater treatment. Suffolk County has already initiated the early steps of developing the plan by researching I/A OWTS programs in other jurisdictions, creating their own I/A OWTS demonstration project, developing this Water Resources Comprehensive Management Plan, performing Sewering Feasibility Studies, and obtaining $383 million from the New York State to extend sewers to the North Babylon, Great River, Village of Patchogue, and Mastic-Shirley areas. These items are the footings for the foundation of a responsible wastewater management plan. Unfortunately there is still more to be done to implement a wastewater management plan to protect and improve our water resources.

8.4.1.1 Study to Identify Priority Areas and Classify Wastewater Treatment Requirements for Each Area

SCDHS is in the process of developing a study to gather valuable information that will be used to prepare the County's wastewater management plan. The

study is expected to be completed within 15-months of selection of a Consultant to assist with the process. The project's final product will be used to guide the County's decision-making process when establishing the best possible prioritized implementation plan for reduction of nitrogen. The Wastewater Management Plan shall define the means of reducing nitrogen discharge from domestic wastewater which impact ground and surface water resources in order to protect and improve drinking water quality, coastal resiliency, and marine habitats.

The Plan will evaluate nitrogen discharge from onsite sewage disposal systems based on a parcel-by-parcel basis using various modeling techniques. This will enable the preparation of a map and plan identifying parcels that will be permitted to remain on conventional onsite sewage disposal systems, parcels that are appropriate to be connected to public sewers, parcels that can be grouped together to connect to a cluster decentralized treatment system, and parcels that would be required to install an innovative/alternative on-site wastewater treatment system (I/A OWTS). The analysis criteria will include ground and surface water modeling, proximity to existing infrastructures such as sewer mains, public water well fields, depth to groundwater, and other factors determined to be essential in developing the Wastewater Management Plan.

The study will provide an evaluation of the potential impacts to surface water ecosystems affected by wastewater generated in the watersheds using available information. Results of this evaluation shall set the nitrogen load reduction targets and/or ambient water quality nitrogen concentration targets. These targets will be useful in establish required wastewater treatment options to meet nitrogen reduction targets (treatment options – connection to STP to meet wastewater effluent total nitrogen (TN) of < 10 mg/l, or I/A OWTS to meet TN <19 mg/l, or conventional system TN>19 mg/l).

The nitrogen targets and/or ambient water quality nitrogen concentration targets established and required treatment options for each parcel will help with the creation of the wastewater management plan. Based on the targets and required treatment obtained from the study, the plan will identify the required treatment and rank and prioritize areas for onsite sewage disposal upgrades by area based on benefit gains such as increased coastal resiliency to storm surges, improved drinking water supply, improved economy, etc. In addition, a required timeline for upgrades can be established to meet the nitrogen targets, the amount of funding required can be estimated to complete the upgrades within the timeline limits.

8.4.1.2 SCDHS Sanitary Code and Construction Standards

A crucial component to permitting the use of I/A OWTS and implementing the wastewater management plan are having standards and codes in effect to address I/A OWTS systems, upgrades/repairs to existing systems, and the RME. The Suffolk County Sanitary Code Article 6 clearly defines when a conventional onsite sewage disposal system can be installed for new construction and when a site must connect to sewers for new construction (new construction includes additions to residential dwellings that include an increase in bedrooms). Article 6 must be amended to include language for the installation of I/A OWTS for new construction in priority areas. As an example section§760-605, paragraph B currently reads:

"B. Individual sewerage systems may be approved by the Department as to the method of sewage disposal provided all of the following conditions are met:

1. *the realty subdivision or development is located outside of Groundwater Management Zones III, V and VI, and all parcels of the realty subdivision or development consist of an area of at least 20,000 square feet; or the realty subdivision or development has a population density equivalent equal to or less than that of a realty subdivision or development of single family residences in which all parcels consist of an area of at least 20,000 square feet;*
2. *the realty subdivision or development is located within Groundwater Management Zones III, V or VI, and all parcels in the realty subdivision or development consist of an area of at least 40,000 square feet; or the realty subdivision or development has a population density equivalent equal to or less than that of a realty subdivision or development of single family residences in which all parcels consist of an area of at least 40,000 square feet;*
3. *the realty subdivision or development, or any portion thereof, is not located within an existing sewer district and is located in an area where subsoil and groundwater conditions are conducive to the proper functioning of individual sewerage systems; and*
4. *the individual sewerage systems comply with the Department's current Standards and the minimum State requirements as set forth in 10 NYCRR, Part 75, to the extent applicable to Suffolk County; and*
5. *the requirements of §760 606 hereof are complied with."*

As an example, an additional sub-paragraph in this section could read:

"Individual sewage systems located in priority areas, identified by the Department, shall install an innovative/alternative onsite wastewater treatment system capable of reducing total nitrogen to 19 mg/l or less acceptable to the

Department for the purpose of protecting ground and surface water resources. Such innovative/alternative onsite wastewater treatment systems shall be subject to the requirements of the Department established Responsible Management Entity per Article XXX, Section XXX of this Sanitary Code"

As for existing residential properties, and if found to be feasible, a new section could be added to the Sanitary Code or Article 5, General Sanitarian, could be revised to include evaluations of systems at the time of transfer. Section §760-605, Sewage Disposal currently reads:

1. No person, either as owner, lessee or tenant of any property, dwelling, building, or place shall construct or maintain any private or individual sewage disposal system, pipe, or drain so as to expose or discharge the sewage contents or any other deleterious liquid or matter therefrom onto the surface of the ground, or expose to the atmosphere nor so to endanger any source or supply of drinking water.

2. No person shall discharge any sewage into any waters of the health district unless a permit therefore has been issued by the Commissioner or unless a permit is issued under the provisions of the New York State Environmental Conservation Law for such discharge.

3. No person shall undertake to construct, operate, or provide a system or facilities for the private or individual disposal of waterborne sewage, domestic or industrial or trade wastes to serve any building, dwelling, school, institution, or any other premises from which such wastes may be discharged, unless such construction conforms to standards approved by the Commissioner or a permit is issued for such system under the provisions of the New York State Environmental Conservation Law. The Commissioner may require the submission of plans and any other information necessary to insure that such systems conform to approved standards.

4. a. No person shall construct or permit to be constructed on any premises any private or individual sewage disposal system where an approved public sanitary sewer is available and accessible.

b. Sewage from any building or premises shall be discharged directly into a municipal sewage disposal system, if available and accessible.

c. If there is no municipal sewage disposal system or facility connecting therewith available and accessible, sewage from any building or premises shall be discharged directly into a privately-owned community sewage disposal system or a facility connecting with a privately-owned community sewage disposal system, if available and accessible.

d. If there is no municipal or privately-owned community sewage disposal system or facility connecting therewith available and accessible, an individual sewage disposal system approved by the Department as hereinafter provided may be used.

e. In the event that a municipal or communal sewage disposal system or facility connecting therewith becomes available and accessible, any building or premises shall be connected to such municipal or privately-owned community sewage disposal system, and immediately thereafter the use of any other sewage disposal system or facility shall be discontinued.

f. At the time of connection of an industrial, non-residential institutional, non-residential commercial or trade building to a municipal or communal sewage disposal system, all other points of liquid discharges except uncontaminated stormwater runoff and non-contact cooling water shall be discontinued and the discharge pipes permanently removed or sealed. All cesspools, septic tanks, dry wells and other drainage facilities for any liquid discharges other than stormwater runoff or non-contact cooling water shall be pumped dry of any liquid, cleaned of any accumulated sludge and filled in to grade with clean soil. Any industrial or domestic sludge or liquid waste resulting from such cleaning shall be removed by a properly licensed industrial or domestic waste hauler. Any pre-treatment necessary to render a liquid waste acceptable to the municipal or communal sewage disposal system shall be provided prior to discharge to the sewer. No discharges to or into the ground shall be allowed when sewer service is available except for stormwater runoff and non-contact cooling water.

As an example, an additional subparagraph could be added to the section to address property transfers as follows:

"*No person shall transfer a property to a new property owner without first having their onsite sewage disposal system inspected by a licensed Professional (Engineer or Architect) and an evaluation report submitted to the Department for review and acceptance. Upon review of the evaluation report by the Department the system shall be deemed acceptable for transfer and a transfer certificate shall be issued or deemed unacceptable for transfer and the system must be upgraded to Department current standards by submitting an application to the Department per Article 6 of this Sanitary Code prior to issuance of a transfer certificate. Transfers exempt from this requirement are:*

a) Transfer from a spouse.

b) Change in ownership solely to exclude a spouse.

c) Transfer subject to life lease or life estate, (until the life lease or life estate expires).

d) Transfer to effect foreclosures or forfeiture of real property.

e) Transfer into a trust where the settlor or the settlor's spouse conveys property to the trust and is also the sole beneficiary of the trust.

f) Transfer creating or ending joint ownership if at least one person is an original owner of the property or his or her spouse.

g) Transfer to establish or release a security interest, i.e. pay off mortgage.

h) Premises built within the previous twenty-four months prior to date of property transfer, i.e. newly constructed home with system approved by the Department.

i) Premises that shall be demolished and shall not be occupied after the property transfer.

j) New homes that have not been occupied.

k) Municipal Sanitary Sewer and/or municipal water service will be available within three (3) months, and system is not failing. Affidavit will be required.

l) Refinance of mortgage connected to the property.

m) A property which receives a final inspection approval by the Department for either an onsite water supply system or septic system during the previous twelve (12) months. After the 12 month period has passed and the Department has not received a notice of deed transfer, the Department will notify the owner and/or applicant that the letter of approval has expired. At that time, the owner and/or applicant will have sixty (60) days to request a follow up inspection and if the inspection demonstrates conditions have not changed, an extension of the initial letter of approval for the property will be issued by the Department. This extension will not exceed twelve (12) months from the expiration date of the initial approval letter."

Currently, the USEPA is undertaking a Health Impact Assessment to provide an unbiased assessment of the impacts of updating the existing codes and standards to require onsite sewage disposal upgrades during property transfers, failures, or by a defined schedule based on priority areas. These upgrades could be the replacement of existing cesspools with conventional sewage disposal systems or replacement of existing cesspools and conventional on-site sewage disposal systems with I/A OWTS. The Health Impact Assessment was initiated by USEPA at the end of 2014 and is expected to be completed during 2015.

NYS Title 10. Department of Health Chapter II Part 75 Appendix 75-A are the wastewater treatment standards for residential onsite systems which were revised in 2010 to include information about enhanced treatment units and responsible management entities (RME). The definition of RME in appendix 75A includes a similar definition to the EPA definition as stated in section 8.3 but also includes a requirement of financing long-term O&M of systems as stated below:

"Responsible Management Entity (RME) - a legal entity with the requisite managerial, financial and technical capacity to ensure long-term management of residential wastewater treatment systems. RMEs may include: sewer districts, utilities, municipal authorities or other entities with the authority to enforce and the capacity to finance the long-term operation and maintenance requirements necessary to ensure residential wastewater treatment systems are functioning properly."

Other amendments to the code would have to address formation of the RME and enforcement powers. In addition the construction standards would have to be updated to address I/A OWTS such as a permitting process to allow a system to be installed in Suffolk County and minimum construction standards. This could be accomplished by amending the current standards or by issuing a new construction standard solely for I/A OWTS.

Appendix 75A and the updated companion to the appendix the "Residential Onsite Wastewater Treatment Handbook" issued 2012 provides standards on the installation of I/A OWTS and management of these systems. The Enhanced Treatment units identified in the Appendix and Handbook are generally systems capable of reducing BOD and suspended solids in wastewater, but these types of systems are similar in design to systems capable of reducing nitrogen. For example, the Orenco Advantex systems have three operating modes with the only variation difference in recirculation configurations. By modifying the recirculation they can increase nitrogen reduction.

The Suffolk County Sanitary Code defines the requirements for sewage and water supplies within Suffolk County. The Residential and Commercial construction standards state the sewage disposal systems permitted to be used in Suffolk County. As stated in section 8.3.3.1, both the Sanitary Code and Construction Standards would need to be amended to permit the use and evaluation I/A OWTS technologies, define the functions and powers of the RME and SCDHS, define when systems are required to be certified and upgraded or repaired. These Codes and Standards can be revised using Appendix 75A along with the "Residential Onsite Wastewater Treatment Handbook" and as stated in 8.3.3.1 Macomb County, Michigan "Regulations

Governing On-Site Sewage Disposal and On-site Water Supply System Evaluation and Maintenance" and Massachusetts Tile 5 Septic System Regulations among other jurisdictions regulations, codes, and standards.

With the concern for emerging contaminants and rising sea levels the construction standards should provide provisions for use of new technologies for treatment of emerging contaminants if determined to be required. In addition, the standards should address rising sea/groundwater level by providing increased separation between the bottom of leaching structures and groundwater and permitting the use of and outlining the requirements of alternate leaching systems such as pressure dosing shallow narrow drain fields.

SCDHS is currently working on updating the residential construction standards to permit the use of an I/A OWTS and in the future the Sanitary Code and commercial construction standards will be revised. These standards will permit the use of I/A OWTS, expedite the installations by requiring I/A OWTS for new construction, modifications to existing structures (e.g. addition of bedrooms), and system evaluations at the time of property transfer, ensure the systems are properly operated and maintained to meet total nitrogen requirements, address contaminants of emerging concern, and rising sea/groundwater levels which are all required to implement the wastewater management plan.

8.4.1.3 Creation and Functions of a Responsible Management Entity to Oversee Funding, Operation, and Maintenance of an I/A OWTS Program

After an I/A OWTS or a decentralized STP is installed, the County must be assured that the system is functioning properly to meet total nitrogen discharge limits to meet nitrogen load targets. These systems require operations and maintenance (O&M) contracts to ensure they are functioning properly and meeting discharge limits. Most of these types of systems have mechanical components that are susceptible to failure, which could eliminate the ability of a system to meet discharge limits or could cause an overflow condition creating a public health hazard. Larger systems (other than single-family dwellings) such as decentralized STPs require daily routine O&M due to the high volume of wastewater being treated. I/A OWTS, on the other hand, require minimum O&M.

A means must be in place to ensure O&M is being completed in order for systems to meet discharge limits. The oversight of these systems is usually accomplished by a Responsible Management Entity. As discussed in the recommendations sections the preferred RME would follow the EPA's Management Model 4 where the RME is responsible for operation and

maintenance. Permitting and construction oversight would still fall within the SCDHS jurisdiction if the RME was an entity independent of the SCDHS.

In addition the RME's responsibilities in Suffolk County would be to provide educational outreach to homeowners, contractors, and design professionals and provide financing options for property owners to permit them to install or repair an I/A OWTS or decentralized STPs in an affordable manner, oversee the operation and maintenance of I/A OWTS and privately owned decentralized STPs.

As soon as the SCDHS updates/amends the Suffolk County Sanitary Code and Construction Standards to permit the use of I/A OWTS, without the need for a variance, and before the creation of the wastewater management plan the SCDHS Office of Wastewater Management should assume the role of temporary RME. After financing options are established for property owners for upgrades and repairs of I/A OWTS, which would be issued by the RME and the wastewater management plan is completed then a public entity or new branch of SCDHS should be established to operate as the RME as determined by the County. One idea outlined in the Suffolk County IBM Smarter Cities report entailed the County consolidating water and wastewater management processes through the integration with the Suffolk County Water Authority, but the legality of instituting the combined water and wastewater through the SCWA would have to be determined. In addition, funding of the RME would have to be provided.

One advantage of establishing the RME as part of the SCDHS is the RME can utilize the existing staff and enforcement powers to regulate I/A OWTS such as issuing violations to property owners who are not maintaining O&M contracts or failing to repair an I/A OWTS. In addition, all of the components of a I/A OWTS program would be under one roof including permitting, evaluation of new technologies, funding of systems, tracking and enforcement, rather than as splitting the duties between the SCDHS and a public entity RME. If the RME was to be part of the SCDHS then funding would be assumed through the County's General Fund or by other means, but if the RME was a public entity then a type of usage fee would likely have to be created under the guidance of the County. One example of a fee issued by Maryland that could be used as a financing means of a SCDHS RME or public entity RME, Maryland created the Bay Restoration Fund (BRF) fee where 60% of the BRF goes to onsite sanitary system and wastewater treatment plant upgrades. The BRF fee assigned to the property tax the fee is $60 per household. Eight percent of the 60% BRF funds used for onsite sanitary system upgrades funds the Maryland Department of the Environment overhead cost to implement the I/A OWTS program such as:

- Review and approval of the design and construction of upgrades,
- Issue loans as the provider,
- Implement an education, outreach, and upgrade program to advise owners of onsite sewage disposal systems on the proper O&M of the system
- Provide technical support to owners of upgraded onsite sewage disposal systems to operate and maintain the upgraded system.

If Suffolk County was to institute a similar fee such as a wastewater discharge fee at $60 per household with private sewage disposal per year (or $5.00 per month) then $21.6 million ($60 per household x 360,000 households) would be collected and 8 percent or $1.73 million would be used to fund the SCDHS RME operation while the remaining $19.87 million could be used for onsite sewage disposal system upgrades in the form of grants.

As part of the RME establishment the County must implement a computer based tracking system such as Barnstable County, MA Carmody system.[15] This would allow the RME to track when I/A OWTS contracts have expired, when the system was pumped out, and when repairs were performed. In addition, sampling data for each system could be entered on the system for performance tracking purposes and could be used as part of a possible data sharing agreement with other jurisdictions utilizing I/A OWTS.

The creation of an RME is estimated to be complete in the third quarter of 2015, which is one of the components to allow the installation of I/A OWTS. In addition, the RME would help to implement the wastewater management plan to ensure water quality goals are being met through proper installation and operation of I/A OWTS and decentralized STPs.

8.4.1.4 Permitting and Evaluation of Innovative/Alternative Onsite Wastewater Treatment Systems for Use in Suffolk County

The main requirement of I/A OWTS is to reduce total nitrogen discharge to the environment. There are many proprietary and non-proprietary systems on the market that claim to reduce nitrogen. Suffolk County is in the process of establishing a means of evaluating I/A OWTS to gain confidence that the systems permitted for use in Suffolk County will provide adequate nitrogen reduction to improve water resources. Suffolk County has developed a tentative process for obtaining approval to install an I/A OWTS, which mirrors the Massachusetts Title V standards. The process for obtaining approval would be similar to the following steps:

1) A manufacturer would submit design specifications and sampling data to SCDHS for review. SCDHS will review the information and if found acceptable will permit the I/A OWTS to be installed as a pilot system.
2) Pilot System – A minimum of five pilot systems would be required to be installed and sampled bi-monthly for a period of 18-months (maximum 15 systems permitted to be installed during the pilot phase). The sampling and operational performance of the pilot systems will be evaluated by SCDHS. Piloting is considered successful if a minimum of 75% meet total nitrogen removal targets for 12 months. If determined acceptable then the system would be granted provisional approval.
3) Provisional Approval – Under provisional approval, 50 I/A OWTS must be installed and sampled for a minimum of 36-months. Again, SCDHS will review the sample results and operation performance. Provisional Use is considered successful if at least 90% of the systems perform properly. If determined acceptable then the system would be granted general use approval.
4) General Use Approval – Systems certified for General Use should maintain the approval as long as there are no significant environmental or public health concerns (e.g., recurring overflows/failures or odor nuisances that can't be abated with proper operation and maintenance).

Table 8-24 Example Standard I/A OWTS Approval Process

Standard Innovative Alternative Onsite Wastewater Treatment Systems Approval Process			
	Pilot Systems	**Provisional Approval**	**General Use Approval**
Number of Systems Required	5 to 15	50	50+
Months of Sampling	0 to 18	36	n/a

Suffolk County has initiated a demonstration project to be used to evaluate I/A OWTS where manufactures pay for the cost of installation of their system. A total of four manufacturers have committed to installing 19 total systems for evaluation and educational purposes. By participating in the demonstration project these manufacturers will be able to fast-track the approval process in Suffolk County as depicted in **Table 8-25** in section 8.3 and **Figure 8-29**. It is anticipated that future demonstration projects will be held to permit the same fast-track privileges to other manufacturers.

Table 8-25 Example Demonstration Project I/A OWTS Approval Process

Approval Process for Innovative Alternative Onsite Wastewater Treatment Systems Installed As Part Of The Demonstration Project W/ NSF 245 Certification or ETV Certification			
	Pilot Systems	**Provisional Approval**	**General Use Approval**
Number of Systems Required	1 to 5	50	50+
Months of Sampling	0 to 6	24	n/a

In order to increase the number of types of I/A OWTS permitted for approval in Suffolk County, the County should consider participating in an I/A OWTS data-sharing program between jurisdictions. One such data-sharing program under development is the Chesapeake Bay states data-sharing program for I/A OWTS. This program will allow jurisdictions to use data from other states to prove the effectiveness of a system. If Suffolk County joined this data-sharing program with the Chesapeake Bay states or created our other jurisdictions then instead of a manufacturer installing five pilot systems the County could review the systems installed in the Chesapeake Bay States and evaluate the data of the systems. If the data is found to be acceptable then the system could move directly to the provisional approval stage without a manufacturer installing a system within Suffolk County.

A program to evaluate and permit the use of I/A OWTS in Suffolk County would be outline in the Suffolk County Sanitary Code and be implemented by SCDHS or the RME. Evaluating and permitting I/A OWTS for use in Suffolk County is necessary for the creation of the wastewater management plan since the use of these systems will enable communities to meet nitrogen targets outlined in the plan when community sewerage treatment is not available.

8.4.1.5 Funding of Innovative/Alternative Onsite Wastewater Treatment Systems (I/A OWTS)

In 2012 Suffolk County prepared a report titled "Suffolk County Decentralized Wastewater Needs Survey". The report outlined the cost to install or replace conventional sanitary system under three scenarios. The first scenario was a standard site with good soils and no ground water conditions installing a 1,500 gallon septic tank with 8' diameter by 16' deep leaching pool. From **Table 8-26**, the average cost for a standard installation of a new conventional system plus abandonment of the existing sanitary system was $6,880. Additional scenarios were also reviewed such as a site with poor soils, which would yield an average sanitary system replacement cost of $19,346 and the worst-case site scenario

with poor soils and high ground yielded an average sanitary system replacement cost of $53,230.[1]

Table 8-26 Average Cost of Installation of a Conventional Sewage Disposal System Consisting of 1,500 gallon septic tank with 8' diameter by 16' deep leaching pool

Contractor	Cost of System	Cost of Abandonment	Total
Al Aparo	$5,739	$900	$6,639
Hampton Drainage	$4,500	$2,000	$4,500
Latham	$5,000	$2,500	$7,500
		Average	$6,880

During the septic tour representatives from Suffolk County obtained estimates for the installation of I/A OWTS treatment systems only. **Table 8-27** depicts the average cost of purchase, installation and O&M for systems approved for use in Maryland. The average cost of these systems is $11,596.[15]

Table 8-27 Average cost of Purchase, Installation and O&M for Systems Approved for Use in Maryland

BAT Approved technologies	Cost of Purchase, Installation and 5 Year O&M	O&M per Year After 5 year Contract
Orenco Advantex AX20	$12,300	$200
Orenco Advantex AX20RT	$12,300	$200
Hoot BNR	$11,954	$150
Norweco Singulair TNT	$11,079	$90.88
Norweco Singulair Green	$11,079	$90.88
Septitech M400 denite	$13,056	$399
Bio-Microbics RetroFAST	$9,405	$300

In New Jersey the average cost of an I/A OWTS with installation and O&M was $18,401 based on the data in **Table 8-28**.[15] Some of the I/A OWTS require a septic tank preceding the treatment unit, which would mean that the total average cost for a standard site to replace their system with an I/A OWTS would be between $18,276 and $25,081. In some cases where septic tanks are not required, such as with the installation of a BUSSE system, the total cost may be reduced.

Table 8-28 Average Cost of Purchase, Installation and O&M for Systems Approved for Use in New Jersey Pinelands

System	Average Treatment System Cost & 5 Year Service Cost	Average Total Cost
Amiphidrome	$19,196	$31,492
Bioclere	$17,654	$31,866
Cromaglass	$22,345	$35,262
FAST	$17,819	$29,633
Bio Barrier	$15,000	N/A
Busse GT	$24,000	N/A
SeptiTech	$16,700	N/A
Hoot ANR	$14,500	N/A

The high costs of I/A OWTS plus the annual O&M cost which can range from as little as $90 year to as high as $1,000 per year places a financial burden on property owners. In order to ease the burden of the installation costs affordable funding options must be established and provided to property owners.[15]

Table 8-29 Average I/A OWTS O&M Costs in Jurisdictions Outside of New York

Septic Tour Jurisdiction Visited	Reported I/A OWTS O&M Contract Yearly Cost
Maryland DEP	$90 to $399
NJ Pinelands Commission	$600 to $1,000
Rhode Island	Not Provided
Barnstable County, MA	Not Provided

Three funding options implemented in other jurisdictions are low interest loans, grants for I/A OWTS treatment unit, and tax incentives. Most jurisdictions obtaining funding to issue loans obtain a loan from the State Revolving fund then use the money to issue low interest loans to property owners. Rhode Island is an example of a state using revolving funds to issue low interest loans for onsite sewage disposal system upgrades or repairs. The Rhode Island Clean Water Finance Agency issues loans to the local communities (Counties, Towns, and Villages) at 0 % interest. The local communities then issue loans to property owners at 2% for 10 years ($25,000 max) to repair or upgrade existing onsite sewage disposal systems.

The New York State Environmental Facilities Corporation (NYSEFC) works with the NYSDEC to issue low-cost financing through the States Clean Water

State Revolving Fund (CWSRF). Interest rates can be as low as zero percent. Suffolk County can apply for financing from the CWSRF as a nonpoint source pollution project which permits funding for decentralized wastewater treatment systems to replace deficient or failing on site systems, including costs for new or replacement septic systems. Environmentally innovative projects that demonstrate new and/or innovative approaches to delivering services or managing water resources. The wastewater management plan is a project that would prioritize areas for upgrades of existing onsite sanitary system to I/A OWTS to reduce nonpoint source nitrogen pollution to surface waters and drinking water supplies. CWSRF loan money can then be used by the RME to provide affordable financing to property owners to upgrade their onsite sewage disposal systems to an I/A OWTS to improve water resources.[34]

Example payment of a I/A OWTS if Suffolk County issues a low interest loan to cover the entire cost of the system installation at a 2% and 1% annual interest rate for 10, 20 and 30 year terms (Interest rates based on RI and MA loan program rates) are summarized on **Table 8-30**.[15]

Table 8-30 Example Monthly Financed Payments for the Installation of an I/A OWTS

I/A OWTS Payment for 1% and 2% annual interest rate for 10, 20 and 30 year terms (Cost Includes Septic Tank, Advanced Treatment Unit, and Leaching product, installation & O&M Cost)				
Interest Rate	**Average Amount Financed (Min and Max Standard System Cost)**	**10 years (Monthly payment)**	**20 years (Monthly payment)**	**30 years (Monthly payment)**
1%	$18,276	$160.09	$84.04	$58.78
	$25,081	$219.71	$115.34	$80.67
2%	$18,276	$168.76	$92.46	$67.55
	$25,081	$230.78	$126.88	$92.70

The second funding option is for the Suffolk County to provide grant opportunities to homeowners to fund upgrade of their onsite sewage disposal system. As previously stated in section 8.4.1.2 Suffolk County could create a fund similar to Maryland's BRF where the fees collected for the fund would be used to finance the RME and provide grants to homeowners for the cost of the I/A OWTS treatment unit and installation. If Suffolk County created a wastewater discharge fee at $60 per household with private sewage disposal per year (or $5.00 per month) then $21.6 million ($60 per household x 360,000

households) would be collected and 8% or $1.73 million would be used to fund the SCDHS RME operation while the remaining $19.87 million could be used for onsite sewage disposal system upgrades in the form of grants. This grant would pay for approximately 1700 to 1100 I/A OWTS treatment units per year based on the average treatment unit costs from Maryland and the New Jersey Pinelands Commission. This would amount to a total nitrogen reduction in Suffolk County of 52 to 81 lbs./day for every 1100 to 1700 systems upgrade by the grants (assumes 300 gpd per system based on SCDHS standards and effluent total nitrogen of 19 mg/l).

A third funding option would be to provide tax incentives to property owners in priority areas who upgrade their onsite sewage disposal system to an I/A OWTS system. The State of Massachusetts offers a tax credit for 40% for repair or replacement of failed cesspools or septic systems up to $6000, spread over 4 years at $1500 per year. Suffolk County would have to investigate the feasibility of implementing a tax credit.

In addition to the above, Suffolk County can offer combinations of the three funding options such as low interest loans combined with grants. The grant could pay for the treatment unit and the loan would be used to finance the septic tank and leaching components, which would reduce a 10-year payment to $101.58 to $161.19 at an interest rate of 1% and $106.70 to $169.31 at 2% interest rate.

If Suffolk County can identify funding sources for the installation of I/A OWTS implementation of the wastewater management plan will occur at a faster rate than if no financing options were provided. In addition, the residents of Suffolk County will see an expedited improvement in water resources as well as a reduced financial burden when installing an I/A OWTS.

8.4.1.6 Decentralized Sewage Treatment Plant Systems

Suffolk County has a number of operating decentralized sewage treatment plants systems serving one or more tax parcels. Most of the decentralized sewage treatment plant systems (non-municipal) were created during the initial phases of development of a subdivision, apartment building, condominium or townhouse development, and industrial/commercial building to permit the project to exceed the Article 6 of the Suffolk County Sanitary Code density requirements. Decentralized sewage treatment plants are required to produce maximum effluent nitrogen of 10 mg/l. The creation of decentralized sewage treatment systems is easy to establish before a site is developed since a developer incorporates the cost of sewering into the selling price of a dwelling, condominium, or townhouse and the rent of an apartment, industrial building, or commercial building.

These types of systems will continue to be implemented by developers for new projects and reviewed and approved by the SCDHS and SCDPW. Monitoring and enforcement operation and maintenance of these systems will continue to be controlled by the SCDHS unless transferred to a RME.

The use of decentralized sewage treatment plant systems is another means of sewering existing developed areas. For these cases, property owners would have to join together to sewer multiple lots. In some cases the cost to construct and installation of a cluster decentralized treatment system has been estimated to be less than a centralized treatment system. One example is depicted in the engineering report prepared by Applied Water Management, dated December 2013, prepared for Peconic Green Growth for a proposed decentralized system to serve West Mattituck.[35] The proposed nitrogen load per day would be reduced from 58.35 pounds/day (lb./day) to 10.4 lb./day. The proposed collection system was recommended to be a combination of gravity and low-pressure sewers. The estimated project cost was stated to be approximately $10.6 million.

The proposal is to sewer 365 single-family dwellings, 36 future single-family dwellings, and a couple of commercial structures with a total design flow of 124,100 gpd. These types of systems would still require approval of the Suffolk County Sewer Agency and a Sewer Agency Contract must be put in place with provisions for the County to take over the plant under certain circumstances. The major roadblocks are organizing homeowners to participate in forming the decentralized system and the cost. If Suffolk County or a local municipality were to organize a small community plus provide funding to construct and install the system then the homeowners could possibly form a type of owners association, which would own and operate the plant possibly reducing costs. Further evaluation of this concept would have to be completed to determine if it would be feasible, economically viable, and could be legally accomplished. If found to be an acceptable and affordable means of sewering then it would help the implementation of the wastewater management plan and oversight of the new decentralized sewer district owned by the association would fall under the oversight of the SCDHS or RME.

8.4.1.7 Public Sewer District Expansions and/or Creation in Identified Priority Areas (Centralized/Municipal)

SCDPW has begun the initial phases of expanding sewers and STP capacity. Suffolk County has recently evaluated the feasibility of sewering various areas throughout Suffolk County through the implementation of the Suffolk County Sewer District/Wastewater Treatment Task Force established by the Suffolk County Legislature to examine Suffolk's existing wastewater treatment facilities, educate the public as to the environmental and economic benefits of wastewater treatment facilities, and seek out public and private resources of

funds to expand Suffolk County's wastewater treatment facilities to suitable areas in the County.

The areas studied or in the process of being studied are Bellport-North Bellport, Deer Park-North Babylon-Wyandanch, Flanders Riverside Corridor, Lake Ronkonkoma Hub, Mastic-Shirley, NY 25 Corridor, Sayville, Southampton Village, and Yaphank. The expansion of sewers into the areas studied has the ability to reduce the nitrogen load to area water resources and improve the local economy in each area. The feasibility studies established costs and anticipated implementation schedules. Due to the high property owner costs associated with the extension of sewers in these areas it was determined that grant funding would be required to extend sewers and remove the financial burden from residential property owners.

One grant was recently received by Suffolk County in the amount of $383 million to extend sewers to portions of the Babylon-Wyandanch study area, Mastic-Shirley Study Area, Great River, and the Village of Patchogue. This will reduce nitrogen loads by eliminating existing onsite sewage disposal systems, which will reduce the nitrogen load to the Great South Bay to improve coast resiliency. In addition, abandonment of onsite sewage disposal systems and connection to sewers in shoreline areas will eliminate the impacts of sea and groundwater level rise to onsite sewage disposal systems. Suffolk County must continue to conduct sewer feasibility studies in identified priority areas and seek additional funding sources to implement the results of the sewer feasibility studies to reduce wastewater nitrogen to improve water resources and local economies. Based on the feasibility studies and study to identify treatment based on a parcel-by-parcel basis (as identified in section 8.4.1.1) Suffolk County can prioritize areas to be sewered. The information is useful in the preparation of a wastewater management plan.

8.4.1.7.1 Improved Sewage Treatment Plant Technologies

SCDPW and SCDHS have both been exploring and permitting the use of improved sewage treatment technologies such as the MBR process. SCDPW and SCDHS will continue to explore new technologies to improve wastewater treatment plant to further reduce nitrogen and emerging contaminates. Pilot programs at existing SCDPW plants are essential to determine if technologies meet claims and would be eligible for implementation in Suffolk County. Technologies can range from full-scale treatment processes to minor process improvement equipment such as pumps, aeration blowers, effluent filters, UV systems, odor control systems, monitoring equipment, etc.

SCDPW and SCDHS should implement water reuse programs such as the Town of Riverhead program where highly polished effluent produced through the use of MBR and UV technology will be used to irrigate a neighboring golf

course. Similar opportunities exist at the SCDPW Bergen Point STP with modifications to use effluent to irrigate the Bergen Point Golf Course and the SCDPW Wind Watch STP with modifications to irrigate the Hamlet Wind Watch Golf & Country Club.

In addition SCDPW has been actively upgrading existing STPs to replace existing aging STPs, improve processes, and increase treatment plant capacity. Some of these treatment plants were discussed in section 8.3.5. These improvements are essential to providing the capacity to extend sewers to unsewered lots and reducing wastewater nitrogen. SCDHS has also been actively requiring owners of private decentralized STPs to upgrade their secondary treatment plant process or aging tertiary treatment process to improved tertiary treatment process to provide improved nitrogen reduction resulting in an 2013 overall wastewater effluent nitrogen average in Suffolk County of 8.7 mg/l which is less than the requirement of 10 mg/l.

Improved sewage treatment plant technologies help Suffolk County meet our water quality goals as part of the wastewater management plan. As an example MBR technology, was proposed as part of some of the sewer feasibility studies where STPs were required due their ability to meet effluent total nitrogen between 3 to 5 mg/l when properly operated.

8.4.1.7.2 Evaluation of Existing Capacity of Scavenger Plants to Process Waste from On-site Sanitary Systems Based on a Defined Pump-out Schedule

Suffolk County has three scavenger plants in operation to treat waste sludge from STPs and pump-outs from onsite sewage disposal systems. STP sludge holding tanks are pumped on average once a month. As for onsite sewage disposal systems, property owners usually have them pumped only when they start to backup into the building they serve. This means if a system has a septic tank and leaching pool that the septic tank was excessively full and solids were discharging from the septic tank clogging leaching systems. If this occurs in an I/A OWTS it would mean the system was probably improperly maintained and therefore wasn't treating wastewater to meet effluent total nitrogen requirements. The implementation of an I/A OWTS program will require that a pump-out schedule be created by the SCDHS to insure I/A OWTS are functioning properly. Some jurisdictions require pumping of an I/A OWTS every 3 to 5 years. Massachusetts Department of Energy and Environmental Affairs website provides a reference guide for homeowners which states "have your septic tank pumped out and system inspected every 3 to 5 years by a licensed septic contractor". Most I/A OWTS systems have septic tanks preceding the system, which should be pumped out routinely to ensure system performance. Therefore the existing capacity of the scavenger plants would have to be evaluated by Suffolk County compared to the required pumping

needs of the existing and proposed wastewater treatment plants and future pumping needs of I/A OWTS. Currently the existing overall treatment capacity of the three scavenger plants is 1.46 MGD (See **Table 8-31**). The evaluation of scavenger plant capacity is crucial to the wastewater management plan to ensure I/A OWTS can be properly pumped to maintained effluent nitrogen requirements and that the sludge removed from the system can be properly treated in Suffolk County.

Table 8-31 Suffolk County Scavenger Plant Capacities

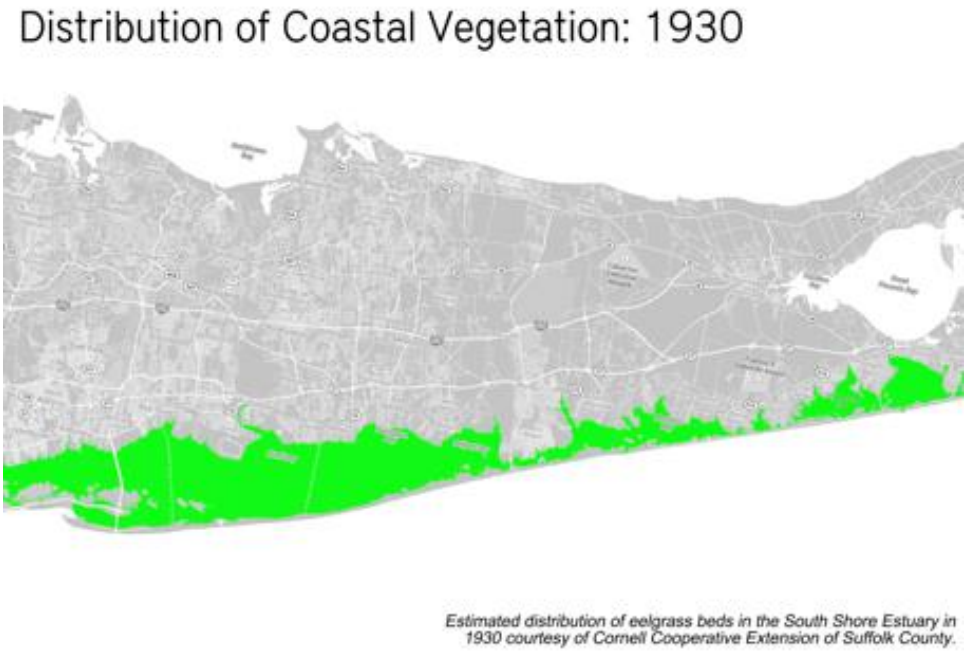
Scavenger Plant	Capacity (MGD)
SCDPW Bergen Point	0.5
Town of Huntington	0.86
Town of Riverhead	0.1

8.4.1.8 Follow-Up Studies and Programs to Monitor Wastewater Management Plan Progress

When implementing the wastewater management plan Suffolk County should establish programs to measure the performance of the wastewater management plan to improve water resources.

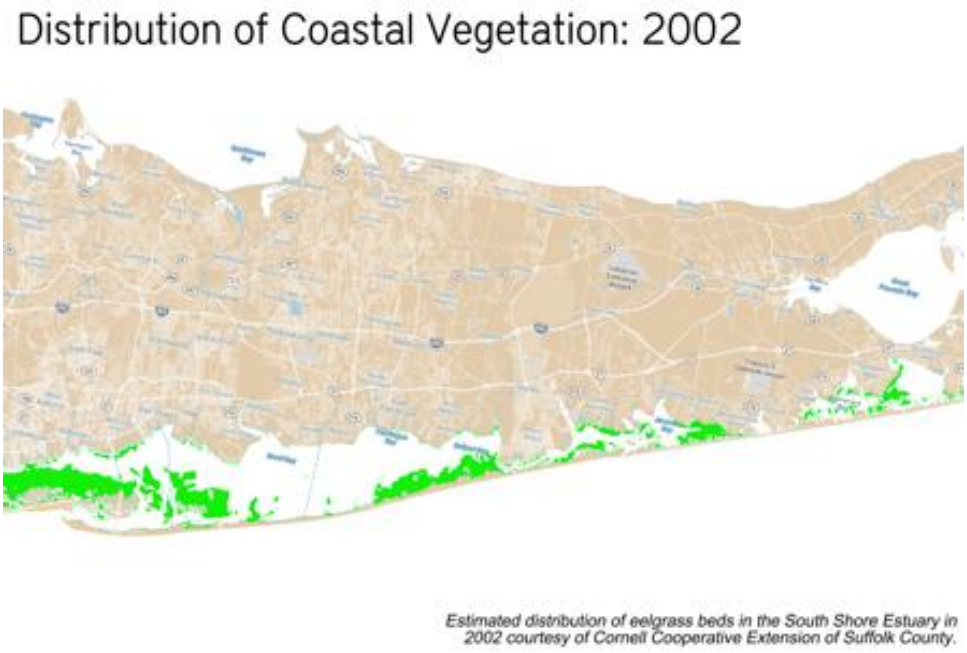
One program would be to measure coastal eel grass which is considered a true seagrass. Eelgrass is important for coastal resiliency because it slows currents and reduces wave forces, and rhizome/root mats stabilize the sea floor by trapping sediments, preventing sediments from shifting or becoming resuspended, helping to reduce the erosion on our shorelines. The NYS Seagrass Task Force estimated that statewide, New York had 21,803 acres of seagrass in 2002 of which 92% were in the South Shore Estuary (which comprises the Great South Bay). **Figures 8-58**, **8-59**, and **8-60** compare South Shore coastal vegetation from 2030 to 2012. It is estimated that in 1930 there were approximately 200,000 acres of seagrass. According to the NYS Seagrass Task Force, "research has shown that elevated nitrogen concentrations not only affect seagrass through light reduction, but also may be toxic to eelgrass."[36]

One of the goals to improve water resources is to improve coast resiliency during storm surges and by reducing nitrogen loads eel grass coverage is expected to increase. Therefore, Suffolk County should measure Suffolk County's seagrass to evaluate the effectiveness of the wastewater management plan (exampled of a measurement schedule could be every 3 years, 5 years, etc.).



Estimated distribution of eelgrass beds in the South Shore Estuary in 1930 courtesy of Cornell Cooperative Extension of Suffolk County.

Figure 8-58 Distribution of South Shore Coastal Vegetation 1930



Estimated distribution of eelgrass beds in the South Shore Estuary in 2002 courtesy of Cornell Cooperative Extension of Suffolk County.

Figure 8-59 Distribution of South Shore Coastal Vegetation 2002

Figure 8-60 Distribution of South Shore Coastal Vegetation 2012

Another means of evaluating the effectiveness of the wastewater management plan to reduce effluent nitrogen contributing to the degradation of our water resources is to establish a monitoring well network where nitrates are measure to determine if they are being reduced as a result of sanitary wastewater treatment.

In addition there may be other programs such as measuring dissolved oxygen in fresh water supplies or nitrogen levels. These programs along with statistics of number of systems upgraded to I/A OWTS, number of systems connected to community systems, O&M tracking (includes sampling and O&M), STP sample results, etc. would be used to evaluate the effectiveness of the program and determine any required revisions to the program. This evaluation should be performed based on an established schedule determined by Suffolk County.

8.4.2 Responsible Management Entity

As previously described, the RME to oversee the O&M, educational outreach, and funding of I/A OWTS and O&M of decentralized treatment systems can be a public utility or preferably an arm of the SCDHS. A crucial component of the RME required to oversee I/A OWTS would be a database tracking system, which must be implemented at the time of establishment of the RME. This system would enable the RME to track installed systems, sampling of installed

systems, maintenance such as O&M scheduled maintenance, repairs, and pump-outs, and O&M contracts.

The RME would need enforcement powers through amendments to the Suffolk County Sanitary Code to allow the RME to fine property owners for not maintaining O&M contracts, failing to make repairs, or failing to operate the system to meet effluent nitrogen requirements. Essentially SCDHS currently performs this function with STPs. The SCDHS Office of Wastewater Management (WWM) monitors all STPs within Suffolk County ensuring O&M contracts are maintained, inspecting the STPs to ensure they are functioning properly and being properly maintained, and monitoring effluent sampling to ensure permitted effluent parameters are met. If O&M contracts are not maintained, STPs are underperforming, or maintenance is not being completed WWM will issue violations with monetary fines and require a corrective action plan. The creation of a SCDHS RME with an updated tracking system would expand on the STP program to include I/A OWTS and the ability to provide funding for I/A OWTS installations for upgrades or repairs.

Education and outreach would be another function of the RME, which would include educational programs for property owners, design professionals, and contractors. Property owner educational programs would consist of pamphlets, website information, and seminars outlining why improved wastewater treatment such as I/A OWTS are required to improve water resources, funding sources and requirements to obtain funding sources for property owners to upgrade or repair I/A OWTS or conventional septic systems, system O&M, O&M contract requirements, basic do's and don'ts for I/A OWTS or conventional septic systems, etc.

Contractors and design professionals would be offered classes teaching SCDHS application requirements for installation of I/A OWTS, required information to be included on site plans for approval of installation of an I/A OWTS, installation requirements, inspection requirements, and O&M requirements. SCDHS already provides occasional classes to design professionals, contractors, and developers regarding application requirements. These classes would have to be expanded to include the new topics identified above.

Through the Office of Consumer Affairs, the RME should provide special license requirements for contractors who install and maintain I/A OWTS. As with most licensed professionals, contractors should be required to take certification credits to maintain their special license to install and maintain I/A OWTS. Classes could be similar to the classes provided by the New England Onsite Wastewater Training Program located at the University of Rhode Island, but should be provided locally by the SCDHS or SUNY Stony Brook.

8.4.3 Property Owners

Property owners play a crucial role in the implementation of a wastewater management plan. Existing property owners connected to sewers and property owners who have the privilege of abandoning their onsite sewage disposal system and can connect to gravity sewers will be the least impacted due to the least amount of O&M required. Property owners connecting to a low-pressure system are required to operate and maintain their low pressure pump station. The property owners who will be most impacted will be homeowners who install I/A OWTS. Even though property owners many not visually see their system they must take precaution to ensure proper operation of the system.

Each manufacturer of an I/A OWTS outline do's and don'ts in the homeowner's manuals. Orenco is one of the manufacturers participating in the Suffolk County Demonstration project. Orenco has a homeowner's manuals posted on their website. The manual describes the things a homeowner must do to help ensure a long life and minimal maintenance. The general rule for Orenco is:[21]

"Nothing should be disposed into any wastewater system that hasn't first been ingested, other than toilet tissue, mild detergents, and wash water."

Their manual outlines chemicals/products that should not be flushed down drains such as chemicals (e.g., pharmaceuticals, cleaners, cesspool additives, etc.) that could impact the treatment process or materials that may damage or clog equipment in the system.

Homeowners must be educated to understand how wastewater impacts ground and surface waters, the importance of these water resources to the community, and how wastewater technologies can protect these resources.

The major responsibilities of homeowners with a low pressure pump station or I/A OWTS are to obey the rules outlined in their homeowner's manual to preserve the life of the system. Other responsibilities of property owners with I/A OWTS are maintaining O&M contracts, pumping their system when required, and making required repairs to ensure proper treatment of wastewater to protect and improve water quality. Failure to maintain the system can lead to replacement of system parts or the entire system.

Property owners should take advantage of any funding resources provided by the RME or Suffolk County, if available, for upgrading or repairing onsite sewage disposal systems to ease the financial burden of installing an I/A OWTS.

Participation of property owners is crucial to the wastewater management plan because failure to maintain and follow the homeowner's manual may lead to

premature failure of the system or failure of the system to properly treat wastewater to meet the wastewater management plan nitrogen targets established to protect and improve water resources.

8.4.4 Contractors and Design Professionals

Contractors and design professionals (Engineers and Architects) in Suffolk County will be required to obtain the proper knowledge to design, operate, maintain and install I/A OWTS. Unfortunately since I/A OWTS will be a new program there will be a learning curve for contractors and design professionals. They must take full advantage of educational resources provided by SCDHS and the RME.

Licensed design professionals are required to obtain continuing education credits to maintain their licenses. SCDHS and/or the RME should gain certification from the State of New York Office of Professions allowing license credits to be issued for classes held on I/A OWTS. In addition, Suffolk County Consumer Affairs should establish a new license for contractors who install and maintain I/A OWTS to protect property owners from contractors who falsely advertise their I/A OWTS installation and O&M experience. Since I/A OWTS technology changes periodically, contractors of I/A OWTS should also be required to obtain continuing education credits.

Design professionals will be required to prepare plans for the installation of an I/A OWTS, certification of construction, and certifications of existing systems during property transfers. Contractors will be responsible for the installation, repairs, pumping, and O&M of I/A OWTS.

Contractors and design professionals are important part of the wastewater management plan because they will provide design of the system, install the system, and maintain the I/A OWTS to ensure effluent wastewater will meet total nitrogen limits to improve water resources.

8.4.5 Summary

In Suffolk County, wastewater is one of the major contributors of nitrogen to the environment, which assists in the degradation of water quality. It is estimated that 69% of the nitrogen comes from onsite sewage disposal systems. This is mainly due to only 26% of Suffolk County being connected to a community sewage disposal system of which most are capable of reducing nitrogen or discharging directly to the Atlantic Ocean. The remaining 74% of the County utilize onsite sewage disposal systems to meet their sewage disposal needs. On average nitrate concentrations of community supply wells that existed in 1987 and community supply wells that have existed in 2013 have

increased by approximately 1 mg/l in both the upper glacial and Magothy aquifers.

Suffolk County contains the highest density of onsite septic systems within the tri-state area with approximately 360,000 homes currently utilizing onsite sewage disposal systems. Of particular concern are the onsite septic systems located in the groundwater contributing areas of drinking water wells and estuarine surface waters. The Suffolk County Department of Economic Development and Planning has identified that approximately 209,000 of these homes with onsite sewage disposal systems are located in areas considered to be high priority areas.

Suffolk County must maintain a balance between protecting water resources and maintaining the ability to dispose of wastewater to protect public health and stimulate development in order to promote economic growth and stability. This will be accomplished by the implementation of a responsible wastewater management plan to limit the impacts of nitrogen from wastewater and emerging wastewater constituents of concern on the County's water resources to preserve and protect these resources for future generations.

The implementation and creation of a wastewater management plan requires setting nitrogen load reduction targets and/or ambient water quality nitrogen concentration targets to meet water quality goals. In addition, the plan shall identifying the means of sewage disposal on a parcel-by parcel basis to meet the nitrogen reduction targets (treatment options – connection to STP to meet wastewater effluent total nitrogen (TN) of < 10mg/l, or installation of an I/A OWTS to meet TN <19 mg/l, or installation of a conventional system to meet TN>19 mg/l). To meet the nitrogen reduction requirements and permit I/A OWTS to be installed in areas where sewers are not available, the current Suffolk County Sanitary Code and SCDHS Onsite Sewage Disposal System Construction Standards must be revised. These codes and standards will be revised to include the formation of an RME to oversee I/A OWTS and decentralized privately owned STP's, permit the installation of I/A OWTS, provide standard construction requirements for I/A OWTS, require property owners to certify their system at the time of transfer if feasible, etc. The RME, established per the revised Sanitary Code, shall provide funding sources for the upgrading and/or repairs of I/A OWTS, education and outreach, performance tracking, and Operation and Maintenance tracking. Education and outreach performed by the RME will target contractors, design professionals, and property owners. The wastewater management plan shall define when sewers should be extended in lieu of installation of onsite sewage disposal systems. Suffolk County shall continue to perform studies to extend sewers within Suffolk County and obtain funding to extend sewers. These items plus the additional topics discussed in this report shall be the basis for establishing

a responsible wastewater management plan to improve and protect Suffolk County's valuable water resources for the future population.

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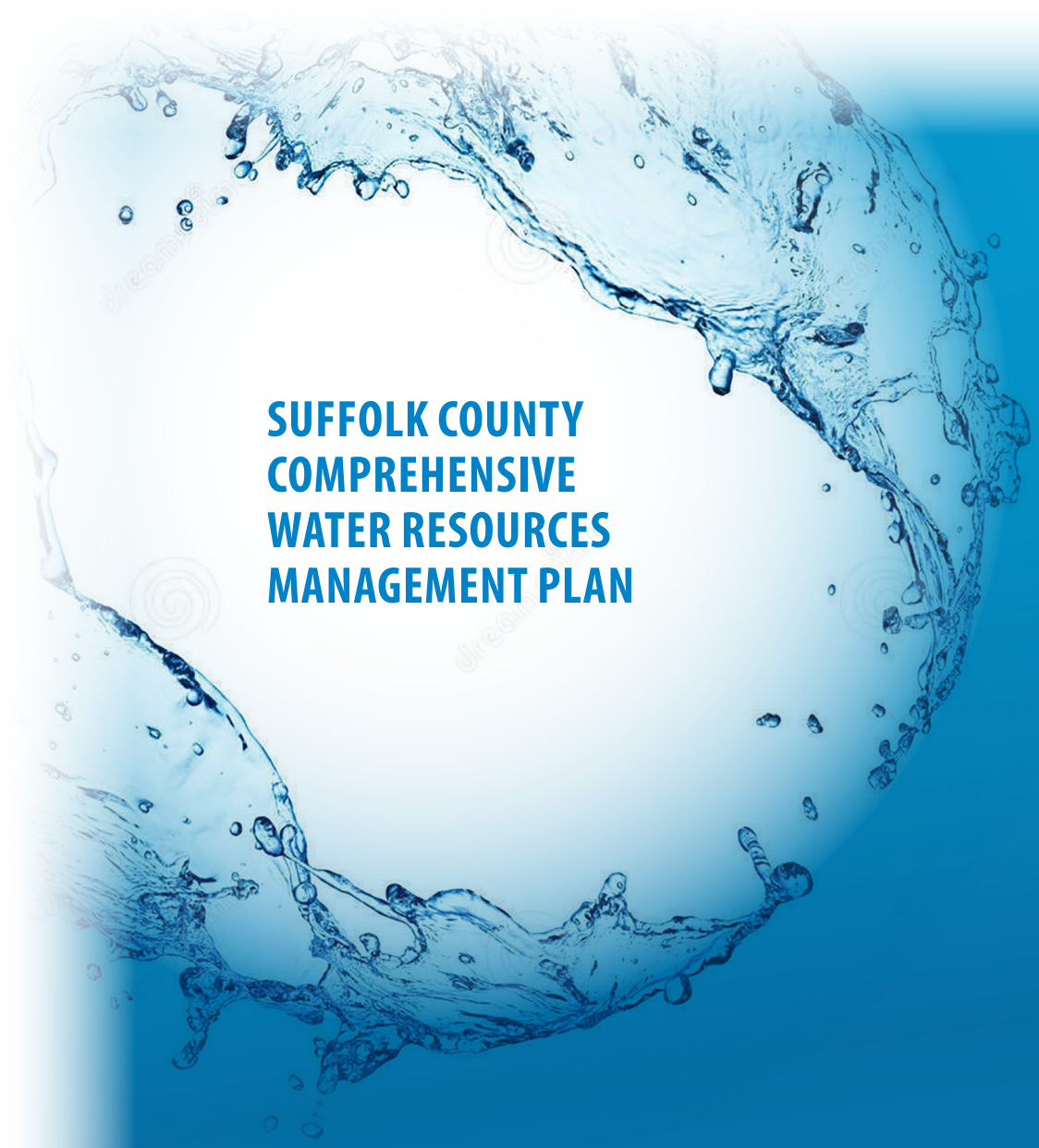

SUFFOLK COUNTY
COMPREHENSIVE
WATER RESOURCES
MANAGEMENT PLAN

Section 9
PLAN IMPLEMENTATION

Section 9 Recommendations and Implementation

9.1 Recommendations

The framework for implementation of the groundwater resource management recommendations is summarized by **Table 9-1.** These recommendations are intended to provide the framework to guide water resource protection and management in Suffolk County through the years ahead, within the context of adaptive management. It is the County's intention that this table provide a flexible framework to guide water resource management, acknowledging that implementation of each recommendation is likely to be affected by changing priorities and opportunities and the availability of key resources, including funding.

Recommendations are organized into seven separate, but inter-related and overlapping categories:

- Nitrogen
- Volatile Organic Compounds
- Pesticides
- Pharmaceuticals and Personal Care Products
- Potable Supply
- Project Management and Data Collection
- Coastal Resiliency and Surface Water Quality

The first four categories of recommendations directly address Suffolk County's recommended approach to address contaminant loads to our groundwater (and surface water) resource. Implementation of these recommendations will also support achievement of the County's goals to provide a safe potable water supply to all residents, as well as improving coastal resiliency and surface water quality. Nitrogen discharged to the ground in unsewered areas has been identified as a priority in the previous 1987 and draft 2010 Comprehensive Water Resources Management Plans. As the impacts of nitrogen release to our groundwater have resulted in even more visible surface water impacts,

contributing to hypoxia, harmful algal blooms and degradation of the wetlands and seagrass beds that provide some protection from the impacts of storm events, the need to develop location-specific wastewater management approaches has been incorporated into this document. Recommendations identified for control of nitrogen sources will improve groundwater quality, surface water quality, potable supply and coastal resiliency.

Management of our water resources in a more comprehensive fashion, simultaneously considering groundwater, wastewater and stormwater management and surface water is necessary for effective protection and management. Comprehensive resource management is especially important considering the accelerated pace of sea-level rise and more frequent extreme weather events. Consequently, a sixth category of recommendations addresses project management and data collection. Comprehensive water resources management was one of the key recommendations in the IBM Smarter Cities Challenge Report. The County has long recognized the need to develop a robust and reliable data collection, evaluation and management program to provide the information necessary to make informed decisions and guide protection efforts; this was another need underscored by the IBM Smarter Cities team.

The success or failure of implementing many of the action items identified in the framework of recommendations is contingent upon securing the necessary funding and stakeholder cooperation. Responsibilities for many of the management activities identified are currently shared by collaborators and partners on the federal, state, county, town and local levels. While Suffolk County may have the ability to implement a number of the actions shown, it will be critical to share data, information and resources with other stakeholders who share water resource protection missions, in order to most effectively accomplish the water quality protection goals articulated in this Plan.

Finally, it will be essential to continue to educate and engage the public to participate in programs to reduce nitrogen, VOC, pesticide and PPCP loading to our waters. Ready access to easily accessible information and resources as identified in the framework will help to provide the information necessary to support informed decision making.

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen	1.1 As a result of Superstorm Sandy in an effort to promote resilience create and/or expand sewer districts for existing communities identified as priority areas and upgrade current wastewater infrastructure	1	SCDPW	SCDEDP, SCDHS	a. Continue to undertake subregional sewer feasibility studies	Short term - On schedule	CP8134 Forge River; CP8139 Carll's River; CP8153 Smithtown/Kings Park; CP8156 Ronkonkoma Hub; CP8157 Connetquot River; CP8191 Center Moriches;CP8192 Flanders/Riverside	
			SCDPW	SCDEDP, SCDHS	b. Advance sewer expansion projects as funding becomes available	Continuous	$383 Million announced as of 2014	
			SCDPW	SCDHS, SCDEDP	c. Plan/Construct Bergen Point outfall replacement	Ongoing	CP8108 $207 million with a $12.5 million grant and $37.5 million loan from SRF	
	1.2 Develop a range of approvable advanced alternative on-site wastewater treatment options available for residential and non-residential applicants in Suffolk County. Gain acceptance and encourage participation	1	SCDHS and SCDPW	SCDEDP, NYSDOH, NYSDEC, USEPA, Towns	a. Assess innovative technologies in nearby states to initiate a County septic demonstration program	Completed; report available online		
					b. Select innovative wastewater treatment companies to participate in a septic demonstration program	Completed		
					c. Select homeowners to participate in a Septic Demonstration Program	Completed		
					d. Install 19 advanced on-site demonstration septic systems	Short term - On schedule	Manufacturers are funding system purchase, installation and maintenance	
					e. Develop demonstration program to evaluate efficacy of shallow narrow drainfields and vegetated wetlands.	Short term - On schedule	Suffolk County Septic/Cesspool Upgrade Program Grant Request	
					f. Monitor effectiveness of on-site demonstration septic systems	Short term - On schedule	SCDHS and SCDPW will perform sampling and analysis, respectively	Effluent nitrogen results
					g. Encourage the use of non-proprietary wastewater treatment systems through demonstration programs	Short term - On schedule	To be determined - could include Watershed Improvement Districts, State Revolving Loan Fund, NYS Water Quality Improvement Program, the Suffolk County Water Quality Protection and Restoration Program, a proposed Aquifer Protection Fee by the public water suppliers, and the Community Preservation Fund for the East End, if supported at the local and state levels	
					h. Develop SCDHS process to approve and permit I/A OWTS systems. Mandate maintenance contracts on all I/A OWTS	Short term - On schedule		
					i. Modify Sanitary Code and establish construction standards for I/A OWTS systems	Short term - On schedule		Results of pilot program
					j. Provide guidelines and train municipalities and private industry to install and maintain advanced onsite systems	Short term - On schedule		Results of pilot program, funding source
					k. Familiarize homeowners and towns on the operations and maintenance of advanced septic systems in comparison to existing septic systems with the goal of providing rationale for an RME.	Short term - On schedule		Public participation, funding
					l. Promote the installation of I/A OWTS systems (Appendix A) for commercial and multi-family development by providing financial incentives	Short term - On schedule		Funding
					m. Establish a database of onsite systems (current and new) to track installation, maintenance, inspection, and performance and use to guide identification of approvable technologies; in coordination with EPA	Short term, On schedule	Integrate with Capital Project 4081, Environmental Health Information Management System	County Funding of Capital Project, see data management below
		2	SCDHS	SCDPW	n. Continue to develop new standards for clustered decentralized systems and for flows ranging from 1,000 - 30,000 gpd.	Short term - On schedule		
		1	SCDHS	SCDEDP	o. Develop and implement a drainfield demonstration program providing alternatives to leaching pools	Short term - On schedule	Suffolk County Water Quality Protection and Restoration Program	

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen	1.3 Develop short term and long term water quality funding and financing mechanisms in partnership with federal, state, county and local agencies and private industry - short term activities may include voluntary homeowner upgrades and in the long term, possible mandatory upgrades that meet specific locational and environmental criteria	1	SCDEDP	SCDPW, SCWA, NYS EFC, USEPA, Towns, NY Works, LIRPC, TNC, CCE, LCV, Estuary Programs	a. Access all potential funding mechanisms, including financing mechanism for long term loans for homeowners, grant opportunities, aquifer protection fee, tax credits, insurance rate adjustments, public private partnerships, benefit assessments, user fees, tax credits, Finance Committee, etc.	Short term - On schedule	To be determined - could include Watershed Improvement Districts, State Revolving Loan Fund, NYS Water Quality Improvement Program, the Suffolk County Water Quality Protection and Restoration Program, the proposed Aquifer Protection Fee by the Suffolk County Water Authority, and for the East End the Community Preservation Fund if supported at the local and state levels	Available funding streams, investor interest, SCWA and homeowner participation
	1.4 Nurture the development of local industries to perform R&D and provide capital to address advanced wastewater treatment	1	SCDHS	SC DPW, SCDEDP, EPA , NYSDEC, LIREDC	a. Participate in the development of a regional (New England and coastal NY) data sharing agreement modeled after CBW data sharing agreement to streamline I/A approval processes	Medium - On schedule		Local industry interest
		1	Stony Brook University	SCDHS, SCDEDP, EPA , Southampton, NYSDEC, LIREDC	b. Participate in the creation of a Wastewater Institute at Stony Brook University	Medium - On schedule		
	1.5 Determine the range of technology options for advanced wastewater treatment by subwatershed to facilitate further prioritization for collective regional action	1	SCDHS	SCDHS, SCDEDP, SCDPW, USEPA, NYSDEC, NYSDOH, local stakeholders	a. Finalize RFP	Short term - On schedule		
					b. Engage stakeholders			
					c. Identify priority subwatersheds			US EPA 3VS Systems Model
					d. Establish goals for nitrogen load allocation for watersheds, estuaries; Evaluate feasibility of enhancing effluent and review water quality goals			NYSDEC nutrient criteria development, water body-specific TMDLs
					e. Finalize methodology for parcel analysis for wastewater technology treatment options			
	1.6 Evaluate the feasibility of updating the Sanitary Code to prohibit the "grandfathering" of State Pollutant Discharge Elimination System (SPDES) and/or SCDHS permitted sanitary flows that exceed and predate Sanitary Code density requirements on other than single-family residential lots, without the installation of an I/A OWTS or connection to sewers; review options to effect upgrades under ECL,NYCCR,SPDES	2	NYSDEC, SCDHS	SCDEDP, NYSDOH, local municipalities and stakeholders	a. Fund and conduct a feasibility study or health impact analysis of possible code changes	Short term - On schedule	Underway with existing staff and funding	
	1.7 Evaluate the feasibility of updating the Sanitary Code to prohibit the replacement of failed onsite wastewater technology (e.g., "replacement in-kind") without SCDHS approval.	1	SCDHS	SCDEDP, SCDPW, USEPA, NYSDEC, NYSDOH, Towns	a. Conduct a health impact analysis of possible Code amendments	Short term - On schedule	Health Impact Assessment funded by the US EPA	Stakeholder input
	1.8 Establish governance to enable the installation and compliance/performance monitoring of appropriate wastewater technology County-wide	1	SCDEDP	SCDPW, SCDHS, NYSDEC	a. Establish legal authority	Short term - On schedule		
					b. Establish wastewater management district			State approval
					c. Establish Responsible Management Entity to manage funding, implementation, operation and maintenance		Initial funding legislatively approved from the Suffolk County Water Quality Protection and Restoration Program	SCDPW, SCDHS, SCWA collaboration, see: http://www.werf.org/i/c/KnowledgeAreas/DecentralizedSystems/RMEsite/RMEs_2.aspx
					d. Staff Responsible Management Entity			Selected organizational approach
	1.9 Facilitate conditions for decentralized/virtual sewer districts, where appropriate with local neighborhood interest	1	SCDPW/ SCDHS	NYSDEC, SCDEDP, Towns, Stakeholders	a. Identify tax defaulted properties and develop siting standards for neighborhood sewage treatment plants	On schedule		
					b. Fund initial feasibility and engineering studies	Completed		

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitro	1.10 Continue to maintain active oversight of existing STPs and operators to maintain compliance with effluent nitrogen limit; where possible and appropriate attain more stringent performance goals to protect groundwater and surface waters	1	SCDHS	NYSDEC	a. Continue monitoring and enforcement efforts	On-going, On schedule	Underway with existing staff and funding; continue to seek additional revenue streams	
			SCDHS	NYSDEC	b. Continue to evaluate new and improved technologies for nitrogen and PPCP removal	On-going, On schedule	Underway with existing staff and funding; continue to seek additional revenue streams	
	1.11 Continue to reduce nitrogen load from homeowner fertilizer application.	1	SCDEDP	SCDHS, PEP	a. Assess effectiveness of and potential improvements to Suffolk County Local Law 41-2007 to reduce nitrogen pollution by reducing use of fertilizer in Suffolk County. Suffolk County continues to use two and a half times the amount of residential fertilizer as any other county in NYS	Short Term, On schedule	Underway with existing staff and funding	Evaluation/documentation of effectiveness . Access and analyze additional public and private data on fertilizer inventory, revenue, and sales
		1	SCDEDP	SCDHS, PEP, NYSDEC, USEPA, CCE, municipalities	b. Enhance educational and advocacy efforts aimed at reducing the negative impacts of residential and commercial yard care (fertilizer and pesticides) on ground and surface water quality	Medium, On schedule	Suffolk County secured funding from NYSDEC for implementation in 2015	Funding
	1.12 Evaluate the feasibility of replicating the Riverhead Sewage Treatment Plant's initiative to re-use wastewater effluent for golf course irrigation countywide, where appropriate	2	SCDHS	SCDPW, NYSDEC	a. Conduct a feasibility study on implementing reuse at candidate sites	Short Term High Priority		Funding

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
1.0 Nitrogen	1.13 Work with agricultural community to reduce use and impacts of excess fertilization	1	SCDEDP	SCDHS, NYSDEC	a. Release updated Agricultural Stewardship Plan	Short term, On schedule		Funding
		1	SCDEDP	SCDHS, NYSDEC, PEP, NRCS, SCSWCD	b. Secure funding to implement the Agricultural Stewardship Plan, and continue to fund the CCE Agricultural Stewardship Program.	Short term, Continuous, On schedule		Funding
		1	Cornell Cooperative Extension	SCDHS, SCDEDP, NYSDEC	c. Provide technical staff to implement research, piloting, testing, reporting and education	Short term, Continuous, On schedule		Funding
		1	SCDEDP	Agricultural Stewardship Committee, NYSDEC, CCE, SCSWCD	d. Work with the agricultural community and other stakeholders to incentivize farmers, especially those participating in the County's purchase of development rights program, to implement BMPs to reduce nitrogen release to ground and surface waters.	Short term, Continuous, On schedule		
	1.14 Increase scavenger plant capacity to process waste from on-site system pump-outs	2	SCDPW		a. Evaluate capacity of existing facilities to receive and treat pump-out	Medium, On Schedule		Ability to expand existing capacity
	1.15 Seek ways to remediate existing nitrogen pollution and its impacts (see Coastal Resiliency & Surface Water Quality actions for more detail)	1	SCDHS	Estuary Programs, NYSDEC, SCWA, Scientists, Cornell Cooperative Extension	a. Continue to implement the Harmful Algal Bloom strategy, wetland stewardship, shellfish restoration; continue to support and fund the use, where appropriate, of marine plants and shellfish as biofiltration to reduce nitrogen in surface waters	On-going, On schedule		Funding, technology development, permitting, species selection for uncertified waters
		1	SCDEDP	Towns, NYSDEC	b. Mitigate the nitrogen and bacterial contribution from wildlife and pets by implementing public education and encouraging alternative population control measures	Short term, Not yet scheduled		
		2	USGS	SCDHS	c. Consider localized studies to evaluate nutrient flux from the sediments into the water column and evaluate sediment management options.	Medium, Not yet scheduled		
		2	SCDHS	NYSDEC and municipal partners	d. Encourage the development of pilot programs for the installation of permeable reactive barriers and other innovative in-situ water quality remediation techniques. Work to identify suitable locations for pilot installation, and support monitoring of effectiveness of nitrogen reduction	Short term, Not yet scheduled	Use existing resources and continue to seek supplemental funding sources	Suitable locations and technology effectiveness
		2	SCDHS	Towns, Villages	e. Consider changing densities in all hydrogeologic zones; evaluation of zone 4 would be the first priority, subject to cost benefit analysis	Short term, Not yet scheduled		Effectiveness of I/A OWTS

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
2.0 Volatile Organic Compounds (VOCs)	2.1 Implement VOC Action Plan	1	SCDHS		a. Identify and inspect high priority facilities (e.g., gas stations/dry cleaners)	Short term, Continuous, On schedule	$100,000 appropriated	Available funding
			SCDHS	NYSDEC, USEPA	b. Initiate enforcement activities to bring facilities into compliance and clean-up actions to address contaminant releases as necessary.	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Results of initial inspections
			SCDHS		c. Within an adaptive management framework, annually reassess inspection priorities, and continue to inspect the next category(ies) of high priority facilities. Based upon status and trends of VOCs detected in drinking water, refine monitoring and inspection strategies	Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources (see below)	
			SCDHS		d. Establish and apply a fee system to fund continued implementation of the inspection/compliance program.	Short term, On schedule		Number of facilities not in compliance with regulations/or with contaminant releases to the environment
			NYSDEC	USEPA	e. Develop and implement a Gas Station operator training/certification program	Medium term, Not yet scheduled		Available funding
			SCDEDP	SCDHS, SCLD	f. Continue to coordinate with Suffolk County Land Bank to identify, evaluate, and prioritize tax-defaulted environmentally contaminated properties	Short term, Continuous, On schedule	Use existing resources	Funding status for initial sites secured through EPA, NYS AG office and NYSDEC.
	2.2 Implement Reducing Toxics Capital Program	1	SCDHS		a. Develop approach to prioritize inspection of remaining 17,000 +/- facilities; consider prioritizing those within supply well contributing areas	Short term, On schedule	$100,000 from 1/4% Program	Available funding
			SCDHS	NYSDEC, NYSDOH	b. Inspect facilities in accordance with identified approach	Short term, Schedule under development	One full time equivalent person to begin implementation in 2016	Available funding
			SCDHS	NYSDEC, USEPA	c. Initiate enforcement/clean-up activities	Medium term, On schedule	Use existing resources and continue to seek supplemental funding sources	Available funding
			SCDHS	NYSDEC, USEPA	d. Continue to require that facility owners at VOC release sites perform soil vapor intrusion investigations where necessary and continue to identify new construction sites with soil vapor intrusion potential.	Short term, Continuous, On schedule	Underway with existing resources	Federal/state guidance, Town/village building codes
	2.3 Implement Remedial Actions	1	SCDHS	NYSDEC, USEPA	a. Initiate enforcement/clean-up activities, refer to Superfund as appropriate	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Available funding

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
2.0 VOCs	2.4 Increase awareness of harmful household products	1	SCDHS	SCDEDP, SCWA, SCDPW, USEPA, NYSDEC, NYSDOH	a. Continue to collaborate with other agencies, remain current on literature to identify bad actors and safer alternatives	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Availability of green alternatives, funding
			SCDHS	SCDEDP, SCWA, USEPA, NYSDEC, NYSDOH, Estuary Programs	b. Conduct public education and outreach to engage public and modify choices . Educate public about EPA Safer Choice labeling program and encourage consumers to adopt it	Short-term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Availability of green alternatives, funding
			SCDHS	NYSDOH, NYSDEC, Estuary Programs	c. Work with County and/or State Legislators to ban any harmful products/additives where viable alternatives are available and expand upon the Suffolk County's Green Clean Purchase program	Medium term, Not yet scheduled		Identification of harmful products with available alternatives, available funding
			SCDHS	Towns, SCDEDP, SCWA, NYSDEC, NYSDOH, USEPA, Estuary Programs	d. Increase awareness of and participation in Town STOP programs	Short-term, Continuous, On schedule		Convenience of/availability of Town programs, funding
	2.5 Implementation of sanitary sewering in priority areas	1	SCDPW	SCDEDP, SCDHS	a. Include areas with high priority facilities in areas to be served by sanitary sewers; see nitrogen recommendations	Medium term, Not yet scheduled		Available funding and competing priorities
	2.6 Continue to evaluate impact of cesspool additives	2	SCDHS		a. Monitor retailers and supply houses to identify drain cleaners and cesspool additives listing organic chemicals as ingredients, and work with companies that have not applied for product certification to remove the products from shelves, obtain certification of safety (if appropriate), or face possible fines.	Short term, Continuous, On schedule	Underway with existing resources	Identification of unregistered products containing organic chemicals

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
3.0 Pesticides	3.1 Work with Agricultural Community to Reduce Use and Impacts of Harmful Pesticides	1	SCDEDP	Cornell, SCDHS, NYSDEC, USGS	a. Update Agricultural Stewardship Program (also supports Nitrogen Recommendation 1.13 above)	Short term, On schedule		Funding
		2	SCDEDP	Cornell, SCDHS, NYSDEC, USGS	b. Establish Agricultural Stewardship Advisory Council	Short term, On schedule		Funding
		1	Cornell Cooperative Extension	SCDEDP, SCDHS, USGS	c. Continue to identify pesticides that are persistent/mobile and used on Suffolk County crops, and identify crop-specific integrated pest management or safer alternatives.	Short term, Continuous, On schedule		Funding, ability to identify more environmentally friendly alternatives, participation of the agricultural community
	3.2 Develop a comprehensive pesticide management strategy, incorporating SCDHS recommendations concerning establishment of a pesticide rating testing system that guides pesticide registration/re-registration and integrate into comprehensive lawn care management initiatives.	2	NYSDEC	SCDHS, CCE	a. Formally incorporate SCDHS into the pesticide registration process.	Short term, Not yet scheduled		NYSDEC priorities
		2	NYSDEC	SCDHS, CCE, USGS	b. Modify pesticide registration process to require piloting to assess leachability, mobility, persistence, toxicity or issue conditional registration with targeted monitoring until pesticide impacts are assessed. Work toward implementation of NYSDEC "Long Island Pesticide Pollution Prevention Strategy"	Short term, Not yet scheduled	NYSDEC, pesticide manufacturers	NYSDEC priorities, manufacturer participation
		1	NYSDEC	SCDHS, CCE, USGS	c. Initiate targeted monitoring in the event that a new pesticide is detected in groundwater and consider implementing use restrictions and/or re-registration requirements as appropriate. Work with collaborators to analyze for pesticides that PEHL can not analyze for	Short term, Continuous, On schedule		
	3.3 Increase public awareness of pesticide impacts and encourage use of safer replacements when possible.	1	NYSDEC	SCDHS, CCE, USGS	a. Outreach and education to engage public and modify choices. Enhance commercial applicator training	Short term, On schedule	Funded through NYSDEC	Ability to identify available, effective alternatives.

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
4.0 Pharmaceuticals and Personal Care Products (PPCPs)	4.1 Provide actionable information regarding use and disposal of household products, pharmaceuticals and personal care products	1	SCDHS	USEPA, NYSDEC, SCWA	a. Continue to monitor Contaminants of Emerging Concern (CECs), contaminants on the Contaminant Candidate Lists (CCL), and literature	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Cooperative opportunities, grant availability, other funding options
		1	SCDHS	USEPA, NYSDEC, SCWA	b. Identify safer alternatives to harmful ingredients/additives identified in PPCPs	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Cooperative opportunities, grant availability, other funding options
		2	SCDHS	USEPA, NYSDEC, SCWA, Group for the East End, Estuary Programs	c. Continue to collaborate with others to implement education and outreach program including development and posting of no-flush signs at pharmacies and identifying the locations of take-back programs. The Group for the East End reports that 2,000 lbs. of unused medications were disposed at seven police stations in east end towns during the first year of program implementation; the program was publicized via mailings, press releases, email blasts and radio and newspapers.	Continuous, On schedule	Implementation of the east end program has been provided through Feb 2016. Covanta Energy's RX disposal program is providing free destruction at the East Northport facility. Continue to use existing resources and continue to seek supplemental funding sources, including 1/4% funding for east end towns	Cooperative opportunities, grant availability, other funding options
	4.2 Continue to assess occurrence of PPCPs in groundwater as well as PPCP sources, to support development of informed management decisions	1	SCDHS	SCWA, USGS, NYSDEC	a. Increase PEHL capabilities to include the following analytes: cotinine, diltiazem, hydrochlorothiazide, meprobamate, metropolol, naproxen, 4-nonylphenol, phenobarbital, sulfamethoxazole, tramadol, Tributylphosphate (TBP), Triphenylphospate (TPP), Tri (2-butoxy-ethyl) phosphate (TBEP), Tri (2-chloro-ethyl) phosphate (TCEP), Tri (2-dichlorisopropyl) phosphate (TDPP) and the Ames test.	Short term, Continuous, On schedule	PEHL analytical capabilities have been expanded to include 1,4-dioxane; SCDHS has entered into a cooperative agreement with SCWA who will analyze approximately 50 samples from small public supply and private wells for seven PPCPs that currently cannot be analyzed by SCDHS PEHL	Funding options, cooperative opportunities
		1	SCDHS	SCWA, USGS, NYSDEC	b. Continue to expand analytical capabilities based on information from other investigations, occurrence data, and available information on mobility, persistence and toxicity	Short term, Continuous, On schedule	PEHL analytical capabilities have been expanded to include 1,4-dioxane; SCDHS has entered into a cooperative agreement with SCWA who will analyze approximately 50 samples from small public supply and private wells for seven PPCPs that currently cannot be analyzed by SCDHS PEHL	Funding options, cooperative opportunities
		1	SCDPW, SCDHS	USGS,USEPA	c. Implement PPCP Monitoring Plan to evaluate PPCPs in wastewater and effectiveness of existing treatment modalities	Short term, Continuous, On schedule		Funding
		1	SCDHS	SCWA, USGS, NYSDEC	d. Assess magnitude of 1,4-dioxane sources (e.g., industrial/commercial vs. household) by targeted monitoring downgradient of laundromats and other potential sources	Short term, Not yet scheduled	Use existing resources and continue to seek supplemental funding sources	
		1	SCDHS	NYSDEC	a. Update annual notice that goes out to all New York State registered facilities if and when changes/amendments are made.	Short term, On schedule	Use existing resources and continue to seek supplemental funding sources	Changes in regulations
		2	SCDHS		b. Work with facilities to keep them current and implement any changes/amendments as needed to stay compliant	Short term, On schedule	Use existing resources and continue to seek supplemental funding sources	

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
5.0 Potable Supply	5.1 To the extent that it is practical, extend community supply to all residents.	1	SCDHS	SCWA	a. Prioritize areas where availability of public supply should be provided	Short term, Continuous, On schedule	SCWA, customers and grants	Community support, infrastructure siting/permitting, funding
		1	SCWA	SCDHS	b. Identify supply sources (existing or new wells) as necessary	Short term, Continuous, On schedule	SCWA	Community support, infrastructure siting/permitting, funding
		1	SCWA	SCDHS	c. Design, construct and connect	Short term, Continuous, On schedule	SCWA	Community support, infrastructure siting/permitting, funding
	5.2 Implement conservation plan to reduce domestic and outdoor irrigation use	2	Suffolk County		a. Require rain sensors/moisture sensors in new sprinkler systems	Short term, Not yet scheduled		Enforcement
		2	Suffolk County	Cornell Cooperative Extension	b. Identify daily irrigation needs on website	Short term, Not yet scheduled		
		2	Suffolk County		c. Implement odd/even irrigation program for non-agricultural properties	Short term, Not yet scheduled		Enforcement
		2	Suffolk County water suppliers		d. If other conservation measures are ineffective, then implement conservation measures including conservation pricing/seasonal rate pricing	Short term, Not yet scheduled		
		2	Suffolk County	SCWA and suppliers, Estuary Programs	e. Implement public outreach/education program to encourage use of water conservation plumbing fixtures	Short term, Schedule varies		
	5.3 Provide safe drinking water to all residents	1	Suffolk County water suppliers	SCDHS	a. Incorporate sub-standard supplies into SCWA or other effectively managed municipal water district.	Short term, Continuous; Schedule varies		
		1	SCDHS		b. Increase capability to analyze private well samples	Short term, Continuous, Not yet scheduled		Funding
		1	SCDHS		c. Increase outreach to private well owners	Short term, Continuous, Not yet scheduled		Funding
		2	SCDHS		d. Increase private well income exemption to $50,000/year	Short term, Continuous, Not yet scheduled		Funding
	5.4 Evaluate Lloyd aquifer	3	NYSDEC	SCDHS, USGS,SCWA	e. Investigate potential impacts and safe yield of water supply pumping from the Lloyd aquifer. Identify and quantify conditions under which the commissioner of NYS DEC can grant exemptions to non coastal communities to pump water from the Lloyd aquifer	Medium, Not yet scheduled	No funding in place	Scope, work plan and funding

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.1 Develop a cross departmental leadership team to implement the Reclaim Our Water initiative and manage the County's water from 'cradle to grave.'	1	SCDEDP	SCDHS, SCDPW, SCWA, County Attorney		Completed		
	6.2 Secure the resources and staff necessary to implement the initial phases of the Water Resources Management Plan	1	SCDHS		a. New positions are being filled	Underway, On schedule	Funding from Suffolk County and NYSDEC	
	6.3 Explore the feasibility of operating the existing 193 sewage treatment plants in Suffolk County under the control of the Suffolk County Department of Public Works	1	SCDPW	SCDEDP, SCDHS, NYSDEC	a. Complete sewer consolidation analysis	Short term, Not yet scheduled		
	6.4 Integrate water and wastewater operations	2	SCDEDP	SCDHS, SCDPW, SCWA	a. Assess the feasibility and business case for consolidation	Medium term, Not yet scheduled		
		2	SCDEDP	SCDHS, SCDPW, SCWA	b. Define a future operating model for water and wastewater operations across the County	Medium term, Not yet scheduled		
		2	SCDPW	NYSDEC, Municipalities	c. Evaluate feasibility of including stormwater utility development	Medium term, Not yet scheduled		
	6.5 Facilitate communities to embrace the solutions for improving water quality	1	Suffolk County	SCDEDP, SCDHS, SCDPW, NYSDEC, Estuary Programs, Towns	a. Provide easily accessible information on water quality through online and social media outlets for public knowledge and use	Ongoing, On schedule		
		1	SCDHS	USEPA, Estuary Programs	b. Develop the economic and social value of clean water to our region	Short term, On schedule	Funding secured by EPA for an ecological assessment study and US EPA 3V scoping project which will build social capital among decision makers and stakeholders on water quality issues and more.	
		1	Suffolk County	County, State, Federal and nonprofits	c. Conduct a marketing campaign around the need for upgraded septic systems (2014 Crapshoot Video contest, Teleconference Town Hall with the County Executive)	Ongoing, On schedule	Funding secured	

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.6 Implement a comprehensive integrated data collection, analysis and evaluation program to monitor groundwater, drinking water and surface water, and guide informed protection and management strategies. Reinstate comprehensive groundwater and stream monitoring program and report annually	1	SCDHS	USGS, SCWA, USEPA, NYSDEC, NYSDOH	a. Collaborate to provide sampling and analytical capabilities to assess contamination by Contaminants of Emerging Concern (CEC) and contaminants on the Contaminant Candidate Lists (CCL)	Short term, On schedule	Position funded for dioxane, cooperative effort with SCWA established	Plethora of new analytes, laboratory capacity, funding, cooperator analytical capabilities and funding
		1	SCDHS		b. Enhance SCDHS's capabilities to respond to home owners request for private well testing and increase the ability to perform private well surveys of areas of suspected contamination	Short term, Not yet scheduled		Laboratory capacity, funding
		1	NYSDEC	SCDHS	c. Require that all non-residential private wells report well location, depth, screened interval and pumpage to NYSDEC	Short term, Continuous, Not yet scheduled		Legal authority, cooperation
		1	SCDHS		d. Continue community and non-community well sampling	Short term, Continuous, On schedule		
		1	SCDHS	NYSDEC	e. Pesticide monitoring in target areas	Short term, Continuous, On schedule	NYSDEC grant	Farmer cooperation, analytical capabilities and capacity
		1	SCDHS, SCWA	NYSDEC	f. Salt water intrusion monitoring	Short term, Continuous, On schedule		
		1	SCDHS	NYSDEC	g. Groundwater monitoring in industrial areas based on Reducing Toxics capital program	Short term, Continuous, Schedule under development		
		1	SCDHS	USEPA	h. Beach Monitoring in compliance with BEACH act	Short term, Continuous, On schedule	BEACH Act Grant HSV-2355	
		1	SCDHS	USGS, Estuary Programs, Stony Brook University	i. Implement stream and estuary monitoring programs	Short term, Continuous, On schedule		Analytical capabilities and laboratory capacity
		1	SCDHS	USEPA, NYSDEC, Towns, USGS, Stony Brook University, Estuary Programs	j. Monitor to support TMDL programs	Short term, Continuous, On schedule		
		1	SCDHS	USEPA, NYSDEC, NYSDOH, USGS, SCWA	k. Continue to update data collection and analytical capabilities to support decision making and consideration of emerging issues	Short term, Continuous, On schedule		
		1	SCDHS	NYSDEC, USGS	l. Update water level monitoring program, focus in particular on unsewered near-shore areas to assess impact on on-site wastewater systems	Short term, Continuous, Not yet scheduled		Resources

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Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.7 Implement and upgrade the Bureau of Public Health Protection and Division of Environmental Quality databases and enhance their capabilities to provide a comprehensive integrated geo-coded data management program for all regulated facilities, public and non-residential private wells (location, pumpage and quality), private well quality, groundwater and surface water quality data, salt water intrusion monitoring data, facility data, inspection records, STP Discharge Monitoring Reports (DMRs) and monitoring data and on-site wastewater management systems' installation, maintenance, inspection and performance	1	SCDHS SCDOIT	SCDPW, SCDEDP	a. Develop scope of work, issue RFP and select data management system	Short term, On schedule with 2015 Capital Program	Capital Project 4081	Funding
		1	SCDHS SCDOIT	SCDPW, SCDEDP	b. Populate database, develop protocols and provide access and training	Short term, On schedule with 2015 Capital Program	Capital Project 4081	Funding
		1	SCDHS SCDOIT	SCDPW, SCDEDP	c. Migrate existing databases to new platform	Medium, On schedule with 2015 Capital Program	Capital Project 4081	Funding
		1	SCDHS SCDOIT	USEPA, NYSDEC, Suffolk County, Estuary Programs	d. Utilize database to access information for management and decisions	Medium, Continuous, On schedule with 2015 Capital Program		Funding
	6.8 Adapt the business processes in the Suffolk County Department of Public Works and Department of Health Services to meet expanded integrated water management responsibility	1	Suffolk County	SCDPW, Performance Management	a. Identify process owners and change agents to prioritize and lead improvement initiatives, create action plans to eliminate problem areas and duplicative work, measure improvements	Ongoing, On schedule		
	6.9 Establish standards for the digital transfer of water quality data parameters between ELAP certified laboratories and NYSDOH, NYSDEC and stakeholders.	2	NYSDOH	SCDHS, NYSDEC, ELAP approved Laboratories	a. Establish Electronic Data Transfer (EDT) standards for water quality parameters	Medium, NYSDEC has standard for non potable water. NYSDOH has no standard.		Funding, Staff
	6.10 Work closely with federal, state and local partners to share readily accessible, actionable information, identify synergies and share resources	1	Suffolk County	USEPA, NYSDOH, NYSDEC, NYSDOS, Towns & Villages, SCWA and other suppliers, stakeholders	a. Produce annual water quality reports on-line including identification of improving trends, areas of concern, new issues	Short term, Continuous, Not yet scheduled		Cooperation and resources
	6.11 Evaluate feasibility of inter-governmental water resource cradle to grave data management plan.	1	Suffolk County	USEPA, USGS, NYSDEC, NYSDOH, SCDHS, SCWA	a. Identify key partners and assess volume of data of interest, data format, plan for periodic EDT updates	Short term, Continuous, Not yet scheduled		Funding, cooperation
		1	Suffolk County	USEPA, USGS, NYSDEC, NYSDOH, SCDHS, SCWA	b. Incorporate key partners' data into County data management plan RFP	Short term, Continuous, Not yet scheduled		Funding, cooperation
		1	Suffolk County	USEPA, USGS, NYSDEC, NYSDOH, SCDHS, SCWA	c. Complete project, mine data from key partners, share access to database with water resource managers/partners	Short term, Continuous, Not yet scheduled		Funding, cooperation
	6.12 Continue to evaluate and address the impacts of composting facilities ,dump sites, micro plastics , sand mines and other emerging contaminants upon water resources	2	SCDHS,CCE, Municipalities	NYSDEC	a. Conduct targeted groundwater monitoring down gradient of composting facilities and work with NYSDEC to define classes of composting and assess appropriate response activities	Short term, Continuous, On schedule	Use existing resources and continue to seek supplemental funding sources	Results of groundwater monitoring

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
6.0 Project Management and Data Collection	6.13 Continue to acquire land and development rights for open space based on water quality criteria	1	SCDEDP	SCDHS	a. Within the context of the SCDEDP's Comprehensive Master List and land acquisition procedures, prioritize parcels within the 50 year contributing area to public supply wells and 25 year contributing area to surface water features for preservation	Continuous, On schedule		Available funding and other priorities
	6.14 Delineation of ground-water source areas and times-of-travel to Long Island streams and estuaries	1	USGS	TNC,SCDHS,NYSDEC	a. Delineate groundwater sources areas and travel times to Long Island streams and estuarine embayments, and (2) produce geospatial layers and metadata that describe these delineations for public dissemination via the Internet.	Short term, Proposed, Not yet scheduled		Funding, cooperation
	6.15 To the extent that it is practical and cost effective incorporate the values and methodologies of EPA's Triple Value decision support tools into the implementation of SCCWRMP	2	SCDHS	SCDEDP	Incorporate the tools of EPA's 3VS into the decision making process of plan implementation	Continuous, Not yet scheduled		Training
	6.16 Optimize compliance with SEQRA regulations. Participate in SEQRA process with towns and other municipalities	2	SCDPW, SCDHS, NYDEC	EPA,NYSDOH, SCWA	Complete Environmental Impact Statement where appropriate.	Medium - On schedule		
	6.17 Coordinate plan implementation with local municipalities. Participate in SEQRA review process and provide data, tools and guidance to municipalities .	2	Towns	SCDHS, SCDPW, SCDEDP, Stakeholders	In implementing plan, county state and municipalities should optimize inter-governmental coordination. This includes participating in SEQRA review, use of GIS coverages (travel times to surface waters and public supply wells), training sessions on wastewater alternatives and programs. SCDHS should continue to use priority sensitive zones (50 yr. to public supply wells 25 yr. to surface water) for programs such as TDR, STP siting, wastewater upgrades and pollution source tracking.	Medium - On schedule		
	6.18 Continuously collect, tabulate and review performance measures of key program elements.	2	Towns	SCDPW, Stakeholders	Annually review key performance indicators and programmatic outcomes. Adaptively manage programs to maximize outputs. At five year intervals reassess programs and goals and key performance indicators	Continuous On schedule		

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
7.0 Coastal Resiliency and Surface Water Quality	7.1 Continue to coordinate regional efforts to address Harmful Algal Blooms by developing and implementing the Harmful Aquatic Blooms Action Plan	1	SCDHS / New York State Sea Grant	SCDHS, NOAA, CCE, PEP	a. Complete HAB Action Plan	Short term, Preliminary Plan Sept. 2015, Final Plan Sept. 2016	SCDHS has developed a work plan and budget for the program.	
	7.2 Coordinate with Federal, State, and local partners to continue to assess the vulnerabilities to sea level rise in Suffolk County and develop action plans that mitigate impacts	1	Suffolk County	NYSDEC, NYSDOS, FEMA, EPA, USACOE, TNC, NY Rising, Estuary Programs, SCSWCD	a. Identify critical areas and review options for sanitary code revisions to address long term needs. Work with local municipalities to help implement Climate Action Plans	Medium term, Underway, On schedule		
	7.3 Implement the Fire Island to Montauk Point project in coordination with the Army Corps of Engineers and appropriate stakeholders	1	US Army Corps of Engineers	Suffolk County, NYSDEC, towns and stakeholders		Short term, Ongoing, On schedule	The Fire Island to Montauk Point (FIMP) project, on the drawing boards since 1964 in various iterations, was allocated $700M by the Superstorm Sandy relief bill. Preliminary projections approximate $450M for road and house elevations, with 7 million cubic yards (cy) of sand borrowing from the Atlantic going to a $207 million, 19 mile-long, 9.5 foot berm to 15 foot dune line interfaced with beach nourishment, plus $60M for green infrastructure projects.	
	7.4 Support the practical implementation of ideas generated by the Rebuild by Design teams	1	New York State			Medium term, Not yet scheduled		
	7.5 Support the implementation and expansion of NY Rising Community Reconstruction Program	1	New York State	Suffolk County		Short term, ongoing, On schedule	Various projects throughout Suffolk County including the "Living" Marsh Grand Canal Levee Improvement	
	7.6 Implement and expand Wetlands Stewardship Strategy efforts throughout Suffolk County	1	SCDEDP	SCDPW, Estuary Programs	a. Implement ongoing and recently funded projects, continue to seek new funding for priority projects identified by stakeholders	Short term, Ongoing	$1,310,000 grant to Suffolk County from the NFWF for Integrated Marsh Management. $525,000 for Smith Point HMGP and $600,000 from NRCS .	
	7.7 Develop drainage strategies in chronically flooded areas through the installation of green infrastructure measures like permeable pavers	1	SCDPW	Estuary Programs, Municipalities, SCSWCD		Short term, Not yet scheduled		Funding
	7.8 Develop a robust stormwater management program in coordination with local municipalities and New York State	1	Suffolk County	NYSDEC, local municipalities, Estuary Programs	a. Assess the effectiveness of current program and funding allocations. Update town codes as necessary.	Short term, Not yet scheduled		
		2	SCDPW	Towns, NYSDEC, SCSWCD	b. Improve coordinated management of streams/sediment removal	Medium Term, Not yet scheduled		
		2	Towns	Suffolk County	c. Continue to support municipal stormwater efforts using Suffolk County Water Quality Protection and Restoration funding	Ongoing	Suffolk County Water Quality Protection and Restoration Program	

Table 9-1 Water Resources Management Plan Framework

Area	Recommendation	Priority	Owner	Collaborators	Key Milestones and Actions	Action Status and Time Range	Funding Status	Variables
7.0 Coastal Resiliency and Surface Water Quality	7.9 Assess the feasibility and effectiveness of hardening coastal infrastructure and the potential to incorporate living shoreline concepts wherever possible and effective.	1	SCDPW, USACE	SC Parks, Estuary Programs NYSDEC, Municipalities	a. Feasibility study completed; identify early implementation tasks and funding sources	Completed		
	7.10 Support the development of an Inter-municipal Agreement among the East End towns and Villages and Suffolk County with the Peconic Estuary Program to implement water quality initiatives	1	PEP	Suffolk County, East End towns	a. Continue to provide funding for the development of clear and measurable outcomes within the Peconic Estuary	Completed	Resolution 440-2014	
	7.11 Examine feasibility of participating in/initiating other inter-municipal agreements (e.g. Northport Harbor, Oyster Bay/Cold Spring Harbor)	2	Suffolk County	Municipalities	a. Prioritize existing funding for joint water quality improvement initiatives	Short Term, PEP IMA Approved by Suffolk County others pending		LISS,SSER, Municipalities
	7.12 Continue to support and coordinate with the Peconic Estuary Program, Long Island Sound Study, and the South Shore Estuary Reserve Program to implement projects	1	Suffolk County	Estuary Programs	a. Provide in-kind staff and financial support to advance the implementation of stakeholder driven initiatives	Short term, Ongoing, On schedule		
	7.13 Optimize the use of data, computer models and TDRs to minimize the siting of wastewater facilities in 25 and 50 year travel time to surface waters and public supply wells.	1	SCDPW, SCDHS, NYDEC, Private industry	SCWA, stakeholders	a. Disseminate water quality, hydrologic data and computer model outputs to optimize siting. Implement SPDES action limits for enhanced performance standards, ensuring nitrogen loading is reduced compared with as-of-right unsewered alternative	On going	Suffolk County Water Quality Protection and Restoration Program	
	7.14 Continue to evaluate and promote development of improved pollution control management measures and structures	2	Towns	Suffolk County	a. Work with towns promote structural and non-structural methods to reduce pollutants	On going		

Key:

Priority - 1 highest to 3 lowest

Schedule - short term - < 5 years
5 years < medium > 10 years
Long term > 10 years

LIST OF ACRONYMS

CCE	Cornell Cooperative Extension	NYSDOS	New York State Department of State	
CP	Capital Program	NYSEFC	New York State Environmental Facilities Corporation	
ECL	Environmental Conservation Law	PEP	Peconic Estuary Program	
ELAP	Environmental Laboratory Accreditation Program	RFP	Request for Proposal	
ESDC	Empire State Development Corporation	SCDEDP	Suffolk County Department of Economic Development and Planning	
FDA	Federal Drug Administration	SCDHS	Suffolk County Department of Health Services	
FEMA	Federal Emergency Management Agency	SCDOIT	Suffolk Department of Information Technology	
HMGP	Habitat Management Grant Program	SCDPW	Suffolk County Department of Public Works	
I/A OWTS	Innovative Alternative Onsite Wastewater Treatment System	SCDPW	Suffolk County Department of Public Works	
IMA	Inter-Municipal Agreement	SCLD	Suffolk County Law Department	
LCV	League of Conservation Voters	SCWA	Suffolk County Water Authority	
LIREDC	Long Island Regional Economic Development Council	SCSWCD	Suffolk County Soil and Water Conservation District	
LIRPC	Long Island Regional Planning Commission	SPDES	State Pollutant Discharge Elimination System	
LISS	Long Island Sound Study	STP	Sewage Treatment Plant	
NFWF	National Fish and Wildlife Federation	SSER	South Shore Estuary Reserve	
NOAA	National Oceanic and Atmospheric Administration	TNC	The Nature Conservancy	
NRCS	National Resources Conservation Service	USACOE	United States Army Corps of Engineers	
NYSDEC	New York State Department of Environmental Conservation	USEPA	United States Environmental Protection Agency	
NYSDOH	New York State Department of Health	USGS	United States Geological Survey	

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9.2 Implementation

The implementation framework summarized by **Table 9-1** includes additional information to further describe how the recommendations will be implemented. The framework identifies an "Owner" for every action and milestone required to fully implement each recommendation. The owner is the organization or entity with the primary responsibility for initiating and coordinating implementation of the activities and programs necessary to achieve the desired result. While some of the actions can be fully implemented by a single organization, many required the cooperation and participation of other stakeholders or collaborators. This will also facilitate sharing key resources – e.g., data and information, technical skills and expertise and funding.

The time frame for implementation of each recommendation is identified as short term (less than five years), medium (five to ten years) or long term (over ten years). Many of the proposed recommendations are targeted to begin implementation in the short term; e.g., within five years. In fact, the County has already initiated many key actions (e.g., initiating identification and piloting of alternative on-site wastewater treatment systems). Nevertheless, full implementation of groundwater resources management recommendations is likely to take decades, and will also be contingent upon available resources.

Successful implementation of each recommendation is subject to a variety of variables, including funding availability, as well as other factors that will influence the timing of implementation, or even whether the recommendation can be fully implemented (e.g., community support). Most of the key activities associated with protection of groundwater quality have already been initiated. The funding status of each of the key milestone and activities is also identified. Full implementation of Plan goals is a long-term process that will require coordination and collaboration with agencies and organizations on the federal, state, county and local level, a careful reevaluation of resource allocation issues, and will also necessitate exploring grant opportunities and other innovative and alternative funding mechanisms. Suffolk County continues to work with state and federal agencies and stakeholders to explore implementation options to cost-effectively execute Plan recommendations.

Clean potable water supply and sanitation are often cited as the most important needs in developing countries and as the most effective means of protecting public health. Due to the efforts of water resource managers on federal, state, county and local levels, Suffolk County residents have access to both. It is critical that County residents do not take access to a safe, reliable supply of clean water for granted.

Finally, despite the best intentions, there are a number of factors that will affect the County's ability to implement the recommendations identified, including piloting results, public interest and input and funding. Consequently, these recommendations will be re-evaluated and modified as appropriate in the coming years as new information, opportunities and priorities are identified.

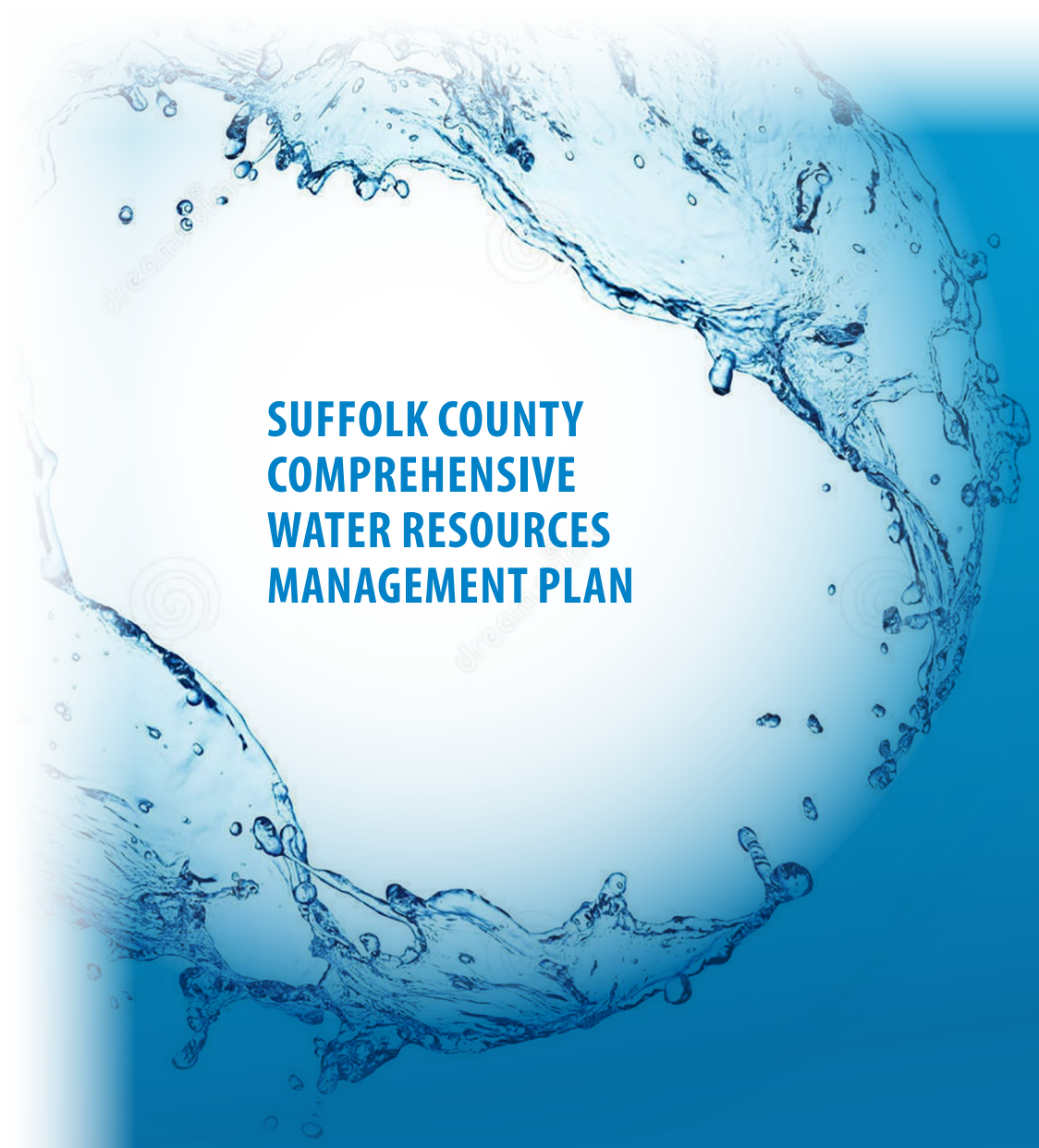
9.2.1 Assessment Monitoring

Implementation of the recommendation identified in the framework will be monitored. Monitoring has two objectives:

- To monitor implementation of the Plan recommendations, and
- To monitor the effectiveness of the Plan recommendations in achieving the Plan goals and objectives.

It is important to monitor the effectiveness of the Plan recommendations in achieving the stated goals and objectives, focusing on measures of progress that are quantifiable; the USEPA has reported that if indicators cannot be measured, then it is not possible to identify progress towards achieving goals. The effectiveness of these recommendations in achieving water resource protection goals and objectives will be assessed according to key performance indicators, also summarized in **Appendix K**.

Annual monitoring of Plan effectiveness and early assessments of Plan effectiveness will allow the County to modify their approach within an adaptive management framework and make improvements as necessary – ineffective actions and programs should be discarded and those recommendations that are most effective can be further enhanced.



SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

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http://www.peconicestuary.org/

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Various fact sheets available at: www.longislandsoundstudy.net

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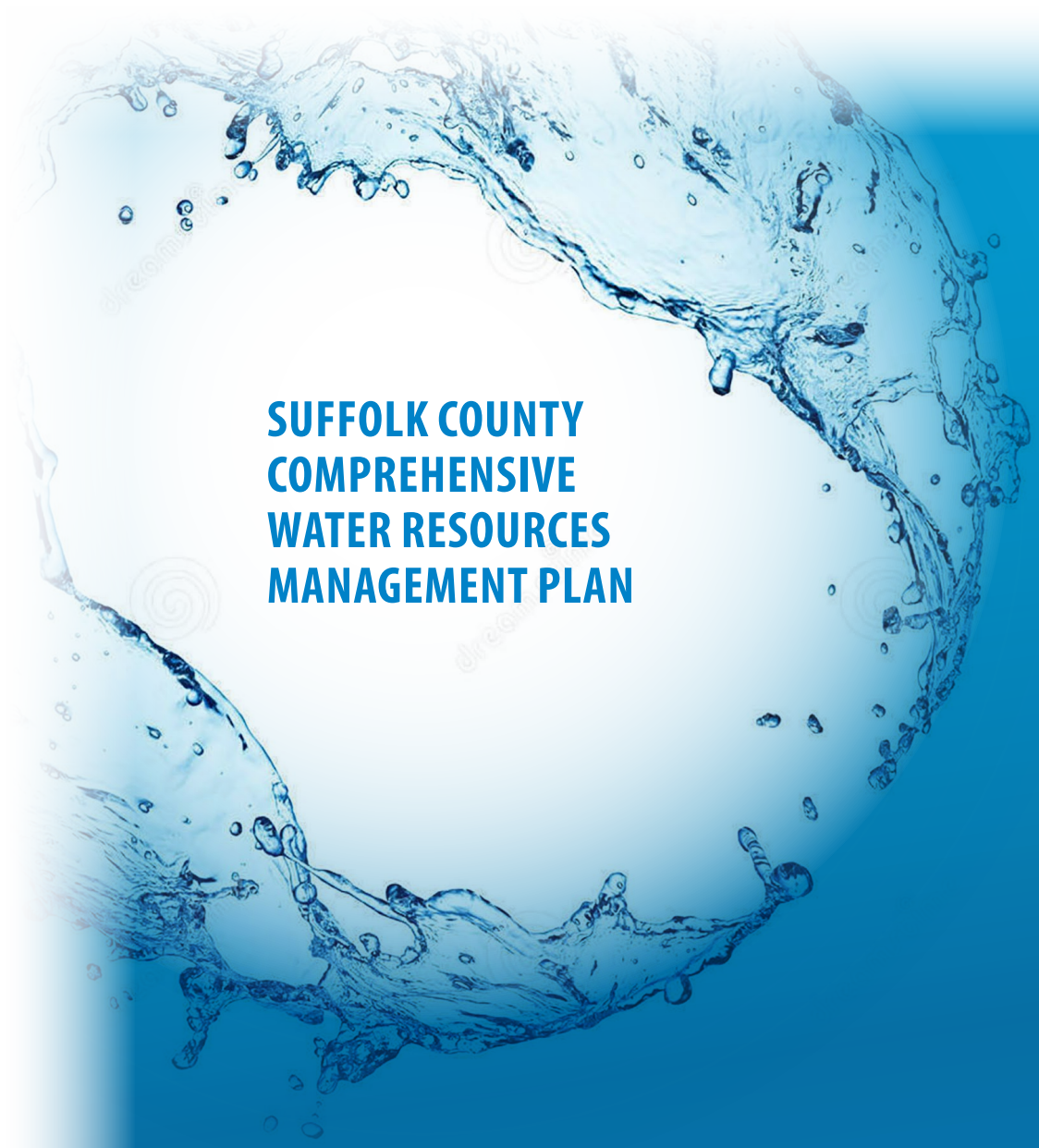


SUFFOLK COUNTY COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN

Appendices

Appendix A

List of Acronyms and Glossary

Glossary

Cluster (Decentralized) Wastewater Systems – are subsurface sanitary systems (such as Cromaglass, Nitrex, BESST, Bioclere, and Aerotor) that service more than one dwelling unit and qualify for a reduced separation distance (75' to habitable buildings and/or property line) under Appendix A (Table A2) of the "commercial standards" promulgated under the Suffolk County Sanitary Code; they can be used for flows of 1,000 to 15,000 gallons per day, and are being considered for flows as high as 30,000 gpd, which would require amending the SCSC.

Contaminant Candidate List 3 (CCL 3) – was published in final form by the USEPA in the Federal Register of October 8, 2009 and is comprised of 116 unregulated contaminants that were selected from an initial list of about 7,500 candidates through a data-driven process that considered adverse health effects (potency and severity) and occurrence (prevalence and magnitude). It includes chemicals used in commerce (such as 1,4-dioxane), pesticides, waterborne pathogens, disinfection byproducts, and biological toxins that have the potential to present health risks through drinking water exposure, see: http://water.epa.gov/scitech/drinkingwater/dws/ccl/ccl3.cfm

Harmful Algal Blooms (HABs) – Algal blooms in themselves are a natural and normal part of any healthy ecosystem, providing a primary level of food for the other organisms that live there. However, these blooms are considered "harmful" when they are dominated by phytoplankton species that create conditions detrimental to the other biota in the system and/or to humans. Brown tides *(Aureococcus anophagefferens)* in the Peconics and Great South Bay, red tides *(Alexandrium fundyense* and *Cochlodinium polykrikoides)* in Huntington and Shinnecock Bays, and the Peconic Estuary, *Dinophysis acuminate* in Northport Harbor and Meetinghouse Creek, and cyanobacteria (multiple species, which can affect fresh and salt water) are the primary examples. They can have severe economic consequences through their impacts on habitat, shellfish populations, and fisheries; some can even have serious human health impacts. And while HABs appear to be occurring in areas with high nitrogen loadings from surrounding land areas, a cause and effect relationship has not yet been firmly established.

Hyporheic Zone – is the area below and adjacent to freshwater rivers and streams in which groundwater and surface waters mix; this region can be the site of chemical and biological activity (e.g., conversion of nitrate to nitrogen gas) that can affect the surface water ecosystem.

Public Water System (PWS) Improvements – in Suffolk County include the consolidation of pressure zones and the replacement of manual gate valves with remotely-activated control valves, which make the balancing of well usage over a larger geographical area easier, and make large-scale transport of water from one region to another through the existing system of water mains more feasible and economic.

Suffolk County Shellfish Aquaculture Lease Program – was adopted in 2009 to provide secure access to publicly owned underwater lands in Peconic Bay and Gardiners Bay for the purpose of shellfish cultivation; it is designed to minimize environmental impacts and user conflicts, while supporting the growth of the shellfish industry, see: http://www.suffolkcountyny.gov/aquaculture

Transit-Oriented Development (TOD) – is a concept similar to Smart Growth in that it includes higher-density mixed-use residential and commercial activities centered around transportation facilities like train stations or bus stops, with a goal of encouraging transit ridership while easing congestion on local roads, and preserving open space and maintaining lower densities in surrounding areas.

Unregulated Contaminants Monitoring Rule 3 (UCMR3) – was published by the USEPA on May 2, 2012 and includes 30 new unregulated contaminants from the CCL 3, including 1,4-dioxane (using EPA Method 522) and hexavalent chromium, that must be monitored by public water systems (PWSs) during 2013-2015, see:
http://water.epa.gov/lawsregs/rulesregs/sdwa/ucmr/ucmr3/upload/UCMR3_FactSheet_General.pdf

WaterSense – is a partnership program run by the USEPA that seeks to protect the future of the nation's water supply by offering simple ways to reduce water use, including the labeling of plumbing and other products that have been certified by licensed third parties to be at least 20% more efficient without sacrificing performance or quality. On November 3, 2011, the USEPA released a final specification for weather-based irrigation controllers, which use local weather and landscape conditions to tailor watering schedules to actual on-site conditions (rather than using a clock with a preset schedule); 67 products are now certified, and their estimated savings are 8,800 gallons per year for the average home, see:
http://www.epa.gov/WaterSense/products/controltech.html

Xeriscaping – is a term used to describe gardening techniques that severely reduce or eliminate the need for irrigation (also called xerogardening); it is often used in relation to lawns, particularly in regards to alternatives turf that requires high levels of irrigation, such as Kentucky bluegrass.

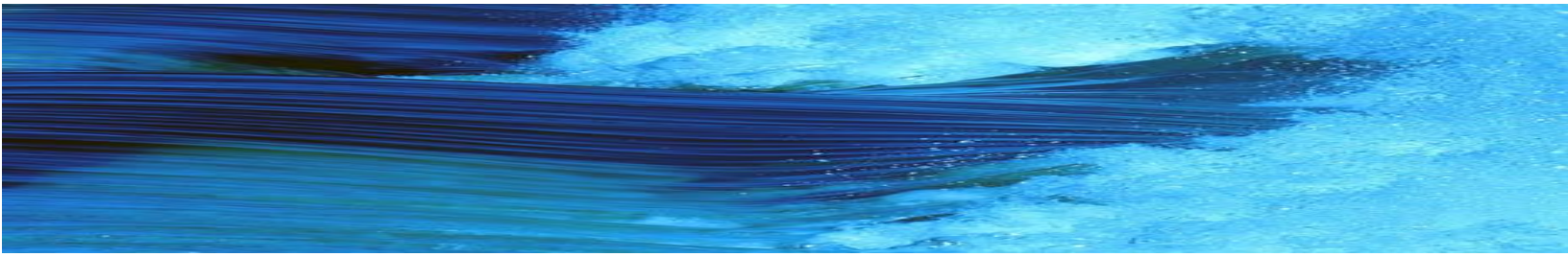
Abbreviations

gpd	gallons per day
µg/L	micrograms per liter (equivalent to parts per billion (ppb))
mg/L	milligrams per liter (equivalent to parts per million (ppm))
D.U./acre	dwelling units per acre

Acronyms

AIA	American Institute of Architects
AWWA	American Water Works Association
BMPs	Best Management Practices
CCE	Cornell Cooperative Extension
CCL 3	Contaminant Candidate List 3 (see Glossary)
CLEARS	Cornell Laboratory for Environmental Applications of Remote Sensing
CLUP	(Central Pine Barrens) Comprehensive Land Use Plan
DEIS	Draft Environmental Impact Statement (under SEQRA)
DEQ	(SCDHS) Division of Environmental Quality
FDA	Federal Drug Administration
FEMA	Federal Emergency Management Agency
GAC	Granular Activated Carbon
GEIS	Generic Environmental Impact Statement (under SEQRA)
GIS	Geographic Information System
GMZ	Groundwater Management Zone (under SCSC Article 6)
HMGP	Habitat Management Grant Program
I/A OWTS	Innovative/Alternative On-Site Wastewater Treatment Systems
IMA	Inter-Municipal Agreement
LCV	League of Conservation Voters
LIRPB	Long Island Regional Planning Board
LIREDC	Long Island Regional Economic Development Council
LIRPC	Long Island Regional Planning Commission
LISS	Long Island Sound Study
MCL	Maximum Contaminant Level (Federal & State Drinking Water Standard)
MCLG	Maximum Contaminant Level Goal (under Federal Safe Drinking Water Act)
MTBE	Methyl Tertiary Butyl Ether (gasoline additive)
NFWF	National Fish and Wildlife Federation
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

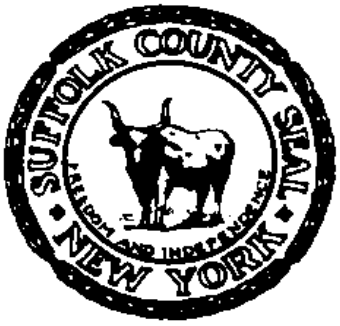
NYSDOS	New York State Department of State
NYSEFC	New York State Environmental Facilities Corporation
PCE	Perchloroethylene (tetrachloroethylene or Perc – dry cleaning solvent)
PEP	Peconic Estuary Program
PPCPs	Pharmaceuticals and Personal Care Products
PWS	Public Water System (both Community and Non-community)
RFP	Request for Proposals
SCDEDP	Suffolk County Department of Economic Development and Planning
SCDHS	Suffolk County Department of Health Services
SCDOIT	Suffolk County Department of Information Technology
SCDPW	Suffolk County Department of Public Works
SCSC	Suffolk County Sanitary Code
SCSWCD	Suffolk County Soil and Water Conservation District
SCWA	Suffolk County Water Authority
SEQRA	(NYS) State Environmental Quality Review Act
SGPA	Special Groundwater Protection Area
SCLD	Suffolk County Law Department
SPDES	(NY) State Pollution Discharge Elimination System
SSER	South Shore Estuary Reserve
STP	Sewage Treatment Plant
SWAP	(Federal) Source Water Assessment Program
SWSD	(Suffolk County) Southwest Sewer District
TCA	Trichloroethane (solvent)
TCE	Trichloroethylene (solvent)
TDR	Transfer of Development Rights
TNC	The Nature Conservancy
TOD	Transit-Oriented Development (similar to Smart Growth)
UCMR3	Unregulated Contaminants Monitoring Rule 3 (see Glossary)
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Chemical
ZBA	Zoning Board of Appeals



Appendix B

Evaluation of Nitrates in Suffolk County, New York Public Water Supply Wells, April 2014

Suffolk County
Department of Health Services



Steven Bellone, Suffolk County Executive
James L. Tomarken, MD, MPH, MBA, FRCPC, FACP, Commissioner
Barry S. Paul, Deputy Commissioner

Evaluation of Nitrates in Suffolk County, New York Public Water Supply Wells

April 2014

Division of Environmental Quality
Walter Dawydiak, Jr., PE, JD, Director

Office of Water Resources
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Abstract

In order to properly benchmark trends in water quality it is important to compare data from the same set of wells, e.g., comparing apples to apples. The 1987 to 2005 comparison of water quality data in the draft Comprehensive Water Resources Management Plan, prepared by CDM, has been reevaluated and expanded to include 2013 data that shows generally a linear trend of increasing average nitrate concentrations in the glacial and magothy aquifer public water supply wells continuing through 2013. The nitrate concentrations in the same subset of 173 glacial aquifer wells rose over 41% from an average concentration of 2.54 milligrams per liter (mg/L) in 1987 to 3.58 mg/L in 2013. The annual rate of increasing nitrate concentrations in the same subset of wells appears to have been relatively steady between 1987 and 2013 at approximately 0.04 mg/L per year.

Nitrate concentrations nearly doubled at an increase of 93.2% in a subset of the same 190 magothy aquifer wells between 1987 and 2013. The average concentration of nitrates in the magothy subset in 1987 was 0.91 mg/L and in 2013 the average concentration was 1.76 mg/L. The calculated rate of increasing nitrate concentrations appears to have increased since 2005 in the same subset of magothy wells. The annual rate of increasing nitrate concentrations between 1987 and 2005 was 0.03 mg/L per year and grew to nearly 0.04 mg/L per year between 2005 and 2013. Similar increasing trends were observed in the glacial and magothy aquifers in an analysis of all public water supply well nitrate data.

Background

There are approximately 1,000 public water supply wells in Suffolk County, New York serving an estimated 1.4 million residents. As of March 2014, there were 38 community water suppliers, approximately 200 non-community public water suppliers, and an estimated 45,000 private wells that rely on Suffolk County's sole source aquifer for potable water supply. Numerous contamination sources including VOCs, pesticides and nitrates threaten the quality of our groundwater and surface waters on Long Island. To assess the current status and trends, Suffolk County contracted with CDM in the mid-2000's to evaluate contamination levels in our aquifers. To assess nitrate contamination, CDM compared analytical results from public water supply wells using data compiled by the Suffolk County Department of Health Services (SCDHS) and the Suffolk County Water Authority (SCWA) for 1987 and 2000 to 2005. CDM presented their analysis in Section 3, Table 3-1 of the draft Comprehensive Water Resources Management Plan (Comp Plan) for Suffolk County. SCDHS, in consultation with CDM, has since revisited and updated this evaluation to include recent data from 2013.

The drinking water standard for nitrates is currently 10 mg/L in New York State based on the potential to cause methemoglobinemia, a.k.a. blue baby syndrome. Several public water supply wells in Suffolk County are approaching or exceeding the nitrate drinking water standard and must blend or treat to reduce concentrations. Public water suppliers on Long Island can spend an estimated $3.5 million in capital expenses for a nitrate removal system at a typical pump station and can spend an additional $125,000 per year in operating costs for electricity, disposal of waste streams, etc.

Findings

In order to properly benchmark trends in water quality it is important to compare data from the same set of wells, e.g., comparing apples to apples. The 1987 to 2005 comparison of nitrate levels in the same set of wells presented in the Comp Plan has been reevaluated and updated to include 2013 data. The data generally shows a linear trend of increasing average nitrate concentrations in the glacial and magothy public water supply wells continuing through 2013. Nitrate data from public water supply wells installed in the Lloyd aquifer was limited and consequently was not included as part of this evaluation. In 2013 there were a total of 5 public supply wells in Suffolk County installed in the Lloyd aquifer, only one of which was sampled in 1987, 2005 and 2013.

The nitrate concentrations in the same subset of 173 glacial aquifer wells rose over 41% from an average concentration of 2.54 milligrams per liter (mg/L) in 1987 to 3.58 mg/L in 2013 (see Figures 1 & 2). The annual rate of increasing nitrate concentrations calculated for the same subset of glacial wells appears to have been relatively steady between 1987 and 2013 at approximately 0.04 mg/L per year.

Nitrate concentrations nearly doubled at an increase of 93.2% in a subset of the same 190 magothy aquifer wells between 1987 and 2013. The average concentration of nitrates in the magothy in 1987 was 0.91 mg/L and in 2013 the average concentration was 1.76 mg/L (see Figures 1 & 3). The calculated rate of increasing nitrate concentrations appears to have increased since 2005 in the same subset of magothy wells. The annual rate of increasing nitrate concentrations between 1987 and 2005 was 0.03 mg/L per year and grew to nearly 0.04 mg/L per year between 2005 and 2013.

Because 2013 analytical results were not available to characterize all of the wells included in the 1987 to 2005 Comp Plan comparison, the number of wells included in the updated 1987, 2005 and 2013 comparison has been reduced. A total of 247 glacial and 227 magothy wells were evaluated for the 1987 and 2005 comparison in the Comp Plan. As non-community water suppliers connect to community water supplies and older community supply wells are retired and replaced, public water supply wells are removed from service and are no longer sampled. As a result, the total number of glacial wells that were sampled in 1987, 2005 and 2013 was

reduced to 173, and the total number of magothy wells that were sampled in 1987, 2005 and 2013 was reduced to 190. However, as shown in Figure 4, the average nitrate concentration trends for the 1987 and 2005 are closely aligned between the two data sets. The number of wells in the same well comparison is expected to continue to decrease as non-community water suppliers connect to community water supplies and older community public supply wells are retired and replaced, or otherwise abandoned and relocated.

Similar increasing trends of nitrate concentrations were observed in the glacial and magothy aquifers in an analysis of all public water supply well nitrate data (see Figure 5). The most likely explanation for the "same wells" comparison showing more degradation than the "all wells" comparison is that older community water supply wells with poorer water quality were taken off-line and newer wells were sited in areas with better water quality in the glacial aquifer or installed deeper into the magothy aquifer. Shallow, non-community water supply wells were also abandoned as many of these small supplies connected to community water suppliers that generally have much deeper wells and better raw water quality.

Methods

Careful examination of the previously presented comparison of nitrate levels from all wells sampled in 1987 and from 2000 to 2005 in the draft Comp Plan has resulted in some changes in the reported average nitrate concentrations. Because some wells in the data sets were sampled once, and other wells were sampled over 30 times by SCWA between 2000 and 2005, nitrate levels from the frequently sampled wells had been given more weight than the results from those wells that were infrequently sampled. An updated evaluation of the data more properly assigns equal weight to the results from each well. As shown in the attached table (Table 1), an updated evaluation of the Comp Plan data still shows an increasing trend of nitrates in the glacial and magothy aquifers.

In performing the most recent analysis, nitrate analytical data for 1987 was again obtained from the SCDHS's Henco database and the 2005 and 2013 analytical results were obtained from the SCDHS's Blacksmith database. Both community and non-community public water supply results were used in the evaluation. Although analytical results for SCWA wells were included in the SCDHS databases, SCWA's self-monitoring nitrate results from the SCWA database were not included in the most recent assessment in order to simplify the analysis. Despite using slightly different data sets, SCDHS data for 1987 and 2005 closely aligned with the 1987 and 2005 average nitrate concentrations presented in the updated Comp Study as shown in the attached table (Table 1).

Community water supply wells with multiple nitrate samples in the same year were averaged together to produce an average nitrate concentration for each well. Nitrate results for non-community water supply sites with multiple wells or multiple samples were averaged together

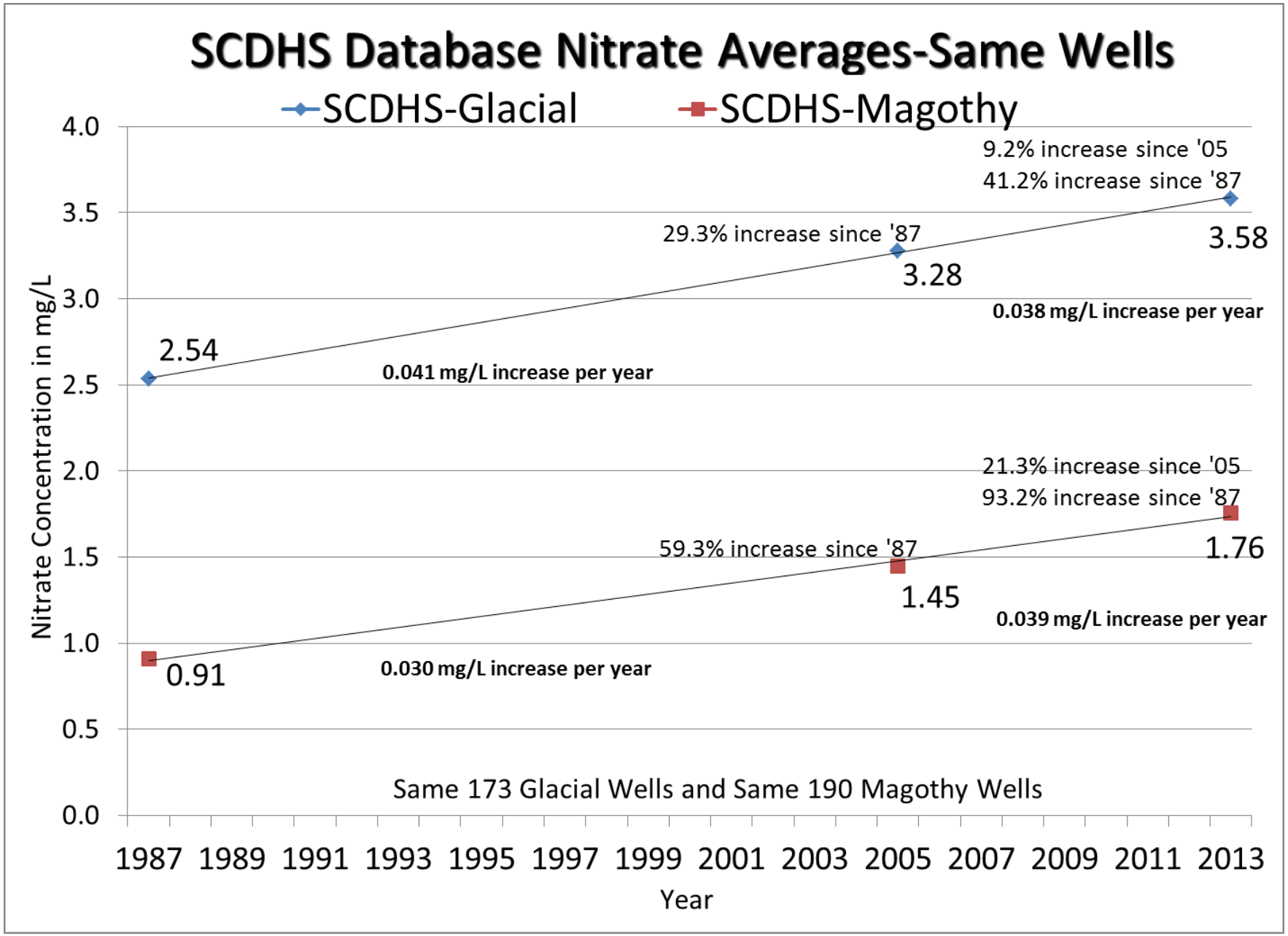
to represent the average nitrate concentration for the site. The average nitrate concentration for each respective year was an unweighted average of all of the averages from each well or site. It was assumed that all non-community public supply wells were screened in the glacial aquifer, with the exception of the two known magothy aquifer wells at Captree State Park. Results were excluded from the analysis if the treatment status at the collection point was a known nitrate removal or reduction technique (i.e. reverse osmosis, ion exchange, blending with water from other wells). Results were not excluded from the analysis based on treatment status at the sample point for other forms of treatment (i.e. greensand filtration, granular activated carbon, air stripper, chlorine, etc.). It was assumed that any effect on the average nitrate concentration due to treatment from other than known nitrate removal and reduction techniques would be negligible based on the number of samples collected from the effluent of treatment systems and the large number of total data points. Where nitrate results were "non-detect" the concentration was assumed to be equal to one-half of the reported detection limit. This is comparable to the methodology used by CDM to produce the updated Comp Plan results.

Conclusion

There is currently a wealth of data available from public supply wells to aid in characterizing nitrate levels throughout Suffolk County's aquifer system. While use of all available data helps to provide resource managers with a complete picture of conditions, it does not provide a good indication of temporal trends. Comparison of nitrate levels measured at the same set of wells over time provides the most reliable assessment of how nitrate levels in the aquifer are changing. As public supply wells continue to be abandoned or replaced, the pool of available data from the same subset of wells will continue to decrease resulting in a very limited assessment of overall quality in the aquifers. Public water supply wells are also generally installed in areas with better water quality, which may be biasing the data in an overall assessment of the aquifer. Alternative methods for compiling a database of consistent and reliable sampling points should be considered (e.g. monitoring well network).

SCDHS has evaluated multiple public supply well data sets; the conclusions of each evaluation have been consistent in documenting a continued upward trend in nitrate levels in both the glacial and magothy aquifers. While nitrate levels generally remain well below the drinking water standard in the vast majority of public supply wells, the increasing trend continues to be of concern. It should be noted that elevated levels of nitrates in groundwater discharging to downgradient surface waters are one of the contributing factors of harmful algal blooms which may result in shellfishing closures, beach closures, and fishing restrictions.

Figure 1


SCDHS Database Nitrate Averages-Same Wells
SCDHS-Glacial
SCDHS-Magothy
Nitrate Concentration in mg/L
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
9.2% increase since '05
41.2% increase since '87
3.58
29.3% increase since '87
3.28
0.038 mg/L increase per year
2.54
0.041 mg/L increase per year
21.3% increase since '05
93.2% increase since '87
1.76
59.3% increase since '87
1.45
0.039 mg/L increase per year
0.91
0.030 mg/L increase per year
Same 173 Glacial Wells and Same 190 Magothy Wells
1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013
Year

SCDHS Database Same Well Nitrate Average Concentrations by Aquifer

Figure 2

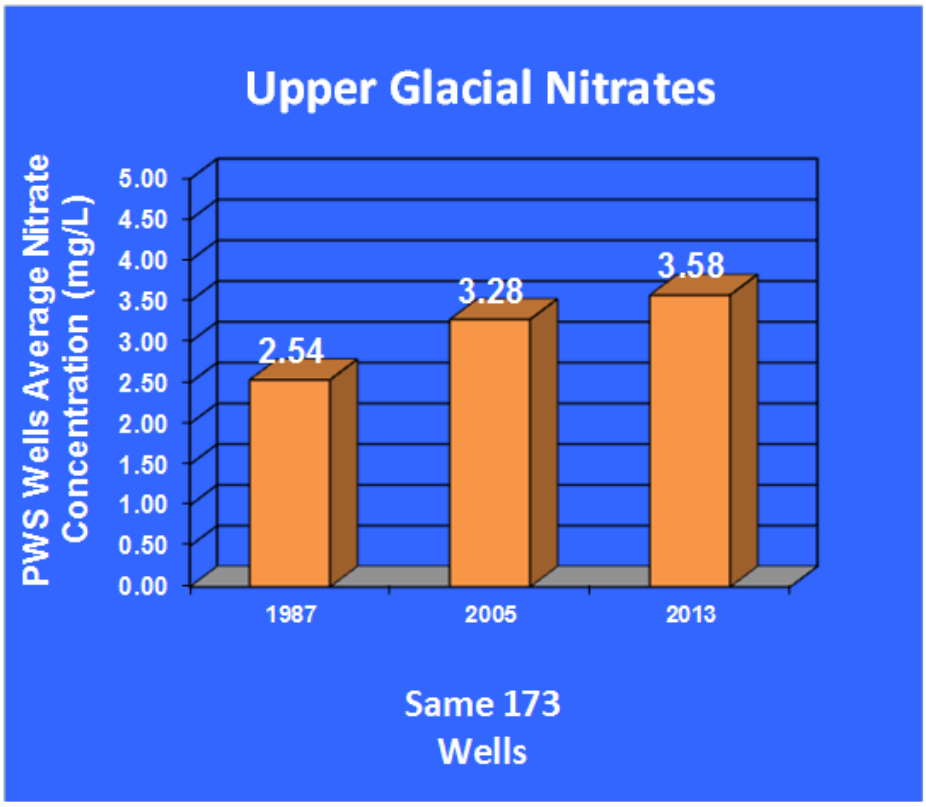


Figure 3

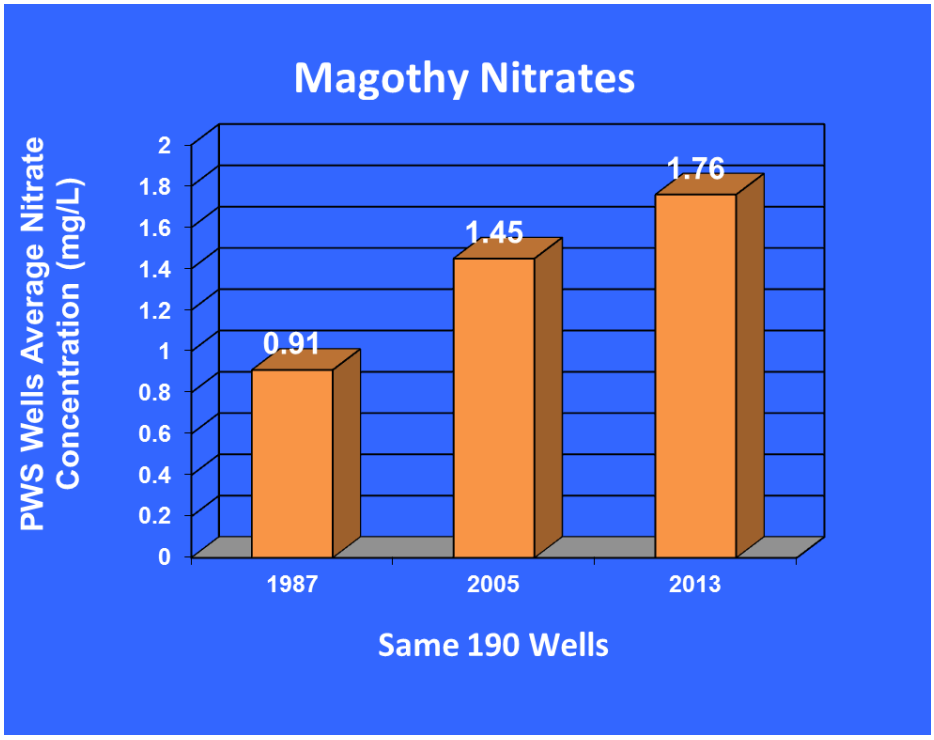


Figure 4

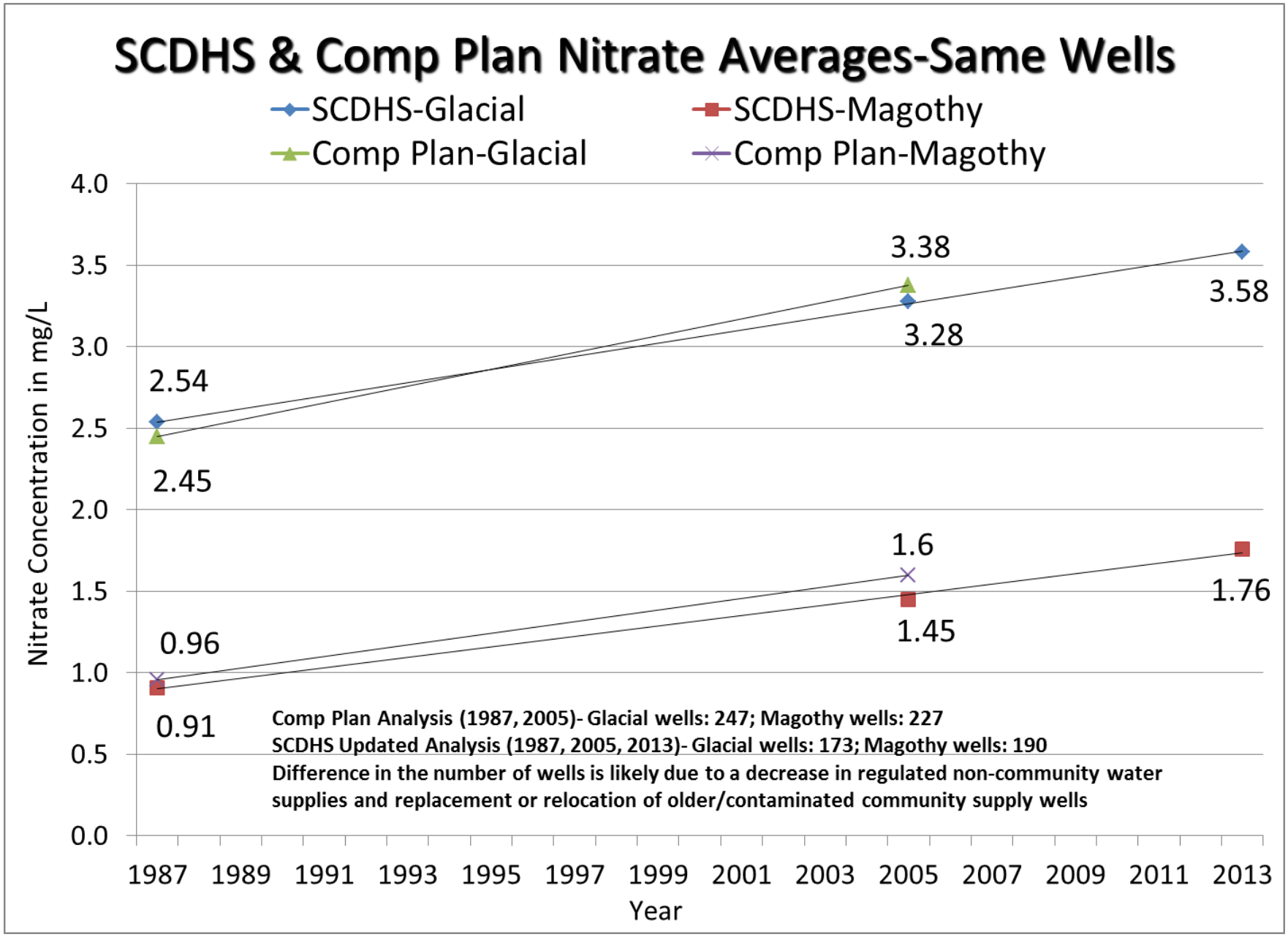

SCDHS & Comp Plan Nitrate Averages-Same Wells
SCDHS-Glacial
SCDHS-Magothy
Comp Plan-Glacial
Comp Plan-Magothy
Nitrate Concentration in mg/L
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3.38
3.58
3.28
2.54
2.45
1.6
1.76
1.45
0.96
0.91
Comp Plan Analysis (1987, 2005)- Glacial wells: 247; Magothy wells: 227
SCDHS Updated Analysis (1987, 2005, 2013)- Glacial wells: 173; Magothy wells: 190
Difference in the number of wells is likely due to a decrease in regulated non-community water supplies and replacement or relocation of older/contaminated community supply wells
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Year

Figure 5

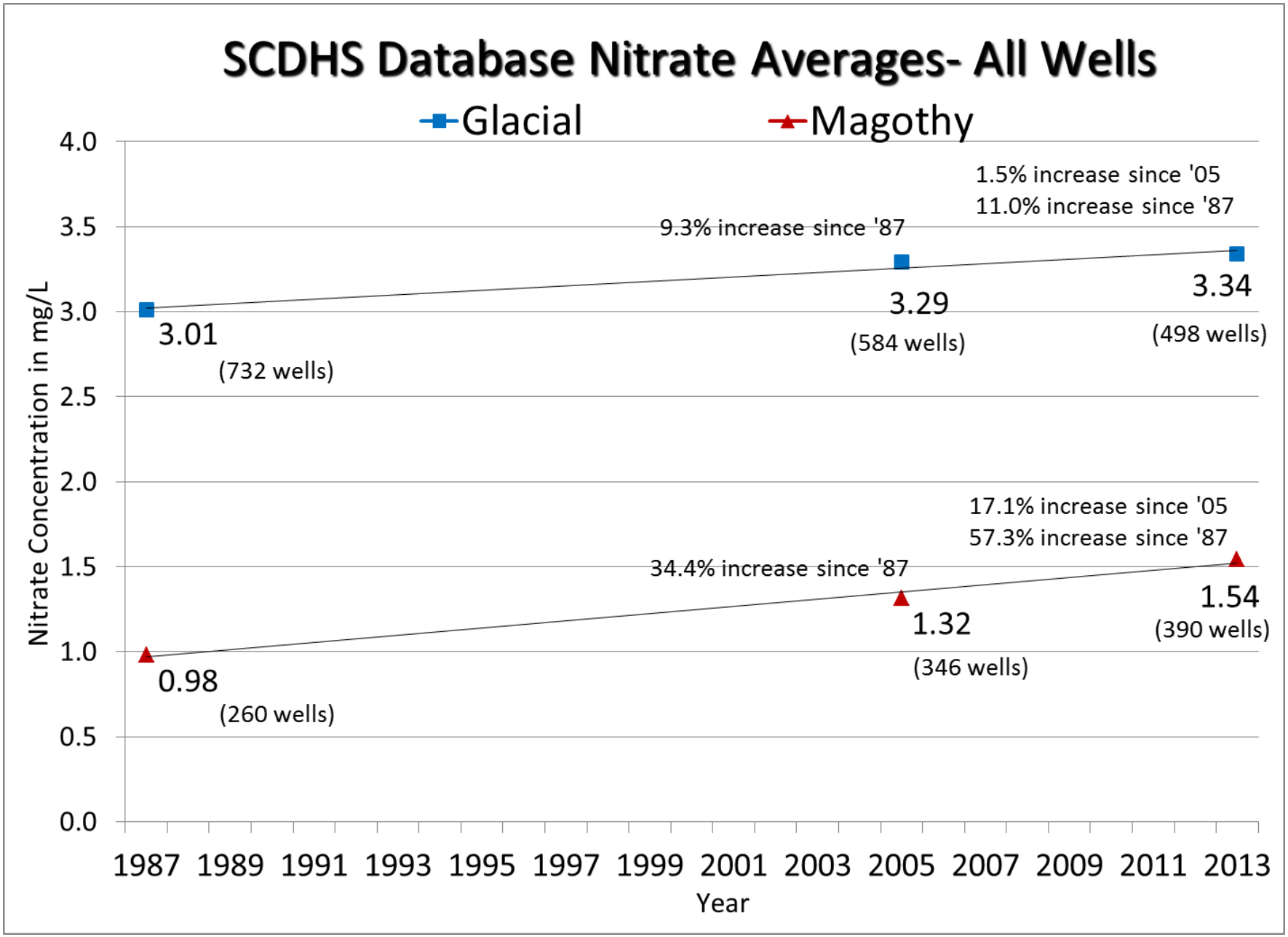

SCDHS Database Nitrate Averages- All Wells
Glacial
Magothy
Nitrate Concentration in mg/L
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.5% increase since '05
11.0% increase since '87
9.3% increase since '87
3.01
(732 wells)
3.29
(584 wells)
3.34
(498 wells)
17.1% increase since '05
57.3% increase since '87
34.4% increase since '87
0.98
(260 wells)
1.32
(346 wells)
1.54
(390 wells)
1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013
Year

Table 1. Nitrate Concentrations from All Community and Non-Community Supply Wells

	Nitrate (mg/L)								
	1987			2005			2013		
	Draft Comp Plan	Revised Comp Plan*	SCDHS Data Only	Draft Comp Plan	Revised Comp Plan*	SCDHS Data Only	Draft Comp Plan	Revised Comp Plan*	SCDHS Data Only
Upper Glacial Aquifer									
n (wells)	714	714	732	575	575	584	N/A	N/A	498
Average	3.12	3.05	3.01	4.34	3.29	3.29	N/A	N/A	3.34
Magothy Aquifer									
n (wells)	281	281	260	376	376	346	N/A	N/A	390
Average	1.14	1.07	0.98	3.43	1.38	1.32	N/A	N/A	1.54

Notes:

The Comp Plan statistics were based on data from the SCDHS Henco and Blacksmith databases as well as data received from the SCWA.

The SCDHS statistics were based solely on data from the SCDHS Henco and Blacksmith databases.

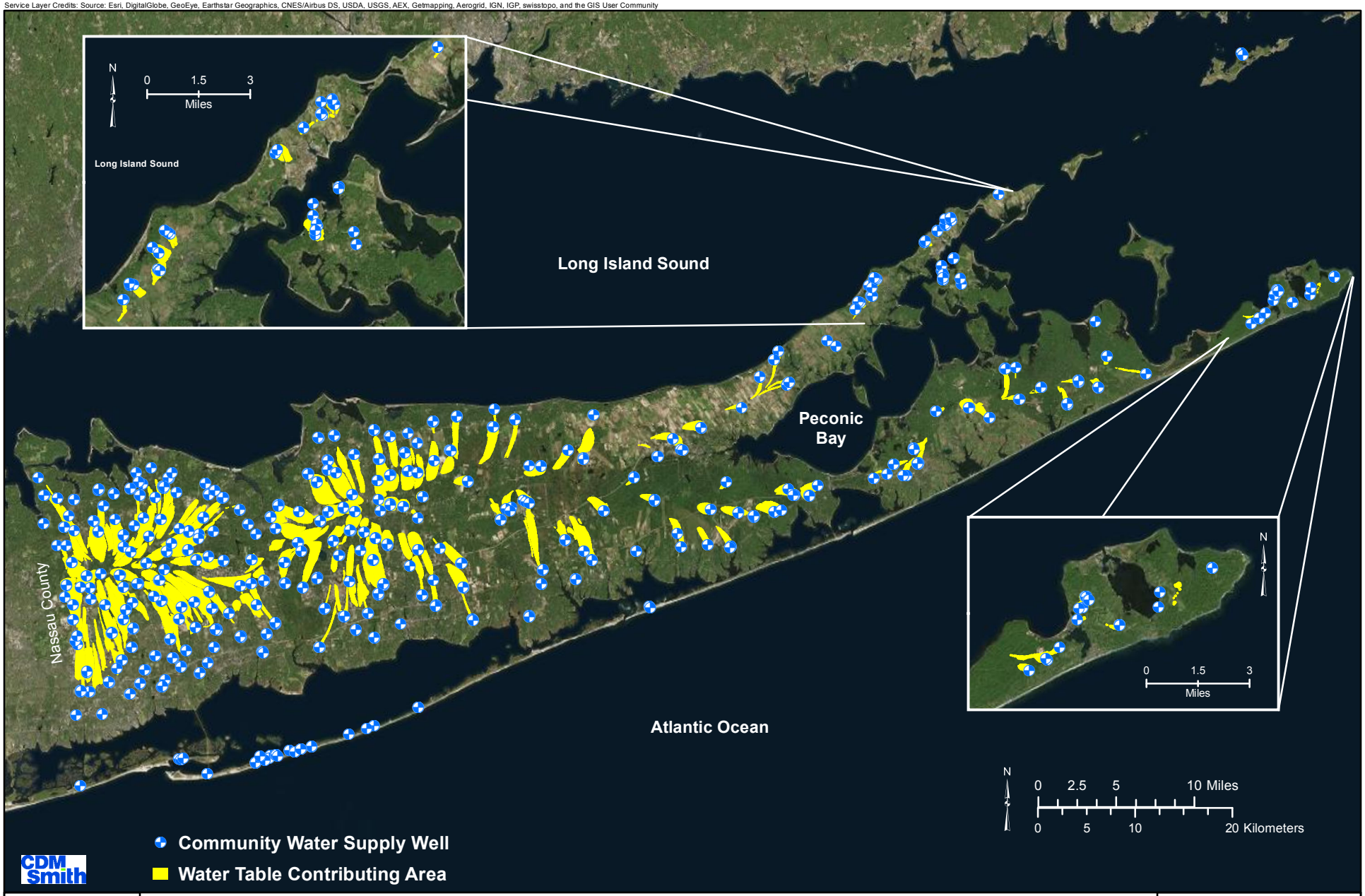
SCDHS databases typically include results from an annual sample collected by SCDHS at all well sources only, whereas the SCWA database includes several results from each well where there is an increased monitoring frequency due to elevated nitrate concentrations.

* Initial Draft Comp Plan analysis aggregated all well data (biased towards more frequent samples at impacted wells), while the Revised Comp Plan used average data for each well in a given year.

Appendix C

SWAP Map

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Simulated Water Table Contributing Areas to Community Public Supply Wells
100 Year Contributing Areas (2010 Analysis)*

Suffolk County Comprehensive Water Resources Management Plan

*** Will be updated in 2015, with a goal of updating every one to two years thereafter**

Figure A-X

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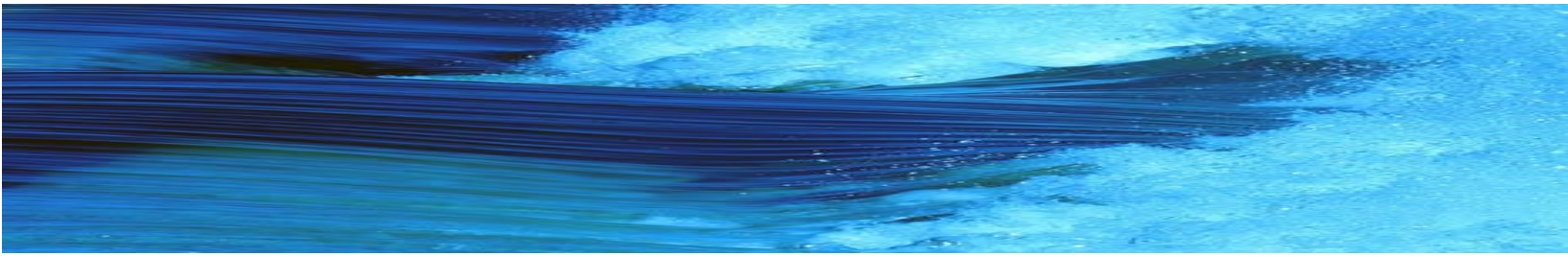

Appendix D

VOC Action Plan

VOC Action Plan

Summary
DEQ proposes to enhance Pollution Control resources to reverse the trend of increasing volatile organic compounds (VOCs) in the environment. The Comprehensive Water Resources Management (COMP) Plan (draft Dec. 2010) shows an increasing trend in the detection of VOCs in public supply wells. The VOC Action Plan will enhance resources in the Division of Environmental Quality in two phases. The first phase will immediately add five staff members to increase inspections and enforcement at high risk facilities. The second phase, which will enhance oversight of the thousands of commercial and industrial facilities in Suffolk County, will be addressed by the Reducing Toxics Study. The goal is to ensure the long-term reduction of VOC's in the environment.

Background
VOC's represent the greatest threats to Suffolk County's groundwater and drinking water resources and must be the mainstay of environmental protection efforts. Ironically, the progressive County programs enacted to combat VOC contamination and the success they have enjoyed have pushed this issue into the background and obscured its importance. Renewed vigilance is required to protect the long-term environmental and economic health of Suffolk County.

- Environmental Impact Significance
  - The COMP Plan shows an increasing trend in the detection of VOCs in public supply wells.
    - Perchloroethylene (PCE) was detected in four times as many wells in 2005 as in 1987.
    - Trichloroethene (TCE) concentrations from the same upper glacial and Magothy wells doubled from 1987 to 2005.
- Threat Assessment
  - Over 19,000 facilities in Suffolk County have the potential to use, store and discharge hazardous materials.
    - Only facilities with permitted storage (3200 sites) are routinely inspected by the Office of Pollution Control (OPC).
    - OPC has insufficient resources to inspect the other 16,000 commercial and industrial facilities.
    - 5% - 10% of these sites are estimated to be improperly/unlawfully storing and disposing of hazardous materials.
  - No routine inspection of dry cleaners, historically responsible for numerous significant PCE groundwater plumes.
  - Underground gasoline storage facilities, the other major groundwater threat, can only be inspected every 3 years.
  - As fewer sites are inspected, environmental cleanups have dropped from 300 per year to 150 per year.
- Superfund/Brownfields
  - Current Superfund/Brownfield sites in Suffolk County have been identified and remediated because Suffolk County has historically been inspecting these sites and uncovering contamination and illicit discharges.
  - Thousands of other remediations occur under SCDHS guidance before there is significant environmental harm.
  - Without sufficient inspection and sampling resources,
    - Small spills will progress into larger Superfund type sites, with potential for significant impact to groundwater.
    - Larger spills will go unchecked and have the potential to impact the environment in a devastating manner.

There are clear environmental, public health and economic consequences for failure to rigorously regulate the storage, handling and disposal of toxic and hazardous materials. As pollution proliferates throughout the county, it could tarnish Suffolk's appeal as an attractive location to vacation, raise their families and set up businesses.

Action Plan
Phase I will be implemented immediately and will focus on high risk facilities.
- This phase will allow for annual inspections of underground gasoline storage facilities and dry cleaners.
- This phase will increase sampling capacity from 120 per year to 1000 to allow for detection of contaminants and enhanced remediations.
- This phase calls for hiring
  - One Public Health Sanitarian (PHS) Trainee to inspect up to 400 dry cleaning facilities per year.
  - One PHS Trainee to inspect up to 500 additional gasoline stations per year.
  - One PHS Trainee to process the additional enforcement actions resulting from increased inspections.
  - One Asst. Public Health Engineer Trainee to review the additional hazardous material storage facility plan submittals that will result from facilities that upgrades tanks to meet code requirements.
  - One Chemist I to analyze the additional samples that will result for the increases/enhanced inspections.

Phase II will focus on all commercial/industrial facilities in the County and long-term solutions to VOCs in the environment.
- The "Reducing Toxics" study will review OPC spill records from some of the 16,000 commercial/industrial facilities that are not routinely inspected but still pose a threat to the environment due toxic or hazardous material spills and discharges.
- The study will examine the best strategies to control contaminants based on the threats posed by specific industries.

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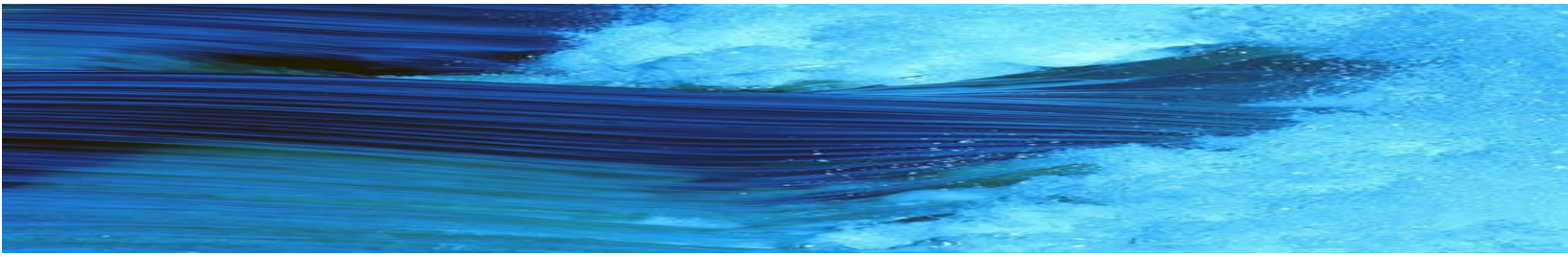

Appendix E

Summary and Basis of Water Quality Parameters Analyzed by the Suffolk County Department of Health Services Public & Environmental Health Laboratory as Compared with Those Regulated in Drinking Water & Analyzed by Other Agencies (March 2015)

(Currently under Agency Review)

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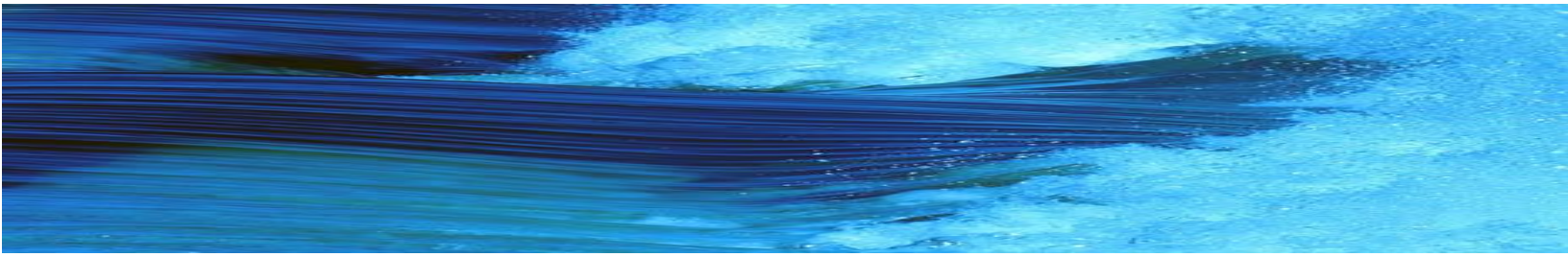

Appendix F

DRAFT Monitoring Well Network Map

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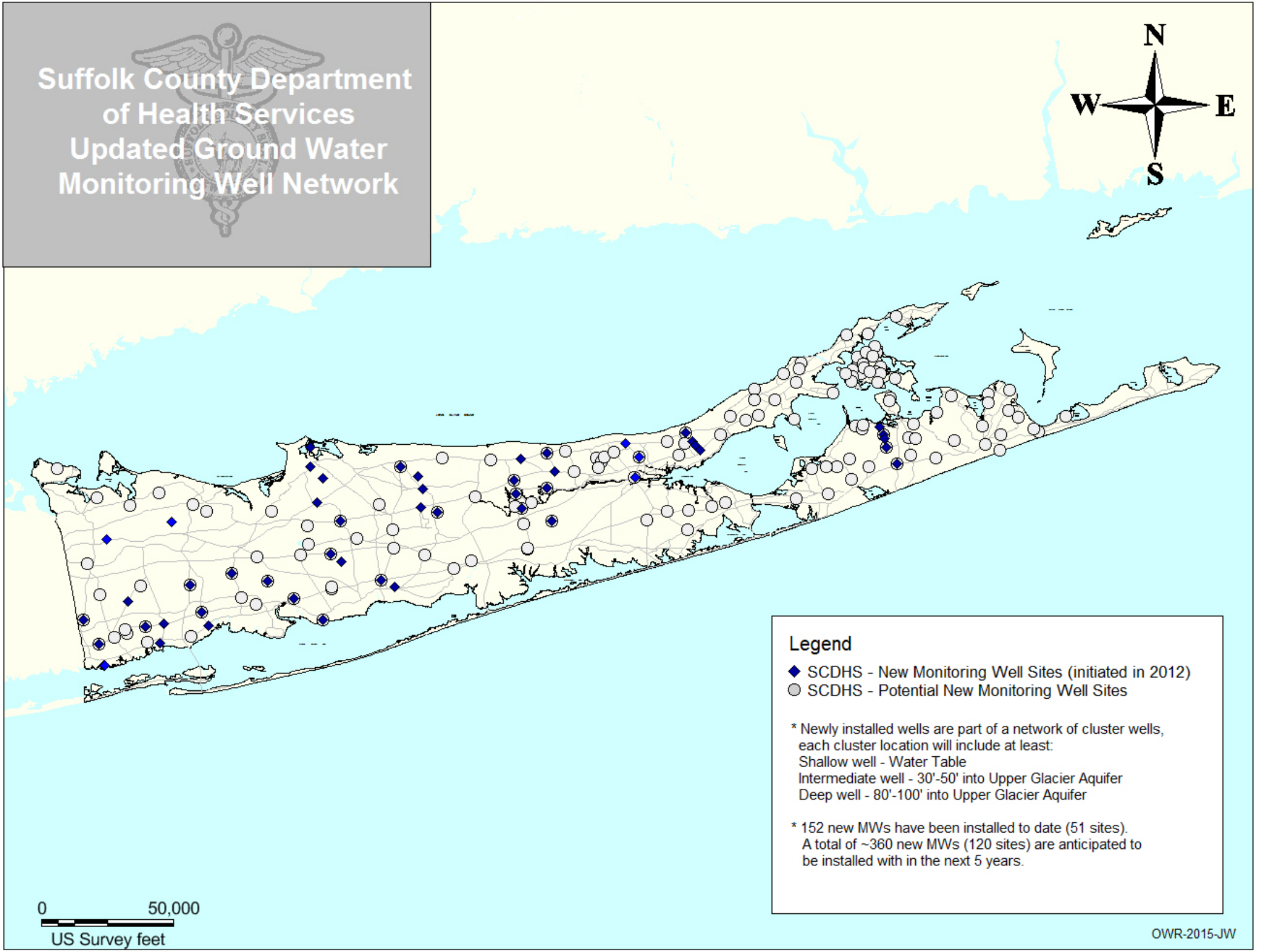
Suffolk County Department of Health Services Updated Ground Water Monitoring Well Network



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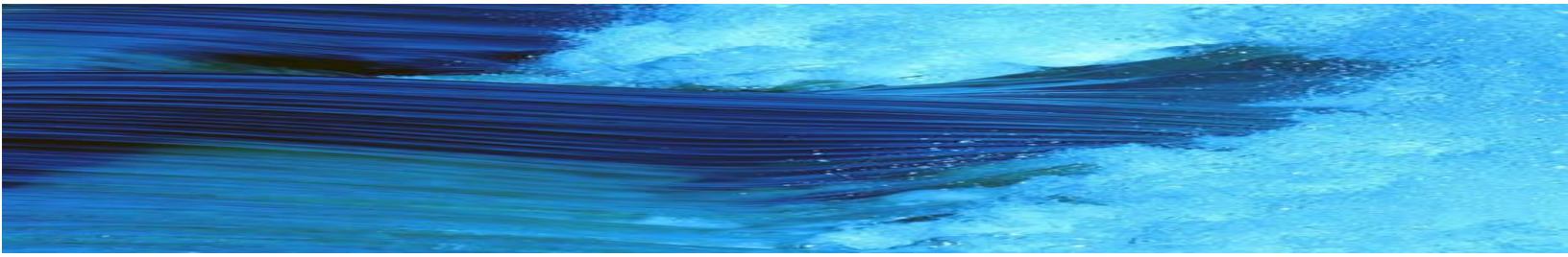
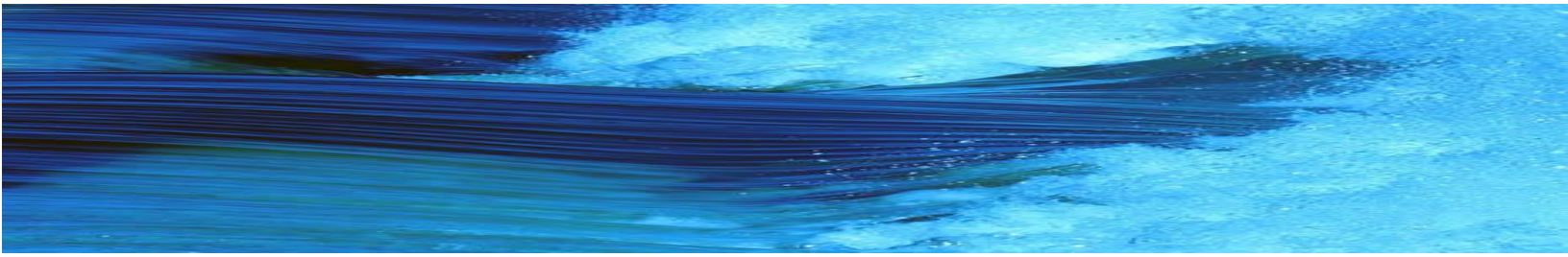


Appendix G

Contaminant Fact Sheets

(Currently under Agency Review)



Appendix H

Suffolk County Community Water Supplies

List of Suffolk County Community Public Water Supply Systems

As of March 19, 2015

No.	Community Water Supply Name	Approximate Population	Location
1	Suffolk County Water Authority	1.1 Million	-
2	South Huntington Water District	81,000	Huntington
3	Greenlawn Water District	42,000	Huntington
4	Riverhead Water District	35,000	Riverhead
5	Dix Hills Water District	34,000	Huntington
6	Smithtown Water District	20,500	Smithtown
7	Hampton Bays Water District	14,400	Southampton
8	St. James Water District	11,200	Saint James
9	East Farmingdale Water District*	7,500	Babylon
10	Brentwood Water District*	6,498	Islip
11	Stony Brook Water District*	4,950	Brookhaven
12	Ocean Beach Water District	4,500	Fire Island
13	Fair Harbor Water District*	4,884	Fire Island
14	Brookhaven National Laboratory	3,300	Upton
15	Fishers Island Water Works	2,500	Fishers Island
16	Village of Greenport	2,100	Southold
17	Saltaire Water District	2,000	Fire Island
18	Northport Veterans Affairs Hospital	2,000	Northport
19	Riverside Water District*	1,800	Riverhead
20	Seaview Water District	1,400	Fire island
21	Calverton Hills Homeowners Association	700	Riverhead
22	Shelter Island Heights Property Owners Corporation	500	Shelter Island
23	West Gilgo Beach Homeowners Association	300	Fire Island
24	West Neck Water District	202	Shelter Island
25	Robert Moses State Park	100	Fire Island
26	Dering Harbor Water District	72	Shelter Island
27	Peconic River Mobile Home Park	66	Riverhead
28	Peconic View Mobile Home Park	60	Riverhead
29	McCrodden Water Company	54	Fire Island
30	Maidstone Park Cottages	34	East Hampton
31	Dougherty Water Company	34	Fire Island
32	McCarren Water Company	30	Fire Island
33	Shelter Island Chalets	17	Shelter Island
34	Bridgeford Colony	16	Montauk
35	Aliperti Cottages	12	Sag Harbor
36	Wolfies' Tavern	10	East Hampton
37	Kings Cabins	7	Shelter Island

*****Operated and maintained by the SCWA

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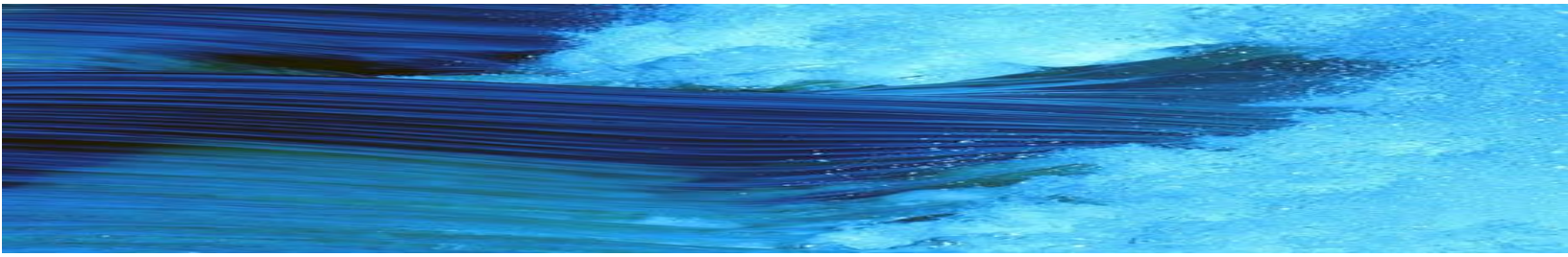


Appendix I

Suffolk County Sewage Treatment Plants

Table 1 - Suffolk County Sewage Treatment Plants (2014)

No.	Sewage Treatment Name	Sewage Treatment Type	Tertiary or Secondary	NYS SPDES Design Flow (MGD)	Discharge Location
1	Artist Lake	Extended aeration denite filter	Tertiary	0.025	Inland
2	Avery Village	SBR	Tertiary	0.025	Inland
3	Bellhaven Nursing Home	SBR	Tertiary	0.04	Inland
4	Birchwood @ Spring Lake	Extended aeration denite filter	Tertiary	0.25	Inland
5	Birchwood Glen	Extended aeration denite filter	Tertiary	0.1	Inland
6	Birchwood Nursing Home	SBR	Tertiary	0.02	Inland
7	Birchwood On The Green	Extended aeration denite filter	Tertiary	0.087	Inland
8	Blue Ridge	SBR	Tertiary	0.25	Inland
9	Bretton Woods	SBR	Tertiary	0.343	Inland
10	Bristal East Northport	Cromaglass	Tertiary	0.015	Inland
11	Bristal @ Lake Grove	Cromaglass	Tertiary	0.015	Inland
12	Encore Atl Shores Bristal Est.	SBR	Tertiary	0.04	Inland
13	Broadway Knolls	SBR	Tertiary	0.066	Inland
14	Broadway West	Cromaglass	Tertiary	0.015	Inland
15	Brookhaven Hospital	SBR	Tertiary	0.15	Inland
16	Brookhaven National Lab	Modular Aeration	Tertiary	1.2	Inland
17	Brookhaven SD #2	BESST	Tertiary	0.2	Inland
18	Brookhaven Town Hall	Extended areation denite filter	Secondary	0.026	Inland
19	Brookwood on the Lake	Bio disc denite filter	Tertiary	0.045	Inland
20	Browning Hotel Marriott Courtyard	SBR	Tertiary	0.056	Inland
21	Cabrini Gardens	Cromaglass	Tertiary	0.0071	Inland
22	Calverton Enterprise Park	Extended aeration	Secondary	0.078	Surface Waters
23	Calverton Hills	Extended aeration	Secondary	0.03	Inland
24	Cedar Lodge	Extended aeration	Secondary	0.03	Inland
25	Cenacle Manor	SBR	Tertiary	0.036	Inland
26	Chatham Holts RI Holt Hotel	SBR	Tertiary	0.02606	Inland
27	Chelmsford Weald Condo	Cromaglass	Tertiary	0.0099	Inland
28	Country Pointe	SBR	Tertiary	0.07	Inland
29	Country View Estates	SBR	Tertiary	0.0156	Inland
30	Country View @ Holtsville	BESST	Tertiary	0.015	Inland
31	Country View @ Smithtown	Cromaglass	Tertiary	0.063	Inland
32	Courtyard at Southampton	Cromaglass	Tertiary	0.015	Inland
33	Crescent Club	Extended Aeration	Secondary	0.03	Inland
34	Dowling	RBC denite filter	Tertiary	0.07	Inland
35	Eagles walk	Cromaglass	Tertiary	0.0428	Inland
36	East Port Meadows	Cromaglass	Tertiary	0.0081	Inland
37	Emanon Group	Cromaglass	Tertiary	0.00344	Inland
38	Emerald Greens	SBR	Tertiary	0.0186	Inland
39	Exit 63 Development	SBR	Tertiary	0.057	Inland
40	Fairfield at Mastic	Cromaglass	Tertiary	0.015	Inland
41	Fairfield at Selden	SBR	Tertiary	0.101	Inland
42	Fairfield Inn by Marriott	Cromaglass	Tertiary	0.015	Inland
43	Fairfield Lk Ronk	Cromaglass	Tertiary	0.015	Inland
44	Fairfield Village (Groton)	MBR	Tertiary	0.025	Inland
45	Fairhaven Apts. @ Nesconset	Extended aeration	Secondary	0.03	Inland
46	Fairway Manor	Extended aeration denite filter	Tertiary	0.0725	Inland
47	Fox Meadows	Extended aeration denite filter	Tertiary	0.034	Inland

2014 Suffolk County Sewage Treatment Plants (Continued Page 2)					
No.	**Sewage Treatment Name**	**Sewage Treatment Type**	**Tertiary or Secondary**	**NYS SPDES Design Flow (MGD)**	**Discharge Location**
48	Greenport Village	SBR	Tertiary	0.65	Surface Waters
49	Greens @ Half Hollow	SBR	Tertiary	0.3	Inland
50	Greenview Commons	SBR	Tertiary	0.03	Inland
51	Greenview Court	Cromaglass	Tertiary	0.0105	Inland
52	Greenwood @ Oakdale	Extended aeration denite filter	Tertiary	0.03712	Inland
53	Greenwood Village	Extended aeration denite filter	Tertiary	0.066	Inland
54	Gurwin Jewish Assisted Living	SBR	Tertiary	0.04	Inland
55	Gurwin Jewish Geriatric Center	SBR	Tertiary	0.045	Inland
56	Hampton Rehab Center	SBR	Tertiary	0.045	Inland
57	Hawthorne (Concord) Village	MBR	Tertiary	0.127	Inland
58	Heatherwood @ Holbrook	BESST	Tertiary	0.03	Inland
59	Heatherwood @Lakeland	Extended aeration denite filter	Tertiary	0.03	Inland
60	Heatherwood House @ Lake Ronk	Extended aeration	Secondary	0.03	Inland
61	Heritage Gardens at Brentwood	BESST	Tertiary	0.03	Inland
62	Hidden Ponds	Extended aeration denite filter	Tertiary	0.08	Inland
63	Hilton Gardens	SBR	Tertiary	0.022	Inland
64	Holiday Inn Express	Cromaglass	Tertiary	0.015	Inland
65	Holiday Inn	Extended aeration denite filter	Tertiary	0.04	Inland
66	Homestead Village	Extended aeration Susp. growth denite	Tertiary	0.115	Inland
67	Huntington Town	SBR	Tertiary	2.5	Surface Waters
68	Inn @ East Winds	Cromaglass	Tertiary	0.015	Inland
69	IRS	SBR	Tertiary	0.085	Inland
70	Island View	SBR	Tertiary	0.0554	Inland
71	Islandia Center	Extended aeration denite filter	Tertiary	0.055	Inland
72	Kensington Gardens st jamess NH	Extended aeration denite filter	Tertiary	0.075	Inland
73	LA fitness	BESST	Tertiary	0.0135	Inland
74	La Quinta	Cromaglass	Tertiary	0.015	Inland
75	Lake Grove Apqartments	SBR	Tertiary	0.08	Inland
76	Lake Pointe	Extended aeration denite filter	Tertiary	0.117	Inland
77	Lakes @ Setauket	Biodisc denite filter	Tertiary	0.0861	Inland
78	Lakeview Woods Bayport	Cromaglass	Tertiary	0.015	Inland
79	Larkfield Gardens Atria	SBR	Tertiary	0.016	Inland
80	Lexington Village	Extended aeration	Secondary	0.03	Inland
81	DSW Plaza Loehmans Plaza	RBC denite filter	Tertiary	0.0428	Inland
82	Mac Arthur Plaza	Extended aeration denite filter	Tertiary	0.015	Inland
83	Medford multicare center for living	SBR	Tertiary	0.05	Inland
84	Medford NH	SBR	Tertiary	0.05	Inland
85	Medford Ponds	BESST	Tertiary	0.0545	Inland
86	Melville Mall	Biodisc denite filter	Tertiary	0.04	Inland
87	Memorial Sloan Kettering	Cromaglass	Tertiary	0.005	Inland
88	Middle Island Co-op	Extended aeration	Secondary	0.015	Inland
89	Mill Pond Estates	BESST	Tertiary	0.05	Inland
90	Montauk Manor	Oxidation ditch	Tertiary (Seasonal)	0.03	Inland
91	Nesconset NH	Extended aeration denite filter	Tertiary	0.042	Inland
92	Newsday	Aerotor/MBR	Tertiary	0.045	Inland
93	North Isle Village	Extended aeration denite filter	Tertiary	0.11	Inland
94	Northport VA	Extended Aeration w/ Suspended Growth De	Tertiary	0.35	Inland
95	Northport Village	Extended aeration denite filter	Tertiary	0.45	Surface Waters

Table 1 - Suffolk County Sewage Treatment Plants (2014)

2014 Suffolk County Sewage Treatment Plants (Continued Page 3)					
No.	**Sewage Treatment Name**	**Sewage Treatment Type**	**Tertiary or Secondary**	**NYS SPDES Design Flow (MGD)**	**Discharge Location**
96	Oak Creek Commons	Cromaglass	Tertiary	0.0048	Inland
97	Oak Hollow NH	Extended aeration upflow denite filter	Tertiary	0.035	Inland
98	Oak Ridge Hollow	Cromaglass	Tertiary	0.015	Inland
99	Oakwood Care Center Affinity	SBR	Tertiary	0.042	Inland
100	Ocean Beach	Chemical Carbon Filter	Secondary	0.5	Surface Waters
101	Orchard @ Bulls Head Inn	Cromaglass	Tertiary	0.085	Inland
102	Patchogue NH	Extended aeration upflow denite filter	Tertiary	0.02	Inland
103	Patch Senior Conifer 16128	SBR	Tertiary	0.04	Inland
104	Patchogue Village	Aerotor/MBR	Tertiary	0.5	Surface Waters
105	Paumanok Village	SBR	Tertiary	0.0427	Inland
106	Petite Fleur	Extended aeration denite filter	Tertiary	0.027	Inland
107	Pine Hills S Mirror Ponds	SBR	Tertiary	0.0225	Inland
108	Pinewood Gardens	Cromaglass	Tertiary	0.0036	Inland
109	Plum Island	Extended aeration	Secondary	0.05	Surface Waters
110	Ponds @ Southampton Village	BESST	Tertiary	0.027	Inland
111	Preserves @ Connetquote	Cromaglass	Tertiary	0.01236	Inland
112	Quail Run	SBR	Tertiary	0.087	Inland
113	Radisson Hotel Best Western	Extended aeration denite filter	Tertiary	0.027	Inland
114	Residence Inn	Cromaglass	Tertiary	0.015	Inland
115	Riverhead Town	SBR	Secondary	1.3	Surface Waters
116	Rocky Point Apts.	Extended aeration	Secondary	0.03	Inland
117	Ross Health Care	BESST	Tertiary	0.015	Inland
118	Rough Riders Landing	Oxidation ditch	Tertiary (Seasonal)	0.032	Inland
119	Saddle Brook	Cromaglass	Tertiary	0.01485	Inland
120	Sag Harbor	SBR	Tertiary	0.25	Surface Waters
121	Sagamore Hills	SBR	Tertiary	0.08	Inland
122	Sayville Commons	SBR	Tertiary	0.1	Inland
123	SCC Riverhead	SBR	Tertiary	0.012	Inland
124	SCC Selden	Extended aeration denite filter	Tertiary	0.151	Inland
125	SD # 1 Port Jefferson	SBR	Tertiary	1.15	Surface Waters
126	SD # 12 Birchwood	SBR	Tertiary	0.12	Inland
127	SD # 13 Wind Watch	Extended aeration denite filter	Tertiary	0.4	Inland
128	SD # 14 Parkland	SBR	Tertiary	1.25	Inland
129	SD # 15 Nob Hill	Extended aeration Susp. Growth denite	Tertiary	0.09	Inland
130	SD # 18 Hauppauge Industrial Park	SBR	Tertiary	1.85	Inland
131	SD # 2 Tallmadge	SBR	Tertiary	0.4	Inland
132	SD # 20W Leisure Village	SBR	Tertiary	0.3	Inland
133	SD # 21 SUNY Stony Brook	Oxidation ditch	Tertiary	2.5	Surface Waters
134	SD # 22 Hauppauge County Center	Cannabal	Tertiary	0.202	Inland
135	SD # 23 Coventry Manor	Bio disc denite filter	Tertiary	0.07	Inland
136	SD # 28 Fairfield@St James	Extended aeration denite filter	Tertiary	0.07	Inland
137	SD # 3 Bergen Point	Aeration	Secondary	30	Surface Waters
138	SD # 5 Strathmore Huntington	SBR	Tertiary	0.236	Inland
139	SD # 6 Kings Park	SBR	Tertiary	1.2	Surface Waters
140	SD # 7 Twelve Pines	Extended aeration susp. Growth denite	Tertiary	0.65	Inland
141	SD # 7 Woodside	Extended aeration denite filter	Tertiary	0.4	Inland
142	SD # 9 College Park	Extended aeration susp. Growth denite	Tertiary	0.045	Inland
143	SD #11 Selden	SBR	Tertiary	1.757	Inland
144	SD 20E Ridgehaven	Extended Aeration denite filter	Tertiary	0.083	Inland
145	SD Gabreski Airport	SBR	Tertiary	0.1	Inland
146	SD Yaphank County Center	Bio disc denite filter	Tertiary	0.25	Inland
147	Setauket Meadows	SBR	Tertiary	0.03	Inland

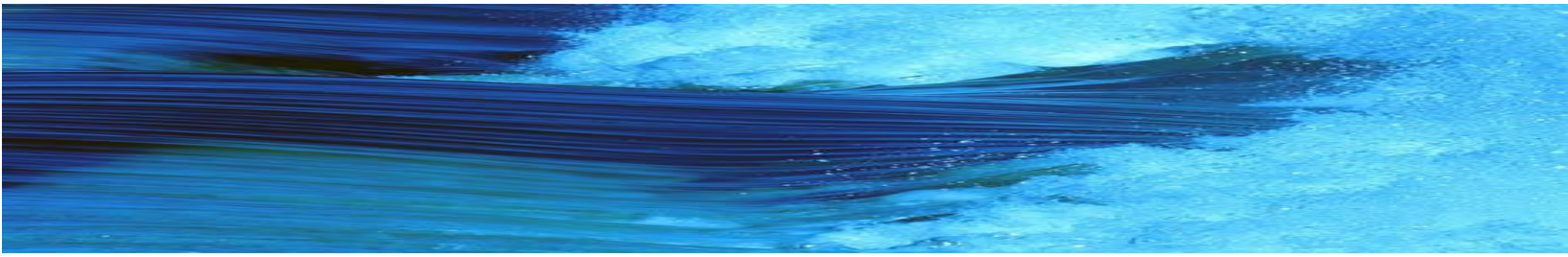
Table 1 - Suffolk County Sewage Treatment Plants (2014)

2014 Suffolk County Sewage Treatment Plants (Continued Page 4)					
No.	**Sewage Treatment Name**	**Sewage Treatment Type**	**Tertiary or Secondary**	**NYS SPDES Design Flow (MGD)**	**Discharge Location**
148	Shelter Island Heights	SBR	Secondary	0.028	Surface Waters
149	Silver Ponds	RBC denite filter	Tertiary	0.0917	Inland
150	Smithaven Mall	SBR	Tertiary	0.125	Inland
151	Smithtown Galleria	SBR	Tertiary	0.17	Inland
152	Somerset Woods	Extended aeration	Secondary	0.03	Inland
153	Southern Meadows	SBR	Tertiary	0.118	Inland
154	Southampton Commons	SBR	Tertiary	0.04	Inland
155	Southampton Hospital	Bio disc denite filter	Tertiary	0.104	Inland
156	Springhorn @ Blue Point	Cromaglass	Tertiary	0.011	Inland
157	Spruce Ponds Garden Apts	SBR	Tertiary	0.008	Inland
158	St Annes Gardens	Cromaglass	Tertiary	0.015	Inland
159	Stone Ridge at Dix Hills	Cromaglass	Tertiary	0.015	Inland
160	Stonehurst III	SBR	Tertiary	0.21	Inland
161	Stonington @ Port Jeff	SBR	Tertiary	0.05	Inland
162	Stony Hollow	SBR	Tertiary	0.1	Inland
163	Stratford Green	MBR	Tertiary	0.152	Inland
164	Stratmore on the Green	Extended aeration denite filter	Tertiary	0.0615	Inland
165	Sunrise assited living Smithtown	Cromaglass	Tertiary	0.0105	Inland
166	Sunrise Dix Hills	Cromaglass	Tertiary	0.012	Inland
167	Sunrise E. Setauket	Cromaglass	Tertiary	0.011	Inland
168	Sunrise Garden Apts.	BESST	Tertiary	0.03	Inland
169	Sunrise Holbrook	Cromaglass	Tertiary	0.011	Inland
170	Sunrise Village	SBR	Tertiary	0.0229	Inland
171	Tall Oaks	Extended aeration	Tertiary	0.03	Inland
172	Timber Ridge @ Westhampton	Cromaglass	Tertiary	0.015	Inland
173	Towne House Village South	Extended aeration	Tertiary	0.03	Inland
174	Valley Forge	SBR	Tertiary	0.0746	Inland
175	Victorian Gardens	SBR	Tertiary	0.09	Inland
176	Victorian Homes @ Medford	SBR	Tertiary	0.01125	Inland
177	Village in the Woods 00130	Extended aeration denite filter	Tertiary	0.0878	Inland
178	Villages @ Lake Grove	SBR	Tertiary	0.065	Inland
179	Fairfield Villas @ Medford	Cromaglass	Tertiary	0.01485	Inland
180	Villas @ Pine Hills	Extended Aeration denite filter	Tertiary	0.181	Inland
181	Vinyards @ E. Morriches	Cromaglass	Tertiary	0.0065	Inland
182	Walden Ponds	SBR	Tertiary	0.056	Inland
183	Waterways @ Blue Point	Extended aeration denite filter	Tertiary	0.09	Inland
184	Waverly Park	SBR	Tertiary	0.03	Inland
185	West Hampton NH	Extended aeration denite filter	Tertiary	0.027	Inland
186	Westhampton Pines	SBR	Tertiary	0.031	Inland
187	Westhampton Senior Living	Cromaglass	tertiary	0.015	Inland
188	Whispering Pines	Extended aeration denite filter	Tertiary	0.105	Inland
189	Willow Ponds	SBR	Tertiary	0.07	Inland
190	Windbrooke Homes	SBR	Tertiary	0.065	Inland
191	Woodbridge @ Hampton Bays	Cromaglass	Tertiary	0.00485	Inland
192	Woodcrest Estates	SBR	Tertiary	0.04	Inland
193	Woodhaven Manor	Extended aeration	Secondary	0.015	Inland
194	Woodhull Garden Apartments	SBR	Tertiary	0.0335	Inland
195	Yardarm	Bio disc denite filter	Tertiary (Seasonal)	0.046	Inland

Table 2
Sewage Treatment Plants Discharging to Surface Waters

Sewage Treatment Name	Design Flow (MGD)	Discharge Location (Estuary)	Has Consistently Attained Nitrogen Discharge Limit (Y/N)
Greenport Village	0.65	Long Island Sound	Y
Huntington Town	2.5	Huntington Bay (LIS)	Y
Northport Village	0.45	Northport Harbor (LIS)	Y
S.C.S.D. #6 Kings Park	1.2	Nissequogue River (LIS)	Y
S.C.S.D. #1 Port Jefferson	1.15	Port Jefferson Harbor (LIS)	Y
S.C.S.D. #21 SUNY SBU	2.5	Port Jefferson Harbor(LIS)	Y
Calverton Enterprise Park	0.078	Peconic River (PE)	Y
Riverhead Town	1.3	Peconic River (PE)	Y
Sag Harbor	0.25	Sag Harbor (PE)	Y
Shelter Island Heights	0.028	Greenport Harbor (PE)	Y
Plum Island	0.05	Gardiners Bay (PE)	Y
Ocean Beach	0.5	Great South Bay	Y
Patchogue Village	0.5	Patchogue River (GSB)	Y
S.C.S.D. #3 Bergen Point	30	Atlantic Ocean	Y

Note: Long Island Sound = LIS, Peconic Estuary = PE, and Great South Bay = GSB



Appendix J

Advanced Wastewater & Transfer of Development Rights Tour Summary

COUNTY OF SUFFOLK

STEVEN BELLONE
SUFFOLK COUNTY EXECUTIVE

REPORT ISSUED BY SUFFOLK COUNTY
DEPARTMENTS OF ECONOMIC DEVELOPMENT & PLANNING, HEALTH SERVICES, AND PUBLIC WORKS

Advanced Wastewater & Transfer of Development Rights Tour Summary

April 28, 2014

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Executive Summary:

A delegation of Suffolk County staff, County Legislator Kara Hahn, Federal, State and nonprofit partners met with leaders from the Maryland Department of Environment, New Jersey Pinelands Commission, University of Rhode Island New England Onsite Wastewater Training Program, and Barnstable County Department of Health's Massachusetts Alternative Septic Systems Test Center, referred as the Septic Tour herein, from March 19 to 21, 2014. The Tour enabled Suffolk County and our partners to gain valuable insight into the development, implementation, and operation of a variety of innovative advanced (I/A) onsite septic system programs that have been in place for over 10 years in order for the County to begin the development of our own I/A onsite septic system program. Key takeaways of the Septic Tour include:

Wastewater Planning Is Important: The development of I/A programs in the regions visited were compelled by the need to improve and protect the water quality. Water quality plans were established in each region to develop water quality goals such as Maryland's Watershed Implementation Plan based on EPA established total maximum daily loads (TMDL) for the Chesapeake Bay, The New Jersey Pinelands Commission Pinelands Comprehensive Management Plan, Rhode Island Special Area Management Plans (SAMPs), and the Cape Cod Commission's Regional Policy Plan, which operates within the context of TMDL. These plans were key to establishing an I/A program to defined areas where I/A systems would be required to be installed, either for new construction or upgrades, to meet established water quality goals.

Technology Demonstration Projects Are Effective: In an effort to identify acceptable I/A systems, each region established pilot programs and/or standards outlining piloting requirements to evaluate technologies in advance of broader installations. In advance of more widespread installations, the State of Rhode Island and the New England Onsite Wastewater Treatment Center (NEOWT) at the University of Rhode Island conducted a series of demonstration projects to train local designers and contractors to install, maintain, and operate, I/A technologies. Critically, homeowners will be exposed to the requirements of a new utility that requires understanding and upkeep.

Program Design Influences Homeowner Costs and Participation: There are more than 25,000 I/A systems capable of nitrogen reduction installed in the regions visited. Treatment unit costs range from $10,000 to $20,000 above the cost of installation of a conventional onsite septic system. Depending on the program, treatment units are sold with a 2 or 5 year operations and maintenance (O&M) contract. After the manufacturer's O&M contract expires, then property owners are required to maintain a yearly O&M contract at an approximate cost of $250 per year. Depending on the technology selected, property owners may incur a higher electric bill to run the treatment unit. If treatment units are well maintained, then the expected life can be 20 years or more.

Low Interest Loans Can Be An Effective Means Of Incenting Homeowner Participation: The jurisdictions visited had a robust involvement, commitment, and investment from state agencies to fund the installation of I/A systems. Rhode Island, with the most number of systems installed, provides low interest loans to homeowners to upgrade their septic systems to I/A systems through the use of a portion of their "big pipe" Federal Clean Water Act Revolving Fund to the State, that were then loaned to local government agencies at low to zero interest rates. The local government would then issue a loan to homeowners with an interest rate of 2% [RI] to 5% [MA] at a 10 or 20 year term. The Maryland Department of Environment provides grant funding to pay for I/A system only (excludes the cost of

leaching field and septic tank) through a State bill creating the Bay Restoration Fund (BRF). The BRF is funded through a fee assessed to the property and added as a property tax or part of a separate bill depending on municipality. The State of Massachusetts offers a tax credit for repair or replacement of failed cesspools or septic systems for 40% of the cost up to $6000, spread over 4 years at $1500 per year.

Program Infrastructure is Needed to Effectively Manage Program: In order to track O&M contracts, maintenance, and performance, Barnstable County has deployed an online tracking system known as the Carmody system, as does Rhode Island as a part of their Web-based Information System [RIWS].

A Variety of Technologies Are Viable Candidates for Further Investigation in Suffolk County: Bio Microbics FAST, Bioclere, Amphidrome, SeptiTech, AdvanTex AX20, and Singulair TNT appear to be the most common units installed in the regions visited and have proven capable of reducing nitrogen in residential sanitary wastewater. In addition, Busse GT and Bio Microbics Bio Barrier are newer onsite treatment technology units that appear to have the ability to remove some personal care and pharmaceuticals products (PPCP) in addition to reducing nitrogen. None of the four state programs allowed in-kind replacement of cesspools.

Septic Test Centers Are 24/7 365 Endeavors: The Barnstable County Department of Health created the Massachusetts Alternative Septic Systems Test Center to test advanced onsite septic systems capable of reducing pollutants in wastewater. PPCP removal, nitrogen reducing systems, and other innovative technologies are being pioneered at the test center. The drawbacks of the center are the high operating costs, it is labor intensive, and the center did not significantly contribute to local business development (of 31 systems tested in Cape Cod, only three came from MA).

Transfer of Development Rights' Programs Were Not Directly Connected to I/A Systems: Transfer of development right (TDR) programs for each region were evaluated to determine if TDR's were an integral part of the control of nitrogen within each municipality. The NJ Pine Barrens Commission, with the least robust program, was the only jurisdiction visited that had an established TDR program to permit increased density within the region. TDR's within the NJ Pine Barrens Region permits property owners to obtain credits for their parcel if they are located in one of three Pineland sending areas. These credits may be purchase by developers wishing to increase density in designated regional growth areas. There was use of I/A to allow development on nonconforming lots, such as NJ which required I/A if lot was less than 3.2 acres. RI required developers to upgrade another system that is in the same sub-watershed as well as the proposed development, so that there is a net zero increase in nitrogen loading.

Next Steps:

In order for Suffolk County to implement an I/A septic program, we suggest several next steps to consider:

1. Develop a baseline inventory of onsite systems and their performance;
2. Identify priority areas for wastewater upgrades based on risk assessment characteristics including public health, water quality modeling, environmental info, etc;
3. Develop a Wastewater Action Plan as part of the Comprehensive Water Resources Management Plan with updated information from water quality and wastewater studies;
4. Review and update ordinances for uniformity to achieve goals outlined in the Wastewater Action Plan and identify sources for incentives;

5. Implement demonstration projects comparable to demonstration projects completed by Rhode Island. Evaluating a decentralized community cluster septic is an added aspect that Suffolk would include;
6. Establish a Responsible Management Entity (RME) to oversee the program and be a conduit for financing;
7. Conduct a nitrogen reduction assessment study that will track the effectiveness of the program to improve water quality;
8. Craft viable financing options, such as access to NYS Environmental Facilities Corporation low interest loans, tax credits, and/or grants; and
9. Develop the appropriate internal infrastructure to implement such a program and evaluate laws and/or standards that must be implemented or updated to operate an I/A program.

Section 2: Overview

Suffolk County, a region with a federally designated sole source aquifer (deriving its drinking water from the ground) must pay particular attention to the 360,000 legacy septic systems and cesspools. Suffolk County has estimated that approximately 200,000 systems are degrading our marshland habitats that act as a second line of defense during storm events like Sandy and/or contributing to groundwater degradation. Septic and cesspool systems are particularly problematic in areas with high water tables in close proximity to surface waters. When flooded or submerged in groundwater, septic systems do not function as designed and fail to adequately treat pathogens. Excess nitrogen from this sewage threatens our valuable natural resources, coastal defenses, and human health. Instituting an innovative and alternative (I/A) onsite septic system program for Suffolk County is, along with sewering, intermediate-sized, clustered community systems, and managing other nitrogen sources like lawn fertilizer, a key component in the mission in reversing the upward trend of nitrogen in our drinking water and our surface waters from legacy septic and cesspool systems.

Figure 1 and 2 compare the population of Suffolk County with the areas visited. The population of Suffolk County exceeds three of the jurisdictions visited (Rhode Island, NJ Pinelands, and Barnstable County, MA) and is about 1/4 the population of the entire state of Maryland. In addition, the density of people per square mile in Suffolk County is greater than all jurisdictions visited. Even though the population and size of the jurisdictions visited vary, they share the same mission as Suffolk County to improve and protect the water quality of their region.

Area	Population
Suffolk County, NY	*1,499,273*
State of Maryland	5,928,814
NJ Pinelands	870,000
State of Rhode Island	1,051,511
Barnstable County, MA	214,990

Figure 1: Population of Jurisdictions Visited[1]

Area	Land Area (square Miles)	Persons per square mile, 2010
Suffolk County, NY	*912.05*	*1,637.4*

[1] http://quickfacts.census.gov/qfd/index.html#

State of Maryland	9,707.24	594.8
NJ Pinelands	1,449	600.41
State of Rhode Island	1,033.81	1,018.1
Barnstable County, MA	393.72	548.8

Figure 2: Land Area VS. Persons per square mile[1]

As with Suffolk County, all the areas visited have residences that utilize onsite sewage disposal systems as the primary means of wastewater discharge. Figure 3 depicts the number of onsite sanitary systems in the places visited compared to Suffolk County. As depicted by the figure 1 and 3, Maryland has 4 times the population of Suffolk County but only 60,000 more onsite sanitary systems. Suffolk has nearly three times as many septic/cesspools than the entire State of Rhode Island.

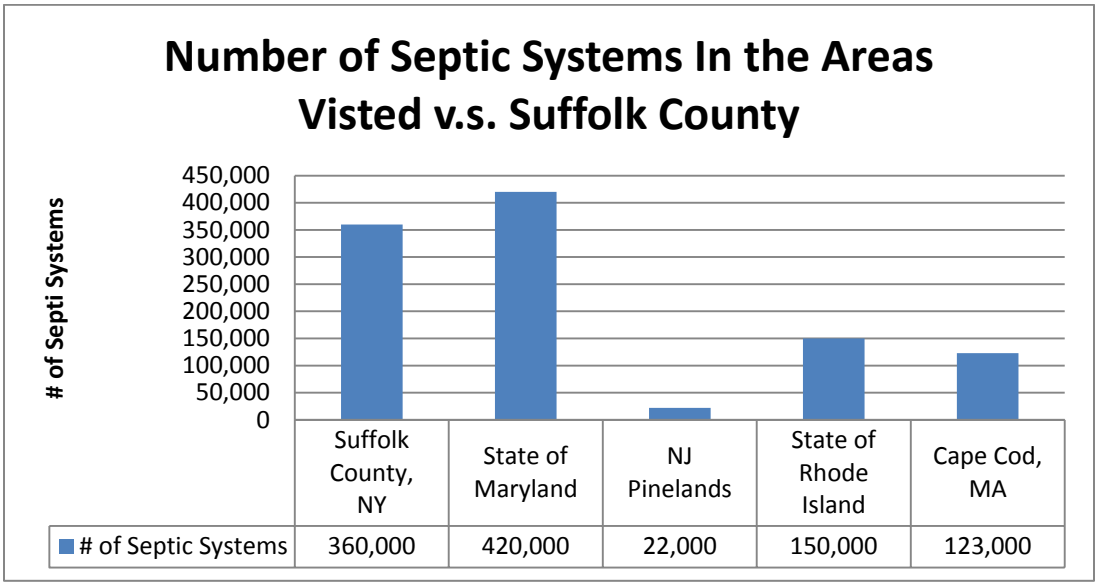

Figure 3: Number of Septic Systems in Jurisdictions Visited Compared to Suffolk County [Note: The NJ Pinelands is a small area within NJ]

Highlights from each State:

Maryland has 420,000 onsite septic systems in a state 4 times the population of Suffolk County, which, by their estimation, contributes 5-9% of the total nitrogen load to the Chesapeake Bay. Of the 420,000 onsite septic systems, approximately 17,000 of these are located in critical areas (land within 1,000 ft of the mean high water line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries) and directly contribute to the TMDL. Maryland has developed the Maryland's Bay Restoration Fund to provide grants for onsite septic system upgrades, wastewater treatment plant upgrades and to reduce agriculture pollution. They've implemented the Bay Restoration Fund (BRF) fee where 60% of the BRF goes to onsite sanitary system and wastewater treatment plant upgrades, 40% to Agriculture Water Quality Cost Share Program to fund conservation measures to prevent soil erosion manage nutrients and safeguard water quality, and 0.5% for administrative fees. The BRF fee, assigned to the property tax, began at $30/household and brought in $60M annually. Last year, the fee was doubled to $60 per household. Maryland has upgraded 5,500

onsite septic systems to date and advised Suffolk County to use property transfer as a program lever for onsite septic system upgrades. Programmatically, they recommended a sole responsible management entity (RME) to both operate and finance an alternative onsite sanitary system program.

The **New Jersey** Pinelands Commission uses transfer development rights (TDR) in addition to the use of alternative onsite septic systems to permit increased density. In Gladstone, NJ, the Willow School in Gladstone, NJ constructed wetlands wastewater treatment system (Figure 16) has been effectively treating 5,000gpd for the past 12 years.

Rhode Island has, far and away, installed the most I/A systems The University of Rhode Island New England Onsite Wastewater Training Center's George Loomis conducts continuing education workshops on I/A systems across the Northeast. Rhode Island commits 5% of the Clean Water State Revolving Fund (CWSRL) to upgrading onsite septic systems and, in the 14 years of their program, has permitted over 19,000 alternative & experimental systems of which 5,809 have nitrogen reducing capabilities. Their Community Septic System Loan is funded at 0% from CWSRL, which it extends up to $25,000 to homeowners at 2% interest for 10 years. Loomis recommended that Suffolk County apply resources to program development and not re-invent the wheel by replicating components that are already highly evolved in Rhode Island and Massachusetts.

In **Barnstable County, MA**, George Heufelder has been testing and evaluating emergent onsite septic systems at the Massachusetts Septic Test Center for 20 years. He noted that a test facility such as the one in Barnstable County is 24/7, 365 days-a-year operation and cautioned against starting up a facility elsewhere. Local towns are responsible for permitting onsite septic systems and determine when an alternative system must be installed for new construction or upgrades. Out of an estimated 1,200 failures per year, only 400 go to I/A. The Cape Cod region has 123,000 septic systems. Barnstable Community Loan Program provides borrowers with loans to upgrade onsite septic systems at 5% over 20 years with a lien placed on the property to ensure repayment. The state offers a tax credit for 40% for repair or replacement of failed cesspools or septic to $6,000, which is spread over 4 years at $1,500 per year. Out of the programs visited, Barnstable County maintains the best tracking system of I/A technologies, known as the Carmody Data System.

Section 3: Water Quality Planning Goals

There is collective recognition in these jurisdictions of the necessity for enhanced wastewater treatment. The US EPA developed Total Maximum Daily Load (TMDL) for the Chesapeake watershed and there is a collective recognition in surrounding jurisdiction of the necessity for enhanced wastewater treatment. The watershed included the states of Maryland, Delaware, New York, Pennsylvania, Virginia, and West Virginia. Each state in the watershed had to develop plans to meet the TMDL's. Maryland's Watershed Implementation Plan consists of three phases. The plan addresses nitrogen reduction from sources such as wastewater treatment plants, onsite sewage disposal systems, fertilizers, agricultural waste, and storm water.

In Maryland only 5-9% of nitrogen stems from onsite sewage disposals systems as compared to Suffolk County where 70% of the nitrogen load originates from onsite sewage disposal systems. Maryland requires all new or replacement onsite sanitary systems located in identified critical areas (land within 1,000 ft of the mean high water line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries) to be alternative onsite septic systems

capable of reducing nitrogen. Comparable systems must be installed elsewhere within the Chesapeake Bay watershed and Atlantic Coast bays. Such systems must meet a maximum effluent total nitrogen concentration of 30mg/l. In addition, Maryland adopted the Sustainable Growth and Agricultural Preservation Act of 2012 where Maryland limits the spread of onsite septic systems on large-lot residential developments to reduce nitrogen pollution to the Chesapeake Bay and other waterways. The Act divides the state of Maryland's into tiers as follows:

Tier I: Areas currently served by sewers

Tier II: Future growth areas planned for sewers

Tier III: Large lot developments and rural villages on septic systems

Tier IV: Preservation and conservation areas where no major subdivisions are permitted on septic systems (A major subdivision is defined as 7 or more lots depending on the county).

The New Jersey Pinelands Commission developed the Pinelands Comprehensive Management Plan to promote orderly development of the Pinelands so as to preserve and protect the significant and unique natural, ecological, agricultural, archaeological, historical, scenic, cultural and recreational resources of the Pinelands.[2] The Pinelands Comprehensive Management Plan developed the Pinelands Septic Dilution Model, which shows the minimum residential lot size required in the NJ pinelands to be 3.2 acres in order to maintain 2.0 mg/l total nitrogen in groundwater at the property line. In order to build on lots smaller than 3.2 acres and meet the 2.0mg/l in groundwater at the property line alternate onsite septic technologies capable of reducing nitrogen must be used. Even with alternative onsite septic system technologies there is a minimum lot size of 1 acre, based on the assumption that these onsite treatment technologies can consistently achieve the Pinelands Pilot Program total nitrogen effluent performance standard of 14 mg/l. As part of the Plan the Alternative Septic System Program was developed to identify nitrogen removing onsite sewage disposal system that could be installed in the region to improve water quality and to permit higher density development. Only 241 systems have been installed in this program.

The Cape Cod Commission, established in Barnstable County, MA developed a regional policy plan, which is updated every five years to protect the region's resources such as public/private drinking water wells and surface waters. In addition, each town in the County may prepare a local comprehensive plan to define the town's vision for how to achieve the goals. These plans must be consistent with regional plans and certified by the Cape Cod Commission. Also, the County is updating their Section 208 US Clean Water Act Plan that was, previously approved in 1978. Their updated 208 Plan is expected to be approved by mid-2014. The approved 208 Plan Update is expected to sit alongside the Regional Policy Plan, but not be formally adopted as part of it. The Cape Cod Commission has also developed the Regional Wastewater Management Plan (RWMP).[3] The RWMP provides models depicting percent nitrogen removal to meet TMDL's. The county has spent approximately $12 million over the past 20 years to identify nitrogen loading targets for embayments and sub-watersheds (Figure 4). Approximately 85% of the parcels located on the Cape are served by onsite sewage disposal systems, which contribute 80% of the nitrogen loading. Alternative onsite septic technologies capable of reducing nitrogen installed on Cape Cod must produce effluent with a total nitrogen concentration of 19- 25 mg/l (approximately a 50% reduction, which, while good, is not perfection).

[2] http://www.state.nj.us/pinelands/cmp/
[3] http://www.capecodcommission.org/resources/RWMP/RWMP_ea_water.pdf

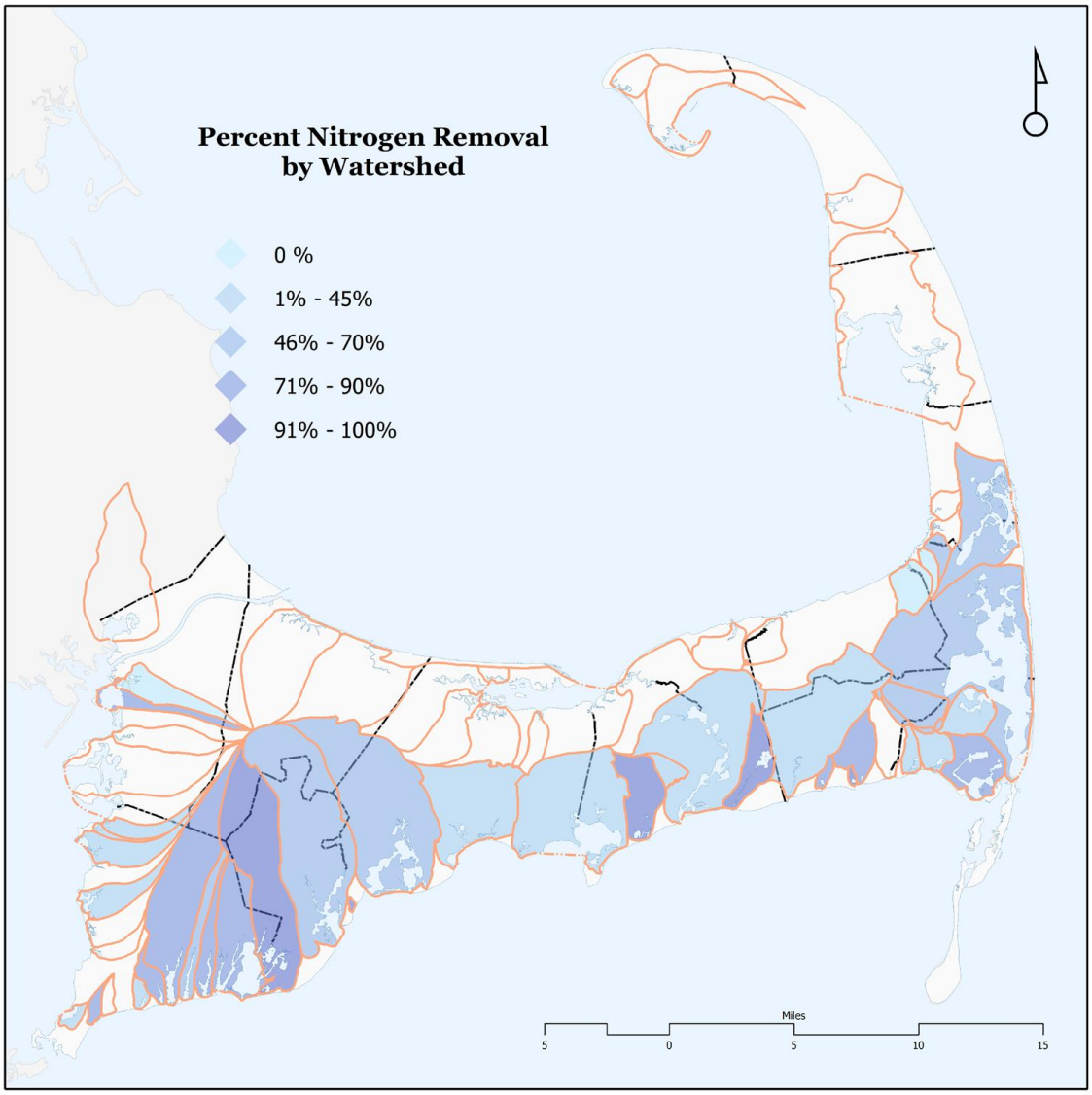

Figure 4: Cape Cod Commission Regional Wastewater Management Plan Model depicting percent nitrogen removal required to meet TMDL's

In Rhode Island the Coastal Resources Management Council (CRMC) was authorized under the federal Coastal Zone Management Act of 1972 to develop and implement Special Area Management Plans (SAMPs) to address specific regional issues. These plans are ecosystem-based management strategies that are consistent with the council's legislative mandate to preserve and restore ecological systems. The CRMC coordinates with local municipalities, as well as government agencies and community organizations, to prepare the SAMPs and implement the management strategies.[4] Based on the CRMC Special Area Management Plans for the South Shore Salt Ponds and Narrow River, all onsite septic systems located within these areas are require to be advanced septic system capable of nitrogen reduction. Currently there are approximately 40,000 to 50,000 onsite septic systems installed CRMC Special Area Management Plans for the South Shore Salt Ponds and Narrow River.

[4] http://www.crmc.ri.gov/samps.html

Section 4: Pilot Programs

Conventional onsite septic systems and cesspools marginally reduce nitrogen in wastewater (Effluent nitrogen from a conventional septic system is approximately 38 mg/l). Based on the water quality plans/goals prepared in the areas visited, pilot programs were implemented to test and select nitrogen reducing onsite septic system technologies.

The Maryland Department of Environment formed the Best Available Technology (BAT) Verification Program to review proposed I/A systems. An application is submitted to Maryland Department of Environment. The BAT Review Committee, comprised of the BRF chair, the division chief of MDE and county representative, evaluates 3rd party certification test methods, independent performance evaluations and test results to verify the vendors' claim. If the Committee accepts the claims then provisional technologies enter a Field Verification Process. Twelve systems plus 3 reserve systems may be installed during the field verification process and must be sampled 4 times each year with a minimum of 1 winter sample. The average total nitrogen concentration in the effluent must be below 30 mg/l. After passing the Field Verification Process a final report with sample results is submitted to the BAT review committee for evaluation. If the committee accepts the report then the system is classified as "Best Available Technology, Field Verified".

In 2002, the New Jersey Pinelands Comprehensive Management was amended to establish a Pilot Program for Alternative Design Wastewater Treatment Systems to reduce groundwater pollution from residential onsite septic systems. The Commission created a pilot study to determine the best systems to be installed within the Pinelands. A Committee was formed to perform a 2-year study to research and evaluate onsite treatment technologies capable of reducing nitrogen. Five advanced treatment technologies were selected to participate in a 5-year Pilot Program to demonstrate their effectiveness at removing nitrogen from residential wastewater. The five systems were recommended by a consultant in a 2001 report, "Performance Expectations for Selected On-Site Wastewater Treatment Systems" (See NJ Pinelands Commission Section for further info regarding the pilot program). A yearly report is issued by the commission outlining the results of the pilot test systems. Three of the 5 systems approved in the 1st round of pilot systems are still permitted today. A 2nd pilot program to evaluate 4 new systems has commenced. Systems selected for the 2nd round where required to be NSF 245 certified and pay $5,000 fee to apply. The two (2) systems that did not complete the 1st round of testing were Cromaglass (residential household model) and Ashco RFSIII. The Commission allows homeowners of failed pilot systems that were removed from the program to update their system with a conventional onsite septic system.

Rhode Island Onsite Wastewater Demo Projects, 1996 to 2005, was conducted by New England Onsite Wastewater Treatment Center (NEOWT) and the knowledge gained from the project was transferred to Department of Environmental Management (DEM), which helped with policy/rule revisions. The demonstration project was a series of 5 demonstration projects in 7 communities. They installed 58 demonstration systems on sites with failed septic systems. Sites were selected using a lottery for homeowners that had failed septic systems. The program provided the systems at a reduced cost or no cost to homeowners on condition that the owner granted a 3-year access period to the property, to allow staff to install, test, and maintain the systems. Labor was provided gratis to gain experience installing new technologies. Today, I/A systems are approved for use by the RI DEM. New alternative treatment systems can be approved by the RI DEM as nitrogen reducing systems per the DEM Onsite wastewater treatment (OWTS) rules governing pilot systems. In order to receive approval for a nitrogen reducing technology:

-The applicant provides certification that the technology meets NSF/ANSI "Standard 245- Wastewater Treatment Systems- Nitrogen Reduction" and the testing results show a preponderance of treated effluent nitrogen concentrations of nineteen (19) mg/l or less; or

-demonstrates approval for use in another jurisdiction in an area where the temperature conditions are similar to or colder than those in Rhode Island and with technology review criteria substantially equivalent to Class One or Class Two summarized above and detailed in OWTS Rules 37.4.1 or 37.4.2 (A)-(B).

- Nitrogen removing systems require renewal every five years

Non-proprietary systems may be approved under the OWTS Rules as an experimental system as follows:

Experimental Systems - This category is designed to allow innovative systems, which have been demonstrated to work in practice or theory, to be installed on a limited basis as they are further tested and studied.

Experimental use is approved when:

1. The applicant demonstrates that the technology will work in practice and in theory;
2. Provides for three (3) to ten (10) proposed installations, a suitable area at each location for the installation of an OWTS permitted under the OWTS Rules, or a Class One A/E OWTS Technology;
3. The applicant proposing the Experimental Technology, the property owner(s) and subsequent purchaser(s) submit a signed statement to the Director agreeing to abandon the Experimental Technology and install an OWTS permitted under these Rules, or a Department approved Class One A/E OWTS Technology if the Experimental OWTS fails to perform as designed; and
4. The applicant submits documentation securing a bond or other form of financial security acceptable to the Director, to replace the entire OWTS in the event it fails to perform as designed.

RUCK, Cromaglass (residential household model), and Biocyle were previously permitted in Rhode Island but were subsequently delisted for use in the state.

The Massachusetts Energy and Environmental Affairs Department approves the types of alternative systems allowed to be installed in the state and outlines the piloting requirements for nitrogen reducing onsite septic systems in their "Title 5" section 15.285 and 15.286. The Department approves the pilot of a new system for up to 15 installations after it reviews technical data, receives an environmental and reporting plan covering at least 18 months for each pilot facility from the vendor, and received assurance from the local authority stating the necessary operation and maintenance activities will be performed and monitored. If successful then the system can move into provisional status, where 50 units can be installed for 2 years. After completing the provisional status requirements then the system is issued a general use permit. Currently there are only three (3) nitrogen reducing systems with a general use permit.

Region Visited	Nitrogen Effluent Requirement for Alt Systems
State of Maryland	30 mg/l
NJ Pinelands	Reduction Based on model to maintain 2 mg/l at property line
State of Rhode Island	19 mg/l
Barnstable County, MA	19 to 25 mg/l

Figure 5: Alternative Onsite Septic Systems Nitrogen Effluent Limit

Section 5: Alternative Onsite Sewage Disposal Systems Capable of Nitrogen Reduction

Figure 6 depicts the number of alternative onsite sewage disposal systems currently installed in the jurisdictions visited. Compared to the total number of onsite sewage disposal systems, Rhode Island has the highest percentage of alternative septic systems installed. Approximately 3.86% of the systems installed in Rhode Island are alternative systems capable of nitrogen reduction. The number of alternative systems in the other areas visited account for approximately 1.0% to 1.4% of the total onsite sewage disposal systems.

Figure 7 outlines the system models that have been installed and are currently still permitted to be installed in the jurisdictions visited on the Tour. Bio Microbics FAST is the only system approved for use in all four jurisdictions visited. Bioclere, Amphidrome, SeptiTech, AdvanTex AX20, and Singulair TNT are approved in at least 3 of 4 regions visited. Most of the systems approved for use utilize an Integrated Fixed Film Activated Sludge (IFAS) Process. The membrane bioreactor (MBR) systems, according to George Heufelder at Massachusetts Alternative Septic Systems Test Center, provide the ability to remove some pharmaceuticals products that could impact groundwater quality. There is much about the University of Florida's Gulf Coast Research and Education Center is well along with a non-proprietary, passive biofiltration system.

Approximately 400 new advanced technology systems are installed in Barnstable County, MA per year. Local towns are responsible for permitting septic systems and determine when an alternative system must be installed for new construction or upgrades. In Barnstable County flow per acre is limited to 440 gpd/ac, in order to increase flow per acre, nitrogen reducing alternative systems may be installed. In addition, if flow is over 2000gpd then nitrogen reducing alternative system must be installed.

In Maryland there are approximately 1,200 and 2,000 new I/A system installs each year. Maryland requires all new or replacement onsite sanitary systems located in identified critical areas to be nitrogen removing. In addition, all new sanitary systems within the Chesapeake Bay watershed and Atlantic Coast bays or in other bodies of water impaired by nitrogen.

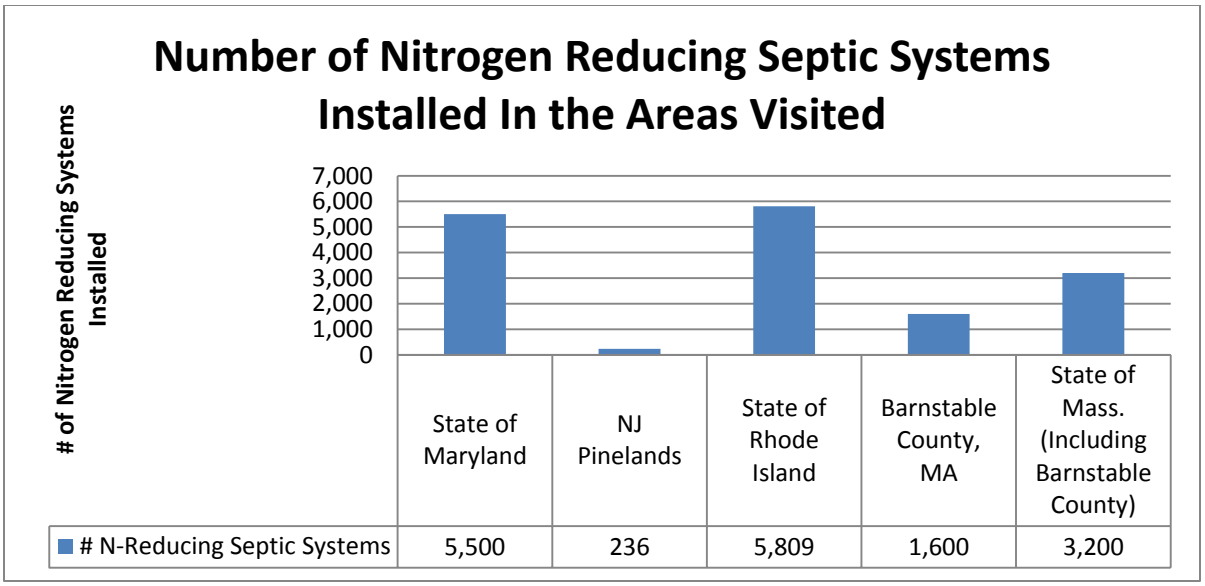

Figure 6: Number of Nitrogen Reducing Septic Systems Installed

Nitrogen Reducing Alternative Septic Systems Permitted to be Installed In Areas Visited						
System	**Company**	**Type of Treatment**	**Maryland**	**NJ Pinelands**	**Rhode Island**	**Barnstable County, MA**
Amphidrome	F.R. Mahony & Assoc	Fixed Film SBR		X	X	X
Bioclere	Aqua Point Inc	Modified trickling filter		X	X	X
Cromaglass	Cromaglass Corp	SBR				
Fast	Bio-Microbics, Inc	IFAS	X	X	X	X
MicroFAST	Bio-Microbics, Inc	IFAS				X
Bio Barrier	Bio-Microbics, Inc	MBR		X		X
Busse GT	Busse Green Tech.	MBR		X		
Hoot ANR	Hoot Systems, LLC	Extended Air	X	X		
SeptiTech	SeptiTech, LLC	IFAS		X	X	X
Singulair TNT	Norweco	Extended Air	X		X	X
Singulair Green	Norweco	Extended Air	X		X	
AdvanTex AX20	Orenco	IFAS	X		X	X
AdvanTex AX100	Orenco	IFAS			X	X

Nitrogen Reducing Alternative Septic Systems Permitted to be Installed In Areas Visited (continued)						
System	**Company**	**Type of Treatment**	**Maryland**	**NJ Pinelands**	**Rhode Island**	**Barnstable County, MA**
Advantex AX-RT	Orenco	IFAS	X		X	X
RUCK	Innovated RUCK Systems					X
Waterloo Biofilter	Waterloo biofilter	Attached growth Trickling Filter				X
Recirculating Sand Filters		Recirculating Sand filter				X
Nitrex	Lombardo Associates	Trickling Filter				X

Figure 7: Types of Nitrogen Reducing Systems Installed (IFAS – Integrated Fixed Film Activated Sludge Process, SBR – Sequence Batch Reactor, MBR – Membrane Bioreactor)

Section 6: Training and Testing Centers

University of Rhode Island New England Onsite Wastewater Training Program center and Barnstable County Department of Health Massachusetts Alternative Septic Systems Test Center were, respectively, toured as part of the trip.

The University of Rhode Island New England Onsite Wastewater Training (NEOWT) Program is operated by George Loomis. NEOWT offers classroom and field training experience for wastewater professionals, regulators, municipal and state officials, watershed groups, and homeowners. The Onsite Wastewater Training Center ("OWTC") located at the University's Peckham Farm. It is a demonstration and field training facility for both conventional and innovative and alternative septic system technologies. The center is operated in partnership with over 40 private sector contractors, the RI Department of Environmental Management, the USEPA and others. They have twenty-two full scale systems constructed above ground for hands-on learning at the OWTC. Additionally, there are over fifty demonstration and research systems installed in six Rhode Island communities. Monitoring data from these systems are currently being reviewed to help evaluate system performance.

NEOWT provides training classes to installers, operators, design professionals, and governmental officials. The center conducts approximately 50 classes a year with registration fees varying from $120 to $225 per class. Classes are conducted on installation of septic systems, surveying, system inspections, designing systems, and system operation. Systems installed at the test center for classes are above ground and operated with clean water.

Figure 8: New England Onsite Wastewater Training Center

Barnstable County Department of Health Massachusetts Alternative Septic Systems Test Center is operated by George Heufelder. The test center went into operation in 1999 testing advanced onsite septic systems capable of reducing pollutants in wastewater, which include nitrogen reducing technologies. Companies pay to have the center test their systems to certify that they system meet one of these four accepted certifications: (1) National Sanitation Foundation (NSF) NSF 245 standards, (2) U.S. Environmental Protection Agency (EPA) Environmental Technology Initiative (ETI), (3) National Sanitation Foundation (NSF) Environmental Technology Verification (ETV), (4) National Sanitation Foundation (NSF) NSF 40 standards. In addition to certification tests, the center performs various other research projects.

Figure 9: Barnstable County Department of Health Massachusetts Alternative Septic Systems Test Center

Section 7: Septic System Inspections at the Time of Property Transfers and Septic System Upgrades

New Jersey requires sanitary systems with cesspools be upgraded at the time of property transfers to a conventional septic system. As of 2012, New Jersey requires all cesspools be upgraded to a conventional onsite septic system.

Each town in Barnstable County has their own health department with the authority to approve the installation of onsite septic systems. In addition, the towns can require septic system inspections at the time of transfer, as the Town of Eastham does. The local Health Department reviews the inspection report to determine if the septic system must be upgraded. The state requires the inspections at time of transfer, but a town may obtain approval for another approach – one town required inspections every 7 years and therefore did not require inspections at the time of transfer.

Rhode Island enacted the Cesspool Phase-Out Act in 2007 requiring all existing parcels utilizing cesspools to be upgraded with a new onsite wastewater treatment system or connected to a sewer system by 2014. Cesspools located within 200ft of a water body or public/private drinking water (critical area) well must be upgraded. Parcels located within specified critical areas that did not have a system on record or sewer connection were notified to be compliant within 3 years. Cesspools located within the Special Area identified by CRMC must be upgraded to nitrogen reducing systems. Rhode Island's attempt to pass a point of sale law eliminating all cesspools failed twice, but will be reintroduced. Since 2008 Rhode Island requires nitrogen reducing septic system if the property is located in a critical resource area and when an alteration by increasing dwelling area by 50%, repairs, or new construction takes place (adding 2 bedrooms is considered new construction).

Section 8: Financing Installation of Alternative Onsite Sewage Disposal Systems

Alternative septic systems capable of nitrogen reduction can cost $9,000 to $24,000 for the treatment system alone (not including septic tank and leaching field). In order for individual homeowners to pay for the advanced system the regions visited provide grants, low interest loans, and/or tax incentives, as well as a hardship provision that extends time for installation (RI).

Figure 10 lists the cost of approved systems with 5 years of O&M for Maryland-approved technologies. In addition to unit cost, the homeowner must pay the increased electrical cost to operate the system ($50 to $100 per year). After five years the homeowner must continue an O&M contract ranging from $90 to $400 per year.

BAT Approved technologies	Cost of Purchase, installation and 5yr O&M	O&M Per Year After 5 year Contract
Orenco Advantex AX20	$12,300	$200
Orenco Adevantex AX20RT	$12,300	$200
Hoot BNR	$11,954	$150
Norweco Singulair TNT	$11,079	$90.88
Norweco Singulair Green	$11,079	$90.88
Septitech M400 denite	$13,056	$399
Bio-Microbics RetroFAST	$9,405	$300

Figure 10: Cost of Maryland Nitrogen Reducing Treatment Unit

The Maryland Department of Environment (MDE) provides grant funding to pay for the nitrogen reducing treatment system only (excludes the cost of leaching field and septic tank) through the Bay Restoration Fund (BRF). Revenue for the BRF is collected by a charge to sewered and on-site septic users. The fee for sewer users is $5.00 per month and is used to upgrade sewage treatment plants to meet an effluent of 3.0 mg/l nitrogen (Wastewater Treatment Plant Funds). The fee for onsite septic system users (Onsite Disposal Fund) is the same on an annual basis at $60 and goes toward the upgrading of existing systems to nitrogen-removing systems or sewers connections.

The BRF fee is added as a property tax or separate bill depending on municipality. If there is a water company, the surcharge is added to the water bill as a separate line item. Each county is responsible for collecting the fees and submitting them to the state comptroller. The comptroller then takes 0.5% for administrative costs, 60% dispersed to MDE to fund upgrades to sanitary systems, and 40% to Agriculture Water Quality Cost Share Program. The Agriculture Water Quality Cost Share Program provides farmers with grants to cover up to 87.5% of the cost to install conservation measures to prevent soil erosion manage nutrients and safeguard water quality. MD stated they prefer not to fund new systems and just require the denitrification component, thus using most funding for existing systems, to realize full benefit of the program. These funds are distributed to the local municipalities based on total numbers of septic systems versus the number of systems in the critical area.

The BRF prioritizes onsite sewage disposal system (OSDS) upgrades as follows:

1. Failing OSDS or holding tanks in the Critical Areas (Critical area within 1,000ft from tidal areas)

2. Failing OSDS or holding tanks not in the Critical Areas

3. Non-failing OSDS in the Critical Areas including new BAT systems

4. Non-Failing OSDS outside the critical areas

Approximately 1,200 of the 2,000 BAT systems installed per year are 100% funded by the BRF. In addition, grant funding can be used to pay for the full cost of the system (BAT system plus septic and leaching) for low income participates. Granted funds are paid for BAT systems when the homeowner submits three (3) bids for MDE for review. After completion of installation of the upgraded system, payment is made directly to the installer following a double sign-off by the State and the property owner (MD initially reimbursed the homeowner, but found that some homeowners were not installing and pocketing the grant money). MD found that prices were being inflated, so they RFPed and set

reimbursement rates. There could be a tiered rate based on level of treatment if targeting various mitigation levels.

Figure 11 states the cost of onsite septic system treatment unit with 5 years of O&M for NJ Pinelands Commission approved technologies. In addition to the unit cost, after five years the homeowner must continue an O&M contract ranging from $600 to $1000 per year. It is the priciest of the four states.

The NJ Pinelands Commission does not offer any financing options for upgrades to existing sanitary systems. The New Jersey Environmental Infrastructure Financing Program can provide funding to replace failing systems provided the local governing body or utilities authority establish a septic management district for financing, planning and corrective measure costs. The New Jersey Pinelands Commission has contracted with Stone Environmental Inc. to assist local entities throughout the Pinelands Area, (towns, counties, etc.) in the development and implementation of long term programs for the management of septic systems.

System	Ave. Treatment System Cost & 5yr Service Cost	Ave. Total Cost
Amiphidrome	$19,196	$31,492
Bioclere	$17,654	$31,866
Cromaglass	$22,345	$35,262
FAST	$17,819	$29,633
Bio Barrier	$15,000	N/A
Busse GT	$24,000	N/A
SeptiTech	$16,700	N/A
Hoot ANR	$14,500	N/A

Figure 11: NJ Pinelands Alternative Septic System Costs

The Rhode Island Clean Water Finance Agency uses State Revolving Loan Fund to provide 2% loans to residential borrowers to upgrade/repair onsite sanitary systems provided the community has a state-approved wastewater management plan. The community receives a 0% loan from the Clean Water Finance Agency, then issues to the borrower at 2% for 10 years with a max loan of $25,000. If the borrower defaults, a lien is placed on the property.

Barnstable Community Loan Program loans homeowner money to upgrade their sanitary system in the event of a system failure. The County borrows money from the state revolving loan fund at a 0% interest rate, then issues to the borrower at 5% for up to 20 years. If a composting Eco-toilet is installed, it's at 0%. A single-party check issued to contractor for work completed with benefit assessment to the property securing payment.

In addition to the loans, the State of Massachusetts offers a tax credit for 40% for repair or replacement of failed cesspools or septic systems up to $6000, spread over 4 years at $1500 per year (none have been extended to date).

Region	Loan	Grant	Tax Incentive
Maryland	--	Bay Restoration Fund Provides grants for total cost of treatment unit. Funded by $60/year fee assessed to onsite septic system owners	--
NJ Pinelands	NJ Environmental Infrastructure Financing Program can provide funding to replace failing systems. The local governing body or utilities authority must form a septic management district to receive financing.	---	---
Rhode Island	RI Clean Water Finance Agency issues loan to local community (w/ plan) at 0% which issues to the borrower @ 2% for 10 years with at a max of $25,000	---	---
Barnstable County, MA	Barnstable Community Loan Program 5% for 20 years. 0% loan for composting unit	---	tax credit for 40% for repair or replacement of failed cesspools or septic systems up to $6000, spread over 4 years @ $1500/year

Figure 12: Septic System Financing Options

Section 9: Operations and Maintenance & Tracking

Each jurisdiction requires the cost of alternative systems include an operation and maintenance (O&M) agreement for varying periods of time. Maryland BAT technologies require a 5-year O&M contract, and property owners are expected to continue thereafter. Maryland hasn't instituted an enforcement system to determine whether homeowners are in compliance on O&M. All BAT technologies must be inspected at least once every year and the service provider must notify the local authority, MDE and the manufacturer of the service performed, and service record maintained, available to MDE or approving authority upon request.

O&M for NJ Pinelands Commission includes quarterly samples for 3 years. After the contract expires the NJ local Health Departments are required to make sure O&M contracts are in place.

Rhode Island requires a minimum 2-year O&M contract with yearly extensions thereafter. The O&M contracts must be recorded with the State Land Evidence Records before a certificate of occupancy is issued. The state does not track the O&M contract after the 2 years.

Barnstable County, MA also requires such a minimum of 2 years O&M contract with yearly extensions thereafter. In 2005, the county deployed a tracking database designed by Carmody Data Systems. All maintenance and sample results must be entered into the tracking system. The system identifies failure rates and pumping rates to determine if system is failing. Alerted to O&M expiration, the County calls the owner and sends a letter notifying the homeowner. Upon a 2nd alert, a certified letter is issued and the homeowner may be called into a hearing. Local Boards of Health can fine (approximately $250) homeowners if O&M not maintained.

Figure 13 (below) indicates the approximate maximum range of effluent total nitrogen in some of the models of alternative systems installed on Cape Cod based on tracking information from their Carmody System.

System	Approximate Max. Effluent TN mg/l Range
BioMicrobics Fast	10 to 45
HOOT	53.9 (1 sample)
Advantex	12 to 45
Amphidrone	18 to 70 (7 samples)
SeptiTech	10 to 30
Singulair	10 to 50
RUCK	16 to 65

Figure 13: Effluent Nitrogen from Barnstable County Tracking System based on Maximum Effluent Data (Note: these are approximate ranges)

The Carmody System provides the ability to generate box-whisker diagrams using minimum and maximum total nitrogen sample data. These diagrams may be used to help evaluate a systems performance. Figure 14 depicts the diagram using the nitrogen data from the 449 BioMicrobics FAST systems installed on Cape Cod. The required effluent nitrogen range of 19 to 25 mg/l is stated on the right side of the diagram. It should be noted that some of the data falls outside the average effluent nitrogen range, which may be attributable to system downtime due to maintenance or fluctuations in water usage, nitrogen and BOD loading, temperature, and occupancy.

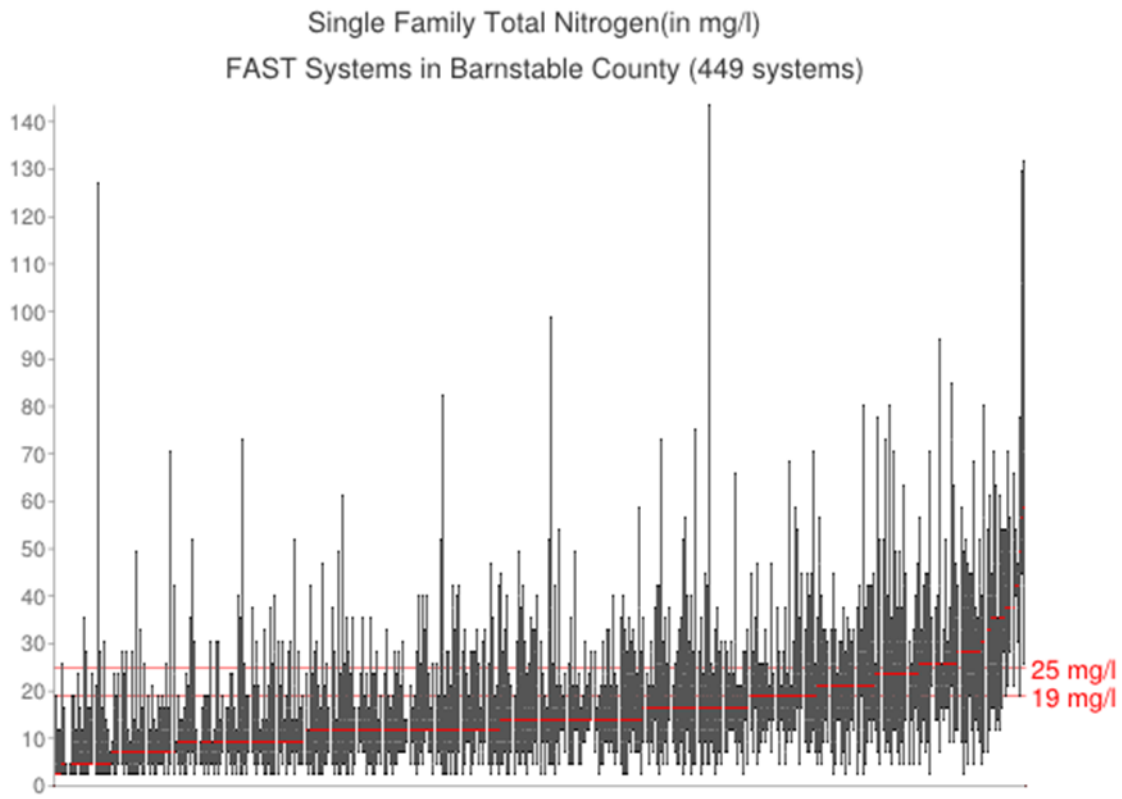

Figure 14: Barnstable County BioMicrobics FAST Total Nitrogen Effluent Data Graph

Section 10: Transfer of Development Rights

Transfer of development right (TDR) programs for each region were evaluated to determine if TDR's were integral to the control of nitrogen within each municipality. Maryland does not have a TDR program at the State level, but rather within the local county jurisdictions.

Rhode Island does not have a transfer of development right program, but permits upgrading of neighboring sanitary systems to nitrogen reducing technologies to permit the increase in dwelling bedrooms on a small lot. For example: The minimum lot size for a dwelling with 3-bedrooms is 20,000sf with a conventional system or 10,000sf with a nitrogen reducing system. Therefore, when proposing a 4-bedroom dwelling on a 10,000sf lot with a nitrogen reducing system then you may propose to upgrade a neighboring septic system to a nitrogen reducing system to obtain the 4th bedroom (Only 2 since 2008).

Property owners within the New Jersey Pinelands can sell credits from their property if it is within three designated sending areas. These credits then may be purchased by developers wishing to increase density in designated regional growth areas.

The Barnstable County Cape Cod Commission, as part of their regional policy plan, will evaluate the feasibility of a regional transfer of development rights program. The Cape Cod Commission has established areas where there can be no net increase in nitrogen loading. Like Rhode Island, for new construction requires the installation of an I/A nitrogen-reduction system on the subject parcel as well on a neighboring lot.

Section 11: Constructed Wetlands Wastewater Treatment Systems

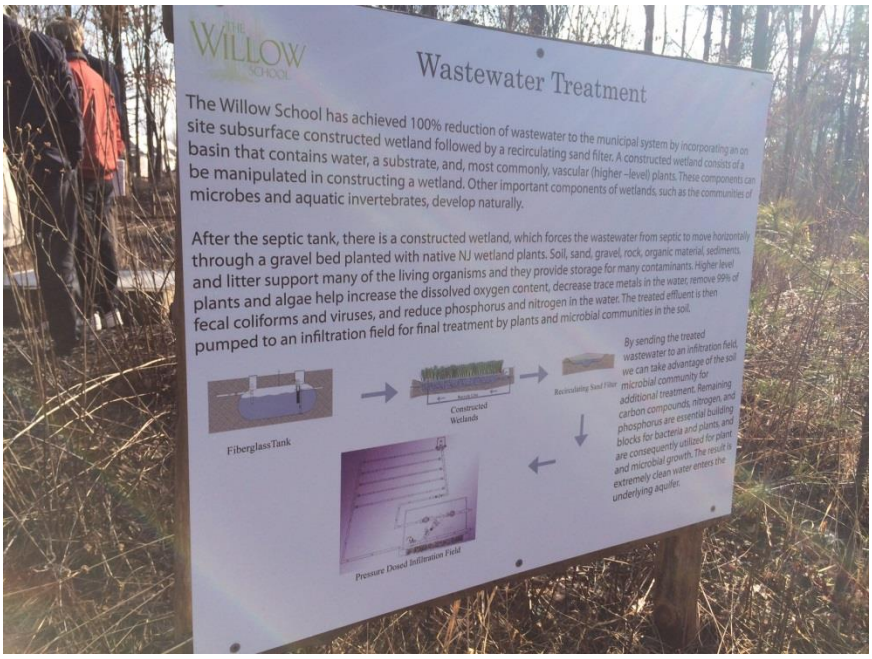

Figure 15: Willow Wood System Treatment Plan Sign and Description of Process Posted at Site

The group toured the vegetated recirculating gravel filter wastewater treatment system at the Willow School in Gladstone, NJ. Dave Smith, P.E., of Natural Systems Utilities, which installed the system, described how it is designed for a flow of 5,000 gpd to serve 216 students and faculty. The system measures approximately 45' x 90'. Flow is collected via sewer collection system and discharged into a septic tank (Figure 16). Flow from the septic tank enters a gravel bed planted with native NJ wetlands plants where nitrogen reduction results from recirculation (recirculation rate of approximately 5x flow, according to Smith). Soil, sand, gravel, rock, organic material, and sediments support many of the living organisms and store many contaminants. Higher level plants and algae help increase the dissolved oxygen, decrease trace metals in the water, remove 99% of fecal coliforms and viruses, and reduce phosphorus and nitrogen in the water. The treated effluent is sent to a recirculating sand filter for polishing then pumped to an infiltration field for final treatment by plants and microbial communities in the soil.

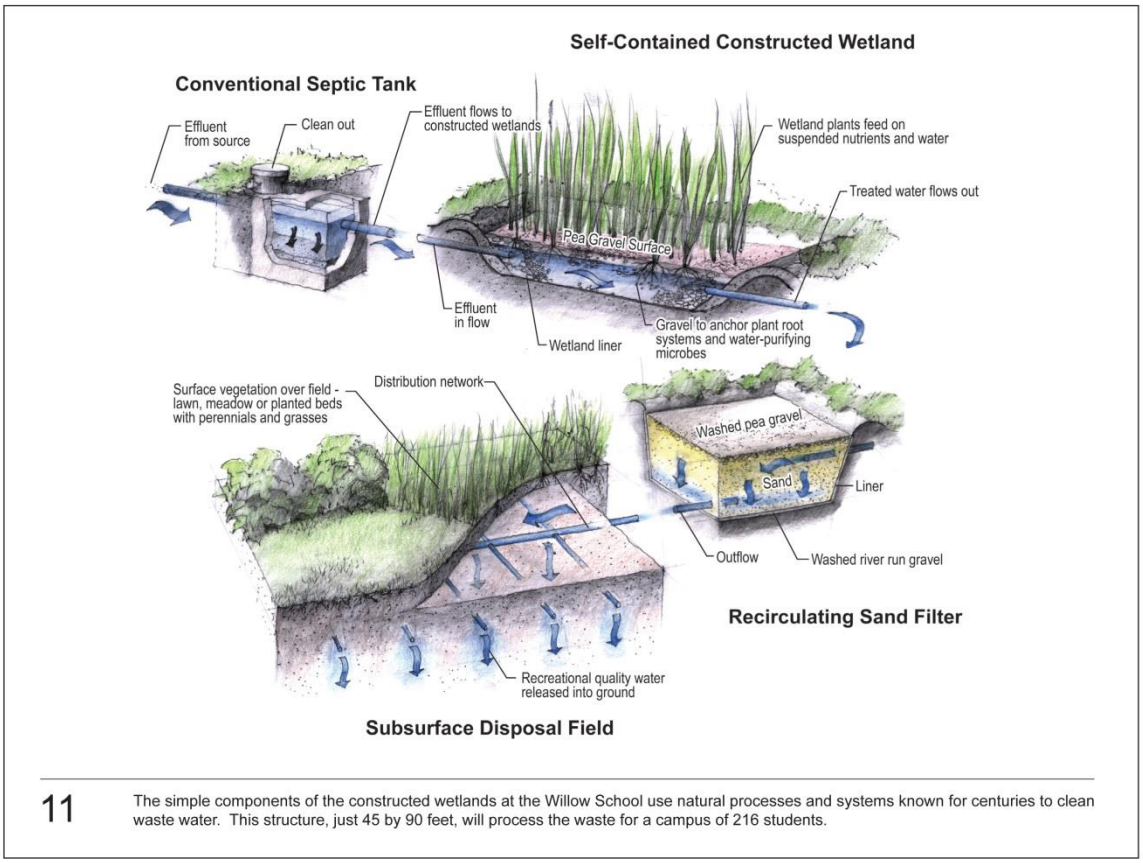

Figure 16: Diagram of Constructed Wetlands Treatment Unit Installed at the Willow School

Section 12: Suffolk County Policy Formulation/Plan for the future use of alternative onsite septic systems

Planning:

- Update master plan for the county covering issues of development and protection/improvement of water quality. Plan should be updated with information from water quality and wastewater studies
- Water quality study –develop a water quality baseline, set groundwater nitrogen limits, determine/update TMDL's for surface waters, and model % reduction of nitrogen in wastewater to meet goals on a sub-watershed level.
- Wastewater study - Based on water quality study goals, determine areas to be sewered, areas to utilize decentralized systems, areas to use nitrogen reduction onsite septics, and areas for conventional systems. Model impacts to justify areas, given that, according to one source, "97% of Suffolk County lies within an area in need of water protection."
- Subsequent to implementation, Suffolk County should perform follow-up to determine the efficacy of nitrogen reduction in the groundwater and surface waters.
- Demonstration Program - Suffolk County is currently in the process of issuing a Request for Expressions of Interest (RFEI) from manufactures.
    - Review technical data, such as NSF 245 certification reports, energy consumption data, maintenance requirements, from those manufacturers wishing to install systems in Suffolk County to determine eligibility.
    - Recruit suitable Suffolk residents for the right to install such systems with the proviso to install, test, and maintain systems over a three-year period.
    - Site selection should be prioritized based on (a) a failing system, (b) an existing block cesspool (c) an existing precast cesspool systems (d) a conventional system close to a public well or surface waters (e) all other types of sites.
    - Possible candidates installed in four jurisdictions visited are Bio Microbics FAST, Bioclere, Amphidrome, SeptiTech, AdvanTex AX20, and Singulair TNT. In addition, Busse GT and Bio Barrier should be also be evaluated for capacity to remove some pharmaceuticals.
    - Key system characteristics include efficacy, footprint, initial cost, O&M cost
- Review the use of non-proprietary systems as compared to proprietary systems in terms of engineering, design, liability, operation and maintenance, affordability, etc.
- Investigate and if applicable, promote the use of alternative leaching technologies as approved under NYS Appendix 75A and used in the jurisdictions visited. Such technologies are pressure dosing leaching systems, shallow narrow drain fields, etc.
- Develop a Responsible Management Entity (RME) and online tracking system
- In conjunction with SUNY Stony Brook University and/or URI, Suffolk may want to evaluate a training center similar to Rhode Island's to provide classes to local and out-of-state operators, installers, and design professionals. Classes, modelled on URI would

teach fundamentals of installation, maintenance, operation, sampling, monitoring, and design. This would be an avenue to licensing installers and operators testing non-proprietary solutions and new/other systems.

Financial:

- Investigate the use of NYS SRF fund to provide loans to homeowners for sanitary system upgrades
- Evaluate grant funds and tax incentives for sanitary system upgrades
- Ascertain construct of RME
- Develop cost/benefit case for alternative nitrogen reduction systems

Staffing:

- Determine the staffing requirements for septic upgrade program (SUP):
  - Permitting installations,
  - Inspections
  - Monitoring
  - Enforcement
  - Financing

Standards/laws:

- Evaluate enabling legislation and code for upgrades
- Consider certification of sanitary systems at time of property transfers
- Evaluate fee's akin to Maryland's BRF and assignment to tax water or sewer bills as well as grant funding.
- Consider tax credits for upgrades.
- Consider law requiring upgrades to cesspools
- Update the SC Sanitary Code Article 6 to provide powers to the SC Dept. Health to act in concert with a management district requiring tracking, piloting requirements, enforcement of O&M's, Update SC Dept. Health Services Office of Wastewater Management Residential and Commercial Standards to permit the use of alternative sanitary systems with construction standards such as setbacks, locations, nitrogen number as well as flow analysis. Evaluate locations that need a change in minimum lot size. Reexamine 'grandfathering' of systems and permitting requirements, depths to groundwater, etc.

Appendix A: Maryland Meeting Notes March 19, 2014 with Maryland Department of Environment (MDE) Onsite Systems Division

Attendees from Maryland:

Jay Prager, Deputy Program Manager Bay Restoration/On-site Disposal Systems

Barry Glotfelty

Brian Cooper

Craig Williams

From the Division's website the functions of the division are as follows:

> *"From the Onsite Systems Division provides technical assistance and direction to County Health Departments and Local Approving Authorities for the implementation of delegated programs for Onsite Sewage Disposal Systems (OSDS) and individual wells. This is of the utmost importance in carrying out our mission of protecting groundwater quality and public health.*
>
> *Some of the functions of the Onsite Systems Division are:*

1) *Co-review of OSDS equal to or greater than 5,000 gpd for compliance with the Large System Guidelines.*
2) *Provide guidance on the applicability and design of alternative and innovative systems*
3) *Provide guidance on the proper interpretation and enforcement of COMAR regulations 26.04.02, 26.04.03, 26.04.04 and 26.04.05, concerning onsite sewage disposal systems, subdivision of land, well construction and shared facilities*
4) *Provide guidance for site and soil evaluation, construction inspections, and enforcement issues, etc.*
5) *Certify Sand Mound Installers*
6) *Maintain a list of Individuals who have taken an approved course in the proper inspection of OSDS for property transfer*
7) *Well Construction"*[5]

The Chesapeake Bay watershed is composed of area from the states of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia and the area of the District of Columbia (Bay Watershed partners). The US Environmental Protection Agency (EPA) has established the Chesapeake Bay Total Maximum Daily Load (TMDL). TMDL sets pollution limits necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayment's. Specifically, the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year (25% reduction in nitrogen, 24% reduction in phosphorus and 20% reduction in

5 http://www.mde.state.md.us/programs/Water/BayRestorationFund/OnsiteDisposalSystems/Pages/OnsiteSystems.aspx

sediment). These pollution limits are further divided by jurisdiction and major river basin based on state-of-the-art modeling tools.[6]

Based on the established TMDL Maryland developed a Watershed Implementation Plan. The plan provides a strategy to reduce pollution from sources (wastewater, storm water, and septic systems) within different geographic areas to meet final target loads. The Watershed Implementation plan is composed of three phases. Phase I was completed on December 31, 2010 and provide a series of proposed strategies that will collectively meet a 2017 targeted TMDL (70% of the total nutrient and sediment reductions needed to meet final 2020 goals). Development of Phase II of the plan occurred in 2011 and provides a more defined series of proposed strategies that will collectively meet the 2017 targeted TMDL (60% of the total nutrient and sediment reductions needed to meet final 2025 goals). The development of Phase III of the plan is expected to start development in 2017.[7]

Maryland has approximately 420,000 on-site septic systems. These septic systems contribute approximately 5-9% of the nitrogen loading to the Chesapeake Bay watershed (25% nitrogen from STP and 36% nitrogen from agricultural). Approximately 90% onsite septic system users also have a private well for means of a water supply. 52,000 of these systems are located in the "Critical Area" land within 1,000 feet of tidal wetlands. Approximately 5,500 septic systems have been upgraded to nitrogen reducing Best Available Technology (BAT). There are approximately 2,000 installs of BAT systems a year with approximately 500-600 voluntary upgrades a year.

The Maryland Department of Environment provides grant funding to pay for the nitrogen reducing treatment system only (excludes leaching field and septic tank) through the Bay Restoration Fund. In order to fund the Bay Restoration Fund a fee is charged to sewered users and on-site septic system users. The fee for sewer users is $5.00 per month and is used to upgrade sewage treatment plants to meet an effluent of 3.0 mg/l nitrogen (Wastewater Treatment Plant Funds). The fee for onsite septic system users (Onsite Disposal Fund) is a $60 annual fee and used to upgrade existing on-site septic system users to a nitrogen reducing system or connect lots to sewers.

Installers of BAT systems must be certified by the State of Maryland and the vendor. Each installer is required to take a state course before being certified by the State. In order for the state to issue final approval of the installed system, both the vendor and installer must approve the system before it is backfilled to protect the state from accountability.

The Bay Restoration Fund fee (approved by Maryland State Senate bill 320) is added as a property tax or separate bill depending on municipality. For example if there is a water company then the surcharge is tagged onto the water bill as a separate line item. Each county are responsible for collecting the fees and submitting to the state comptroller. The comptroller then takes 0.5% for administrative costs, 60% dispersed to DEP to fund upgrades to sanitary systems, and 40% to Agriculture Water Quality Cost Share Program. The Agriculture Water Quality Cost Share Program provides farmers with grants to cover up to 87.5% of the cost to install conservation measures to prevent soil erosion manage nutrients and safeguard water quality. These funds are distributed to the local municipalities based on the number of septic systems weighted against the number of septic systems in the critical area.

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6 http://www.epa.gov/reg3wapd/pdf/pdf_chesbay/FinalBayTMDL/BayTMDLExecutiveSummaryFINAL122910_final.pdf

7 http://www.mde.state.md.us/programs/Water/TMDL/ChesapeakeBayTMDL/Pages/programs/waterprograms/tmdl/cb_tmdl/index.aspx

The Bay Restoration fund prioritizes onsite sewage disposal system (OSDS) upgrades as follows:

1. Failing OSDS or holding tanks in the Critical Areas (Critical area within 1,000ft from tidal areas)
2. Failing OSDS or holding tanks not in the Critical Areas
3. Non-failing OSDS in the Critical Areas including new BAT systems
4. Non-Failing OSDS outside the critical areas

Approximately 1,200 of the 2,000 BAT systems that are installed a year are 100% funded. In addition, grant funding can be used to pay for the full cost of the system (BAT system plus septic and leaching) for low income participates. In order for grant funds to pay for the BAT system, the homeowner must submit three (3) bids for review by DEM then after the completion of installation of the upgraded systems the payment is paid directly to the installer after a double sign-off by the State and the property owner is received (MD initially reimbursed the homeowner, but found that some homeowners were not installing the systems and keeping the grant money).

The Maryland Department of Environment has formed the BAT Verification Program used to select systems that are capable of meeting nitrogen requirements. A system must achieve either a 50% or higher reduction of Total nitrogen at the arithmetic mean and/or a treated effluent total nitrogen of 30 mg/L or less, based on an influent of at least 60 mg/L or influent to effluent comparison. The verification process is outlined in figures 17 and 18. Figure 17: Flow Chart of MD Dept. of Environment BAT Verification Process Page 1.

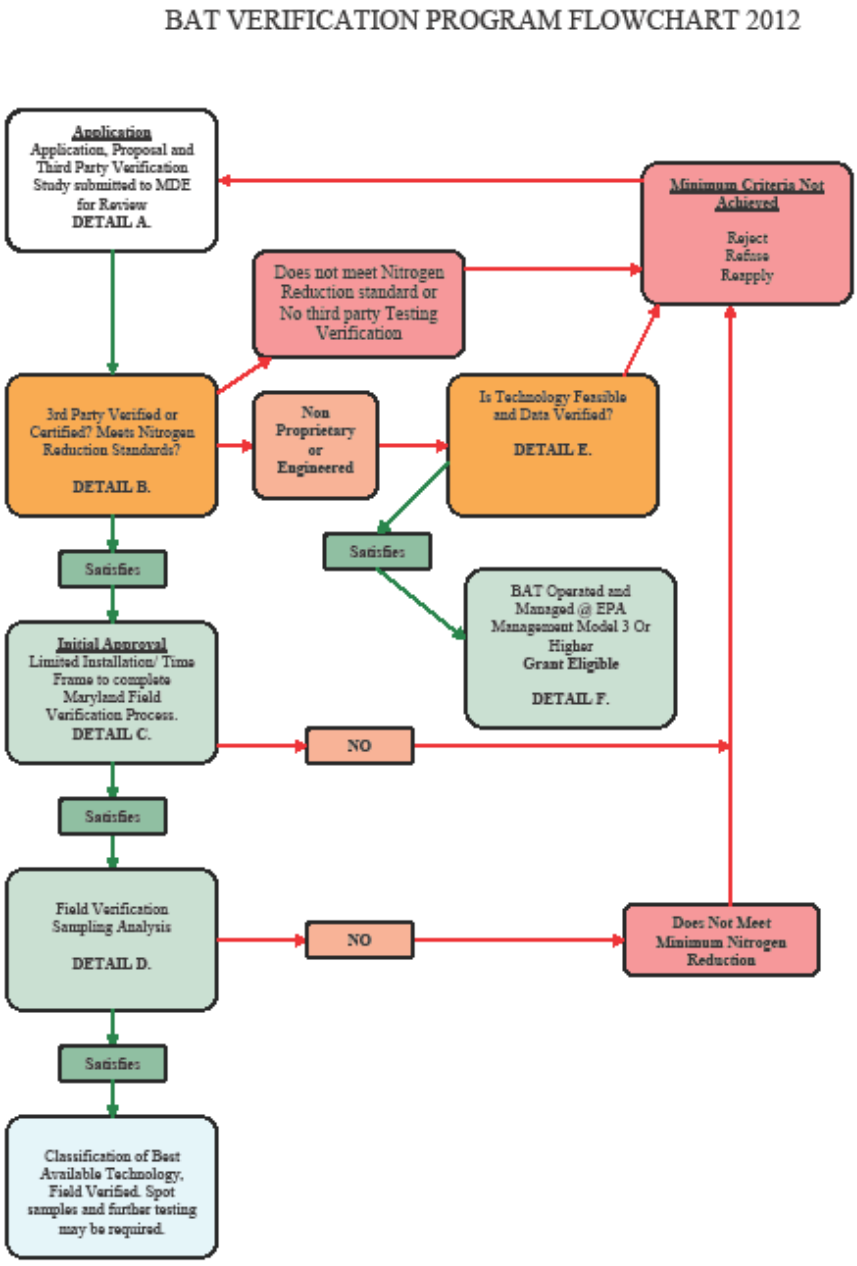


Figure 17: Flow Chart of MD Dept. of Environment BAT Verification Process Page 1

BEST AVAILABLE TECHNOLOGY (BAT)

VERIFICATION PROGRAM FLOWCHART DETAIL 2012

Detail A. Submit an application for BAT review to the Maryland Department of the Environment (MDE) including vendor contacts, general technology description, operating manuals and third party performance verification. NSF/ANSI 245-2010 is an example of a third-party testing standard for nutrient reduction residential wastewater treatment systems. The application is reviewed by the BAT Review Committee, which consists of 3 individuals with expertise and knowledge in nutrient reduction technologies. Any changes to the technology, throughout tenure of BAT classification, must first be presented to the BAT Review Committee for approval.

Detail B. The BAT Review Committee evaluates the third party evaluation/certification's test methods, independent performance evaluations and test results to verify the vendor's claim. The application must include average daily ambient temperature data. Daily average ambient air temperatures will be compared from the testing location for the duration of the testing to the Baltimore Region for the same time period. Not more than ten (10) sampling days in the test period should be greater then fifteen degrees (15°F) Fahrenheit warmer than that of the Maryland based comparison. If the results of the third party testing indicate the MDE nitrogen reduction standard can be met, the technology proceeds to Detail C and is approved as a provisional technology. If the results of the third party testing indicate the MDE nitrogen reduction standard cannot be met, the technology must re-apply. If the technology is individually engineered or deemed non-proprietary, proceed to detail E.

Detail C. Provisional technologies enter the Maryland Field Verification Process. The first twelve (12) installations, BRF funded or not, will be used in the initial analysis. Three (3) additional systems will be designated as reserve systems in the need of a replacement for one of the original twelve. MDE approval must be given prior to any changes. The vendor/applicant must submit a field verification plan that includes detailed instructions for collecting samples and a sampling schedule. All technologies must sample a minimum of 12 units 4 times each in consecutive quarters to include at least one quarter of winter time samples. Winter time is classified as December 15 through February 15 of a given season. Adequately trained sample collection personnel shall be provided by a certified laboratory and shall be independent of the technology vendor, technology vendor's authorized service provider and the system design engineer of record. The technology vendor is responsible for the training of the sampling laboratory personnel. All monitoring results must be reported to MDE and the local Approving Authority on an as sampled basis by the sampling organization. A service provider certified by the vendor and MDE shall be responsible for operating and maintaining the system. The review committee will analyze the sampling data on a quarterly basis. Should the arithmetic mean of the total nitrogen for the twelve systems in the verification program exceed 30 mg/L the technology will not be permitted to install any further systems for the duration of the field verification period. At the conclusion of the field verification period, the vendor/applicant shall submit to MDE final report that includes all monitoring information and a summary of all maintenance activities at the systems monitored.

Detail D. The BAT Review Committee is responsible for evaluating the final report submitted by the applicant/vendor at the conclusion of the field verification period. Forty eight (48) TN effluent data points per technology will be used in the analysis, no more or less will be considered unless previously approved by the review committee. The arithmetic mean of the effluent TN shall be equal to or less than 30 mg/l TN. If the nitrogen reduction standard has been met, the technology receives an unconditional approval. The Field Verification classification awards the Manufacturer to competitively market the BAT as a Field Verified Technology. Spot sampling may be required of technologies with unconditional approval. These spot samples may be used in an analysis for continuation of performance and viability of technology. Systems not meeting the nitrogen removal standard will either be rejected or remain in a modified field verification program. Any modified field verification program must be proposed by the vendor/applicant and approved by the BAT Review Committee. New installations of a technology will not be permitted while in a modified field verification program. The vendor must comply with all MDE and local regulations, policies and guidance.

Detail E. For non-proprietary technologies, the vendor/applicant must provide a detailed description of the technology process, which illustrates sound scientific fundamentals and engineering practice. Non-proprietary technologies which have undergone independent field verification through national demonstration projects, university research studies or other formal state verification programs may be approved as a highly managed system and enter Detail F. Technologies not demonstrated to meet the nitrogen removal standard are rejected.

Detail F. Highly managed systems must have renewable operating permits and/or a responsible management entity; or a combination of both. Plans must be submitted to and approved by the BAT Review Committee. Provisions must be made for sampling, reporting, maintenance and enforcement. Nitrogen reduction standards established for third party verified/certified systems must be met.

Figure 18: Flow Chart of MD Dept. of Environment BAT Verification Process Page 2

As of June 30, 2012 the technologies meeting the BAT verification include:

BAT Approved technologies	Cost of Purchase, installation and 5yr O&M	O&M Per Year After 5 year Contract
Orenco Advantex AX20	$12,300	$200
Orenco Adevantex AX20RT	$12,300	$200
Hoot BNR	$11,954	$150
Norweco Singulair TNT	$11,079	$90.88
Norweco Singulair Green	$11,079	$90.88
SeptiTech M400 denite	$13,056	$399
Bio-Microbics RetroFAST	$9,405	$300

Figure 19: Approved BAT, Cost of Install, and Yearly O&M Costs

The BAT technologies come with a 5 year Operation and Maintenance Contract. After the 5yr contract has expired properties owners must continue a yearly maintenance contract (O&M between $90 to $400 per year plus electric of $50 to $100 per year). All BAT technologies must be inspected at least once every year and the service provider must notify the local authority, MDE and the manufacturer of the service performed. The service record must be maintained by the service provider and available to MDE or approving authority upon request.

In addition to the cost of the BAT unit, the homeowner must pay for the leaching. In Maryland they use shallow drain fields which can cost approximately $7,000. Drain fields are required to provide a minimum of 4ft vertical separation to groundwater, but in certain cases the separation is reduced.

Currently MD does not require system to be certified when property is transferred. In addition they do not require anything to be recorded against the property notifying future property owners that a BAT system is installed.

The state does not have a transfer of development rights (TDR) program. TDR programs are within the local counties jurisdiction.

Appendix B: New Jersey Pinelands Commission Meeting Notes March 19, 2014

Representing the Commission: Edward Wengrowski, Environmental Technologies Coordinator

> "The New Jersey Pinelands Commission staff evaluates proposed unsewered development sites for their suitability for on-site wastewater systems based upon soil and groundwater conditions and for potential impacts from nitrogen releases. In addition, a number of advanced on-site treatment technologies are being tested in the Pinelands to determine their reliability in meeting groundwater quality standards. Further, the Commission is actively involved in assisting local governments throughout the Pinelands in the development of long-term institutional arrangements for the management of on-site wastewater systems."[8]

The New Jersey Pinelands is approximately 1 million acres and an estimated 22,000 onsite sanitary systems located in the Pinelands. Currently there are approximately 236 alternative onsite sewage disposals installed in the Pinelands. New Jersey requires sanitary systems with cesspools to be upgraded at the time of property transfers. As of 2012, New Jersey requires cesspools to be upgrade to a conventional onsite septic system.

The NJ Pinelands Commission does not offer any financing options for upgrades to existing sanitary systems. The New Jersey Environmental Infrastructure Financing Program can provide funding to replace failing systems provided the local governing body or utilities authority establish a septic management district for financing, planning and corrective measure costs. The New Jersey Pinelands Commission has contracted with Stone Environmental Inc. to assist local entities throughout the Pinelands Area, (towns, counties, etc.) in the development and implementation of long term programs for the management of septic systems.

In 2002, the Pinelands Comprehensive Management was amended to establish a Pilot Program for Alternative Design Wastewater Treatment System to reduce groundwater pollution form residential onsite septic systems. Based on the Pinelands Comprehensive Management Plan Pinelands Septic Dilution Model, the minimum residential lot size required in the NJ pinelands is 3.2 acres to provide 2.0 mg/l nitrogen at the property line. In order to build on smaller lots, to a minimum of 1 acre, and meet the 2.0mg/l in groundwater at the property line alternate nitrogen reducing technologies may be used. For a 1 acre lot to meet the 2 mg/l total nitrogen standard, these alternate nitrogen reducing technologies are expected to achieve the Pinelands Pilot Program effluent total nitrogen performance standard of 14 mg/l. A Committee was formed to perform a 2 year study to research and evaluate onsite treatment technologies capable of reducing nitrogen. Under the pilot program, five advanced treatment technologies were selected to participate in a 5 year Pilot Program to demonstrate their effectiveness at removing nitrogen from residential wastewater. The five systems were recommended by a consultant in a 2001 report titled "Performance Expectations for Selected On-Site Wastewater Treatment Systems" (prepared by Anish R. Jantrania, Ph.D., P.E., M.B.A.).

The requirements of the pilot program are as follows:[9]

1) Plans for the systems must be prepared by a NJ professional engineer and must be certified by the technology vendor's in-house engineer.

[8] http://www.state.nj.us/pinelands/landuse/waste/
[9] http://www.state.nj.us/pinelands/landuse/waste/assp/index.html

2) The NJ professional engineer preparing the plan and the vendor's engineer will have to conduct final inspections and certify the system.
3) The systems must be covered under a 5 year warranty to assure homeowners that equipment failures will be covered during warranty period without additional cost to the homeowner.
4) The systems will be covered under a renewable, non-cancelable operation and maintenance contract which requires the service provider (vendors indicate these will be licensed wastewater treatment system operators) to periodically visit the site to monitor system operation, make necessary process adjustments, and pump solids as required.
5) The effluent from the systems will be sampled on a quarterly basis for a minimum of three years and analyzed by a NJ certified laboratory for nitrogen parameters. The results of the effluent monitoring will be provided to the Pinelands Commission which will maintain a database on each of the systems. In the event that a technology is determined to consistently fail to meet nitrate nitrogen removal expectations, the technology would no longer be considered for new installations;
6) The Pinelands Commission will conduct homeowner, engineer, installer, and registered environmental health specialist outreach and training efforts to facilitate proper use, design, installation and maintenance of the systems;
7) No more than ten of the same manufacturer's alternate design wastewater treatment system may be installed in the same subdivided development, except by special approval of the Executive Director; and
8) The property owner upon which an alternate design wastewater treatment system is installed needs to record with the deed to the property a notice that identifies the technology, acknowledges the owner's responsibility to operate and maintain it, and grants access to the property for the purpose of system monitoring.

The Original five Pilot Program reducing wastewater systems studied in the 1st round were:

System Name	System Vendor	Treatment Process	Approx. Number Installed	Comments
Amphidrome	F.R. Mahony & Assoc	Fixed Film SBR	100	
Bioclere	Aqua Point Inc	Modified Trickling Filter	57	
Cromaglass	Cromaglass Corp	SBR	56	Recommend for Removal of Program 8/5/13
Fast	Bio-Microbics, Inc	Fixed Film Activated Sludge	23	
Ashco RFSIII	Ashco-A-Corp	Recirculating Sand Filter	n/a	Removed from program 12/3/07

Figure 20: Number of NJ Pinelands Commission Round 1 Pilot System Installed[10]

[10] NJ Pinelands Commission, (August 5, 2013), *Annual Report to the New Jersey Pinelands Commission Alternate Design Treatment Systems Pilot Program.*

New NSF 245 Nitrogen Reducing Wastewater Systems to be studied in the 2nd round of the Pilot Program are:

System Name	System Vendor	Treatment Process
Bio Barrier	Bio-Microbics, Inc	MBR
Busse GT	Busse Green Technologies	MBR
Hoot ANR	Hoot Systems, LLC	Extended Aeration/Activated Sludge
SeptiTech	SeptiTech, LLC	Fixed Film Trickling Filter

Figure 21: NJ Pinelands Commission Round 2 Pilot Systems[9]

Pilot Program Technology Costs

System	Ave. Treatment System Cost & 5yr Service Cost	Ave. Total Cost
Amiphidrome	$19,196	$31,492
Bioclere	$17,654	$31,866
Cromaglass	$22,345	$35,262
FAST	$17,819	$29,633
Bio Barrier	$15,000	N/A
Busse GT	$24,000	N/A
SeptiTech	$16,700	N/A
Hoot ANR	$14,500	N/A

Figure 22: Cost of NJ Pinelands Pilot Systems[9]

Sites that utilize an alternative onsite sewage disposal system are required to file a deed notice to notify future homeowners of the existence of the system. If a system is removed from the pilot program then the homeowner may convert their system to a conventional onsite sewage disposal system. In 2012 New Jersey Department of Environmental Protection new standards require local Health Departments to ensure O&M contracts are maintained. Systems must be maintained by a licensed operator to perform O&M.

Transfer of Development Rights within the New Jersey Pine Barrens Region permits property owners to obtain credits for their parcel if they are located in one of three Pineland sending areas. These credits may be purchase by developers wishing to increase density in designated regional growth areas.

<u>Appendix C:</u> Rhode Island Meeting Notes March 20, 2014 with New England Onsite Wastewater Treatment Center (NEOWT) at the University of Rhode Island and Rhode Island Department of Environmental Management (DEM)

Attendees from Rhode Island:

Brian Moore, Rhode Island DEM

George Loomis, NEOWT

David Kalen, NEOWT

Rhode Island DEM established Onsite Wastewater Treatment System Rules, which became effective July 9, 2012. The rules establishing minimum standards for the proper location, design, construction and maintenance of onsite wastewater treatment systems (OWTSs) used for the treatment and dispersal of wastewater. Rhode Island DEM issues all permits for onsite wastewater treatment systems. Rhode Island has approximately 150,000 onsite septic systems (15% of the septic systems are cesspools) installed. Between 30% and 50% of the onsite systems are cesspools.

In Rhode Island the Coastal Resources Management Council (CRMC) was authorized under the federal Coastal Zone Management Act of 1972 to develop and implement Special Area Management Plans (SAMPs) to address specific regional issues. These plans are ecosystem-based management strategies that are consistent with the council's legislative mandate to preserve and restore ecological systems. The CRMC coordinates with local municipalities, as well as government agencies and community organizations, to prepare the SAMPs and implement the management strategies. Based on the CRMC Special Area Management Plans for the South Shore Salt Ponds and Narrow River, all onsite septic systems located within these areas are require to be advanced septic system capable of nitrogen reduction (Standards for surface waters is 0.3 – 0.5 mg/L for TN and 14/100 m F coliform).

Failed onsite septic systems may be replaced with a conventional onsite septic system. In cases were the failed system is on very small lot, lot is in close proximity to wells and water bodies, or lots are subject to other constraints then a conventional onsite septic system may not be feasible and an alternative technology would be required. In addition under the Rhode Island septic system rules, cesspools within the CRMC Special Area Management Plans for the South Shore Salt Ponds and Narrow River have to be replaced with an advanced septic system that reduces nitrogen.

Only alternative technologies that have been approved and on Rhode Islands approved Alternative or Experimental Technology List are permitted to be installed. In addition, systems required to reduce nitrogen must reduce total nitrogen by 50% or to 19mg/l (takes approximately 100 days to develop process to reduce nitrogen in the system)). These systems are reviewed and approved by a nine member technical review committee composed of representatives of local government, the University of Rhode Island, CRMC, environmental organizations, and the private sector. Currently there are over 19,000 alternative and experimental OWTS installed in Rhode Island of which 5,809 have nitrogen reducing capabilities.

Nitrogen removing systems are classified as Alternative Class II systems in the DEM rules. In order to receive approval for a nitrogen reducing technology:[11]

- The applicant provides certification that the technology meets NSF/ANSI "Standard 245- Wastewater Treatment Systems- Nitrogen Reduction" and the testing results show a preponderance of treated effluent nitrogen concentrations of nineteen (19) mg/l or less; or
- demonstrates approval for use in another jurisdiction in an area where the temperature conditions are similar to or colder than those in Rhode Island and with technology review criteria substantially equivalent to Class One or Class Two summarized above and detailed in OWTS Rules 37.4.1 or 37.4.2 (A)-(B).

Class II certifications require renewal every five years.

The Following Systems are approved in Rhode Island for nitrogen removal:

1) AdvanTex AX20
2) AdvanTex AX100
3) AdvanTex AX-RT Series
4) Amphidrome
5) Bioclere
6) BioMicrobics Fast
7) Norweco Singulair TNT & Green TNT
8) SeptiTech M series

All installations of nitrogen reducing systems are required to come with 2 years of O&M and notice recorded into land evidence record to alert future property owners that the system exists. O&M contracts must be maintained after the 2 year period at an estimated cost of $250 to $400 per year. In addition, system maintenance and pumping is reported to jurisdictions via a web based system.

The Cesspool Phase-Out Act was passed in 2007 requiring all existing parcels utilizing cesspools to upgrade with a new onsite wastewater treatment system or connected to sewers system by 2014. The cesspool act affected areas where any cesspools located within 200ft of a water body or public/private drinking water well must be upgraded. DEM estimates the cost to upgrade to a conventional system to an ideal site to be$10,000 - $15,000 and $20,000 - $40,000 for a difficult site. In Comparison to cost to upgrade to an alternative system is $16,000 - $25,000 for an ideal site and $25,000 to $35,000 for a difficult site. For difficult sites, the cost to install an alternative system can be less expensive than the installation of a conventional system in some cases.

The Rhode Island Clean Water Finance Agency uses State Revolving Loan Fund to provide low interest loans to residential borrowers to upgrade/repair onsite sanitary systems provided the community has a state-approved wastewater management plan. Terms 2% for 10 years with a max loan of $25,000.

7 communities in Rhode Island have established a wastewater management plan, which requires mandatory inspection program. This permits the state to provide wastewater management planning grants to those communities. As part of wastewater management program, pumping records and point of sale ordinance can be considered in the plan.

[11] http://www.dem.ri.gov/programs/benviron/water/permits/isds/index.htm

Besides the Rhode Island Clean Water Finance Agency uses State Revolving Loan Fund other public funding options are available to homeowners:

Other sources of funding for Low to Middle class individuals:

- RIHMFC Home Equity Loans
- Home Equity Conversion Mortgage Loans for Senior Citizens
- CDBG Home Repair Program
- USDA Rural Development 504 Grants/Loans

Rhode Island does not have a transfer of development right program, but permits upgrading of neighboring sanitary systems to nitrogen reducing technologies to permit the increase in dwelling bedrooms on a small lot. For example: The minimum lot size for a dwelling with 3-bedrooms is 20,000sf with a conventional system or 10,000sf with a nitrogen reducing system. Therefore, when proposing a 4-bedroom dwelling on a 10,000sf lot with a nitrogen reducing system then you may propose to upgrade a neighboring septic system to a nitrogen reducing system to obtain the 4th bedroom (Only 2 since 2008).

Below is a description of the New England Onsite Wastewater Training Program (NEOWT) from their website:

"The New England Onsite Wastewater Training Program is located at the University of Rhode Island in Kingston, RI. The program offers classroom and field training experience for wastewater professionals, regulators, municipal and state officials, watershed groups, and homeowners. A primary component of the program is the Onsite Wastewater Training Center ("OWTC") located at the University's Peckham Farm. It is a demonstration and field training facility for both conventional and innovative and alternative septic system technologies. The OWTC is one of eight regional centers in the nation and has been in operation since 1993. It is operated in partnership with over 40 private sector contractors, the RI Department of Environmental Management, the USEPA and others. We have twenty-two full scale systems constructed above ground for hands-on learning at the OWTC. Additionally, there are over fifty demonstration and research systems installed in six Rhode Island communities. Monitoring data from these systems are currently being reviewed to help evaluate system performance."[12]

Rhode Island Onsite Wastewater Demo Projects, 1996 to 2005, was conducted by NEOWT and the knowledge gained from the project was transferred to DEM, which helped with policy/rule revisions. The demo project was a series of 5 demo projects in 7 communities. They installed 58 demo systems on sites with failed septic systems. Used lottery of failed systems, provided reduced costs to owner in return for 3 year access for education. The demo project obtained an agreement with homeowners for a 3 year period, which allowed staff to install, test, and maintain systems. Installation was donated by installers that wanted to understand how to install new technologies.

NEOWT provides training classes to installers, operators, design professionals, and governmental officials. The center conducts approximately 50 classes a year with registration fees varying from $120 to $225 per class. Classes are conducted on installation of septic systems, surveying, system inspections,

[12] http://www.uri.edu/ce/wq/OWT/index.htm

designing systems, and system operation. Systems installed at the test center for classes are installed above ground and operated with clean water.

Appendix D: Massachusetts Meeting Notes March 21, 2014 with Massachusetts Alternative Septic Test Center, Cape Cod Commission, and Community Septic Management Loan Program

Attendees from Massachusetts:

George Heufelder, *Massachusetts Alternative Septic Test Center*

Kendall Ayers, Community Septic Loan Management Loan Program

Approximately 85% of Barnstable County, MA residences utilize onsite sewage disposal systems as a means of wastewater treatment. There are approximately 123,000 onsite septic systems installed in the county. These systems contribute a significant amount of nitrogen load to their groundwater and surface water resources.

Barnstable County, Massachusetts developed the Cape Cod commission, which developed a regional policy plan that is updated every five years to protect the region's resources such as public/private drinking water heads and surface waters. The county spent approximately $12 million over 20 years to perform studies and identify nitrogen loading targets for embayments. In addition they mapped nitrogen removal to meet goals by sub sheds. Approximately 80% of the nitrogen loading to surface and groundwater resources on the cape originates from onsite sewage disposal systems. Nitrogen reducing systems that are required to be installed on Cape Cod must reduce nitrogen by 50% to 19- 25 mg/l.

Each town in the County has their own Boards of Health that regulate the use of wells and onsite septic systems. The towns have delegated the county the rights to track innovative alternative septic (I/A) systems.

There are currently approximately 1,600 I/A systems installed in the Cape and additional 1,600 I/A installed elsewhere in the State. Approximately 400 new advanced technology systems are installed in Barnstable County, MA. per year. Local towns are responsible for permitting septic systems and determine when an alternative system must be installed for new construction or upgrades (normally required to be installed in determined nitrogen sensitive areas). In Barnstable County flow per acre is limited to 440 gpd/ac. If the proposed wastewater flow exceeds 440gpd/ac then nitrogen reducing alternative systems can be installed. In addition, if the wastewater flow is over 2000gpd then nitrogen reducing alternative system must be installed.

Barnstable County, in 2005, implemented a tracking database designed by Carmody Data Systems to track the systems installed. All maintenance and sample results must be entered into the tracking system. The system can identify failure rates and pumping rates to determine if system is failing. In addition, MA requires a minimum of 2 years of O&M with the purchase of the I/A system provided by the vendor. After the 2 year O&M expires homeowners are required to extend O&M on a yearly basis. O&M must be performed by licensed operators (Class 2 operator), When alert is received on the Carmody system indicating an O&M has expired, the County calls the owner and sends letter notifying the homeowner. If a 2nd alert is received then a certified letter is sent and the homeowner may be

called into a hearing. Local Boards of Health can issue a fine of approximately $250 to homeowners if O&M contracts are not maintained. The system can be accessed at http://www.barnstablecountyhealth.org/ia-systems/information-center/data-and-statistics/ia-box-whisker-diagrams to view performance data of the systems installed.

Massachusetts Energy and Environmental Affairs Department approves the types of alternative systems allowed to be installed in the state and outlines the piloting requirements for nitrogen reducing onsite septic systems in there "Title 5" section 15.285 and 15.286.

From their website:[13]

> *"Piloting: Piloting involves the installation, field testing, and technical evaluation to demonstrate that the technology can function effectively under the physical and climatological conditions at the pilot sites and provide environmental protection equivalent to a conventional Title 5 system. Click here for approval letters for technologies approved for piloting.*
>
> *•MassDEP will accept technologies for piloting when available data on the technology shows that it is likely to be able to provide a level of environmental protection at least equivalent to a conventional Title 5 system.*
>
> *•Piloting of a particular I/A technology may be conducted either for new construction or in remedial situations. Up to 15 sites per technology may be piloted.*
>
> *•Piloting must be done for at least 18 months and result in a full technical reporting of results. Piloting generally is not intended to address long-term operation and maintenance, although the information gathered during piloting should be used to understand these issues.*
>
> *•When a technology completes pilot testing, MassDEP can allow the technology to proceed to the Provisional Use Approval stage, require additional piloting, or disapprove the system. Piloting is considered successful if at least 75% of the pilot sites performed at the expected level of treatment for at least 12 months.*
>
> *•Piloting systems that meet performance goals are allowed to remain in place long-term. For piloting systems that exhibit problems, adjustments to system design and operation are necessary. In extreme circumstances, the piloting system may need to be replaced. To date, no piloting system has had to be replaced.*
>
> *Provisional Use: Provisional Use Approvals are intended to evaluate whether an I/A technology can provide environmental protection at least equivalent to a conventional system under actual field conditions in Massachusetts and with a broader range of uses than in the controlled environment of piloting. Click here for approval letters for technologies approved for provisional use.*

[13] http://www.mass.gov/eea/agencies/massdep/water/wastewater/massdeps-technology-approval-process-for-ia-systems.html

•Provisional Use Approval typically occurs after a technology has been piloted successfully or has been proved satisfactory past performance over at least two years of general usage in one or more states outside Massachusetts. A system approved for Provisional Use can be installed in remedial situations or for new construction where a system in compliance with Title 5 could be built.

•Under Provisional Use Approval, a minimum of 50 systems must be installed and evaluated for at least three years.

•The Provisional Use Approval stage evaluates operation, maintenance, and monitoring issues, and MassDEP uses the data to set final discharge standards and other conditions for General Use.

•Provisional Use is considered successful if at least 90% of the installations have demonstrated over three year's performance at least equivalent to a conventional Title 5 system.

Certification for General Use: When an I/A technology has successfully completed the Provisional Use stage, it receives Certification for General Use. I/A systems certified for General Use can be installed at any site where a conventional Title 5 system can be installed. Additional monitoring and reporting is generally not required, although MassDEP has the option of requiring monitoring as part of its Certification.

MassDEP can determine that a technology certified for General Use may be used for new construction on lots that do not meet all of the requirements of Title 5 for installation of a conventional septic system. However, as of December 2003, no I/A technology has yet been certified for General Use for new construction on a lot that does not meet the required percolation rates, that does not have at least four feet of naturally occurring soil, or does not have the necessary separation from high groundwater."

Currently there are only three (3) nitrogen reducing systems with a general use permit. Figure 23 lists the systems that are currently in use for nitrogen removal and in different stages of pilot program.

Amphidrome	Norweco Singulair Green
Bioclere	Orenco AdvanTex AX100
BioMicrobics Fast	Orenco AdvanTex AX-RT
BioMicrobics MicroFAST	RUCK
BioMicrobics Bio Barrier	Waterloo Biofilter
SeptiTech	Recirculating Sand Filters
Norweco Singulair TNT	Nitrex

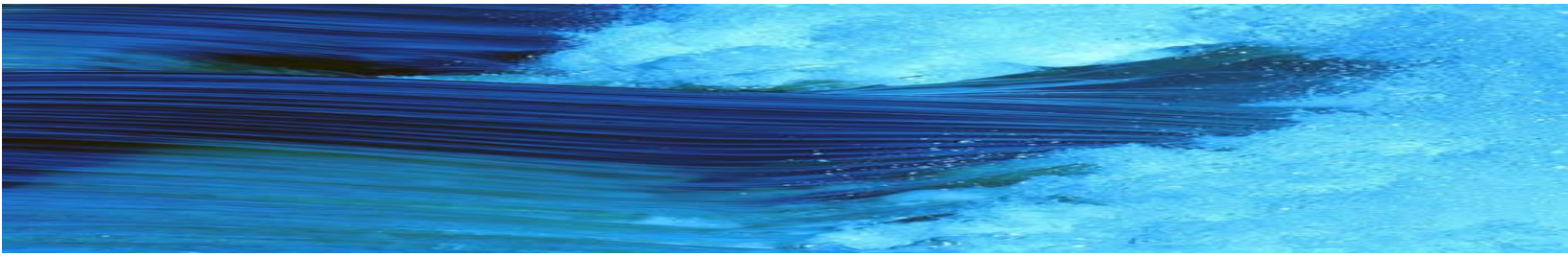
Figure 23: Nitrogen removing systems permitted to be installed under Title 5 pilot requirements

Barnstable Community Loan Program loans homeowner money to upgrade their sanitary system in the event of a system failure. The County borrows money from the state revolving loan fund at a 0% interest rate. Barnstable County then issues a loan to the borrower at 5% for up to20 years. If a composting toilet is proposed then the borrower can borrow the money at 0% to install the system. The borrower

makes payments monthly or quarterly to Barnstable County. A single-party check issued to contractor for work completed. A benefit assessment is placed against the property to ensure the payment of the loan (approximately 400 loans have been issued to date).

In addition to the loans, the State of Massachusetts offers a tax credit for 40% of the septic system cost up to $6000, which is spread over 4 years at $1500 per year.

The Barnstable County Department of Health Massachusetts Alternative Septic Systems Test Center is operated by George Heufelder. The test center went into operation in 1999 testing advanced onsite septic systems capable of reducing pollutants in wastewater, which include nitrogen reducing technologies. Companies pay to have the center test their systems to certify that the system meet one of four accepted certifications as follows: (1) National Sanitation Foundation (NSF) NSF 245 standards, (2) U.S. Environmental Protection Agency (EPA) Environmental Technology Initiative (ETI), (3) National Sanitation Foundation (NSF) Environmental Technology Verification (ETV), National Sanitation Foundation (NSF) NSF 40 standards. In addition to certification test, the center performs other various research projects.



Appendix K

Key Performance Indicators

(Under Development)

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